# INFRASTRUCTURE REQUIREMENTS
# FOR AN
# EXPANDED FUEL ETHANOL INDUSTRY

**Downstream Alternatives Inc.**

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**Phase II Project Deliverable Report**

**Oak Ridge National Laboratory**
**Ethanol Project**

**Subcontract No. 4500010570**

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## DISCLAIMER

# INFRASTRUCTURE REQUIREMENTS FOR AN EXPANDED FUEL ETHANOL INDUSTRY

## TABLE OF CONTENTS

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## TABLES

## FIGURES

## APPENDICES



NOTE: Appendix J not included for general distribution

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# Executive Summary

## Executive Summary

The U.S. Department of Energy's (DOE) Office of Transportation Technologies (OTT) through its Office of Fuels Development (OFD) is responsible for major planning and analysis to ensure consistency of various program objectives with the Energy Policy Act (EPACT). Oak Ridge National Laboratory (ORNL) is supporting OFD in its analysis of current and future ethanol demand for the transportation fuels market.

The DOE is interested in the logistics of, and any constraints associated with, ethanol industry expansion because it is engaged in research and development work on cellulosic ethanol development. Understanding the infrastructure development necessary for an expanded ethanol industry is an important part of this work.

Downstream Alternatives, Inc. (DAI) was retained to provide technical expertise specifically related to ethanol transportation, distribution, and marketing issues.

Phase II of DAI's work required analysis of the infrastructure requirements for an expanded ethanol industry. This report is the project deliverable for the Phase II assignment. Two cases of expanded ethanol production are studied as discussed below.

Four study cases were originally considered. They were entitled Cases A, B, B1, and C. From those, two study cases were selected for this work. The first case (Case B1) was based on ethanol production of 5.1 billion gallons per year (bgy). The second case (Case C) was based on 10.0 billion gallons of annual production. These cases were selected because Case B1 equates roughly to the 2010 ethanol demand envisioned to result from some legislative proposals for a Renewable Fuels Standard being considered at the inception of this work. However, this study is not associated with any particular time line or year. Selection of the higher volume Study Case C for analysis was to see if efficiencies of scale would materialize, to determine if pipeline shipments of ethanol could result, and to identify any constraining infrastructure barriers.

The base assumptions for production by PADD, amounts imported and exported among PADDs, and the amount of ethanol used in each PADD were developed by Technology and Management Services Inc. (TMS). These base assumptions also included estimates for feedstocks used (i.e., grain or

cellulosic feedstock). The study cases are not intended to be actual forecasts of ethanol production and consumption and are not associated with any particular future year. They are intended only to represent plausible scenarios for an expanded ethanol industry at some future time. The scenarios are based on Bioethanol Program estimates of key parameters, such as estimates of future demand for ethanol and R&D successes in the production of ethanol from cellulosic feedstocks, that were current at the initiation of DAI's Phase II work. The base assumptions for each case are provided in Tables ES-1 and ES-2.

**Table ES-1 Ethanol Production, Exports, Imports & Use by PADD - 5.1 BGY (Case B1) (BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 0.2 | 0.2 | | 1.1 | 1.3 |
| 2 | 4.0 | 0.5 | 4.5 | 2.3 | | 2.2 |
| 3 | | 0.2 | 0.2 | | 0.5 | 0.7 |
| 4 | | | 0.0 | | 0.1 | 0.1 |
| 5 | | 0.2 | 0.2 | | 0.6 | 0.8 |
| | 4.0 | 1.1 | 5.1 | 2.3 | 2.3 | 5.1 |

**Table ES-2 Ethanol Production, Exports, Imports & Use by PADD - 10.0 BGY (Case C) (BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 1.4 | 1.4 | | 1.3 | 2.7 |
| 2 | 4.5 | 2.1 | 6.6 | 2.9 | | 3.7 |
| 3 | | 1.1 | 1.1 | | 0.7 | 1.8 |
| 4 | | 0.4 | 0.4 | | | 0.4 |
| 5 | | 0.5 | 0.5 | | 0.9 | 1.4 |
| | 4.5 | 5.5 | 10.0 | 2.9 | 2.9 | 10.0 |

The base year used for retail ethanol markets was 1999 because information on ethanol volume use by state was available for that calendar year. Total ethanol volume, for use in gasoline ethanol blends in 1999, was 1.29 bgy. Using this as a starting point, increased ethanol volume, used in E-10/E-5.7 blends, is 2.987 bgy in Case B1 and Case C adds another 4.5 bgy for E-10/E-5.7 use, representing a total incremental ethanol volume of 7.487 bgy compared to the 1999 starting point. The incremental increase, for use of ethanol in E-10/E-5.7, in both Study Cases is broken down by PADD in the following table.

**Table ES-3 Incremental Increase For Use Of Ethanol In E-10/E-5.7**

| PADD | New Ethanol Volume For Use in E-10/E-5.7 (bgy) | | |
|---|---|---|---|
| | B1 | B | B1 + C |
| I | 1.102 | 1.200 | 2.302 |
| II | 1.072 | 1.300 | 2.372 |
| III | 0.626 | 1.100 | 1.726 |
| IV | 0.042 | 0.300 | 0.342 |
| V | 0.145 | 0.600 | 0.745 |
| Total | 2.987 | 4.500 | 7.487 |

Both Study Case B1 and C also assumed that E-85 use would increase in PADDs I and II, to assess potential costs of such an expansion. New ethanol volume use in E-85 for Case B1 was 0.1 bgy in PADD I and 0.2 bgy in PADD II. In Study Case C, ethanol use in E-85 was increased by 0.2 bgy in both PADDs, bringing the total ethanol used in E-85 to 0.3 in PADD I and 0.4 bgy in PADD II.

Achieving the production and use levels for the Study Cases selected is obviously dependent upon how various technical, logistic, and public policy issues are addressed by the ethanol and petroleum industries, as well as the federal government. However, the purpose of this study was to assess infrastructure demands and to identify any infrastructure constraints under the assumption that the Study Case volumes would be achieved.

Each Study Case was started by first selecting potential areas for plant placement, considering feedstock availability, compared to the feedstock requirements, of the TMS scenarios. Existing plants and plants under construction at the time the study was started were also used.

Once plant location information was developed, calculations were made to determine how much ethanol could be used in major markets within each PADD. This included use of E-10 blends in all PADDs (E-5.7 blends in California). The study also assessed the requirements for expanded use of E-85 in PADDs I and II.

Next, the servicing terminals for the market areas were identified and assessed. Estimates were made of various required improvements that would be needed. This included the need for additional tankage (consisting of both new tankage and modifications to existing tankage), installation of blending systems at all new ethanol terminals, and installation of rail spurs at a sufficient number of terminals to handle projected rail tank car volume. An assessment was also made of the number of retail installations required to handle specified volumes of E-85 in PADDs I and II. In the case of E-10 blends, an assessment was made of the number of retail facilities that would need to be converted to handle specified volumes. An estimate of required investment for each equipment category was made. Total estimated costs, and amortized costs, were calculated for each PADD for both Study Cases.

Transportation requirements and costs were also estimated. This was done by determining the most logical destination for the ethanol production for each plant and the most likely mode of shipment. In both Study Cases, all ethanol is used in the PADD where it is produced, except in PADD II, which also exports significant volumes to the other PADDs. The assessment included ethanol shipped from plants directly to terminals as well as ethanol exported from PADD II to the other PADDs. In some cases ethanol would be shipped to "hub terminals" by rail, barge, or ship, and then redistributed by truck to other nearby terminals . The assessment also included these product movements.

Estimates were made of the transportation equipment currently in use and the additional transportation equipment that would be required in each Study Case. The total and amortized costs of any additional equipment were also estimated.

Composite freight rates for each PADD were developed based on the ethanol volume shipped and its origin and destination points. Total freight costs were then calculated for both study cases.

Based on various observations made during the course of the work, certain recommendations are also provided.

Finally, chapter six of this report contains a comparative summary of Study Cases B1 and C.

Ethanol Plants/Production Levels: In Study Case B1 the ethanol production level is achieved by 125 plants producing 5.1 bgy. In Case C the number of plants increases to 241 with a total production capacity of 10.0 bgy.

Ethanol Use in E-10/E-5.7: New ethanol volume for use of E-10 and E-5.7 (in the case of California) totals 2.987 bgy in Case B1. An additional 4.5 bgy of ethanol is used for these blends in Case C. Total ethanol volume for use in E-10/E-5.7 then is 4.8 bgy in Study Case B1 and 9.3 bgy in Study Case C. The following maps depict ethanol plant locations and key ethanol markets.

**Figure ES-1 Study Case B1 Ethanol Plant Locations and Key Ethanol Markets,**

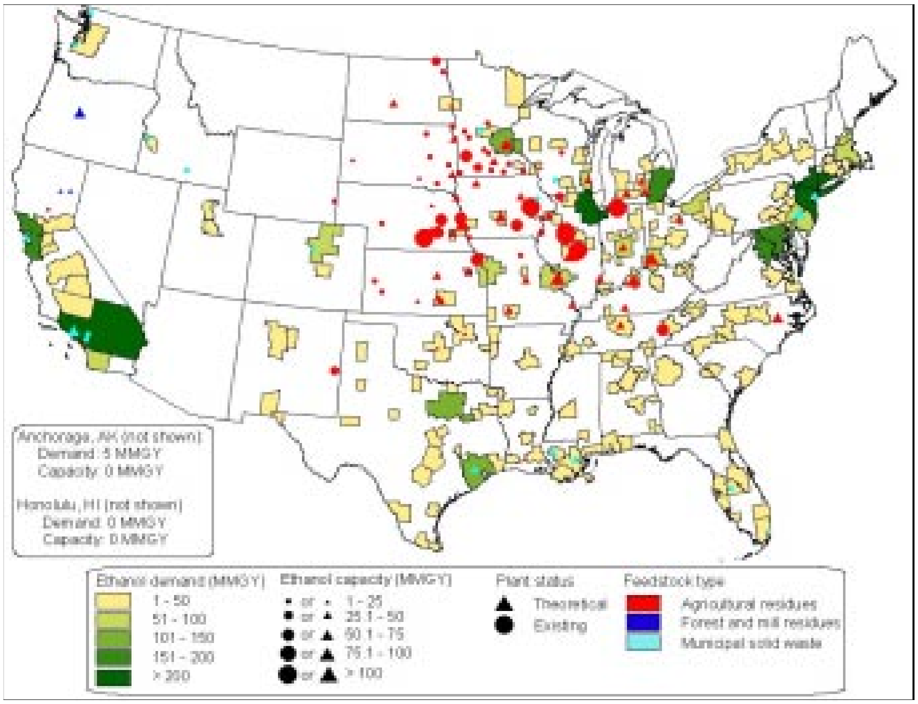


Figure ES-1. Ethanol plant location and size (existing and theoretical) and ethanol demand by metropolitan area in million gallons per year (MMGY) – Scenario B1

**Figure ES-2 Study Case C Ethanol Plant Locations and Key Ethanol Markets**

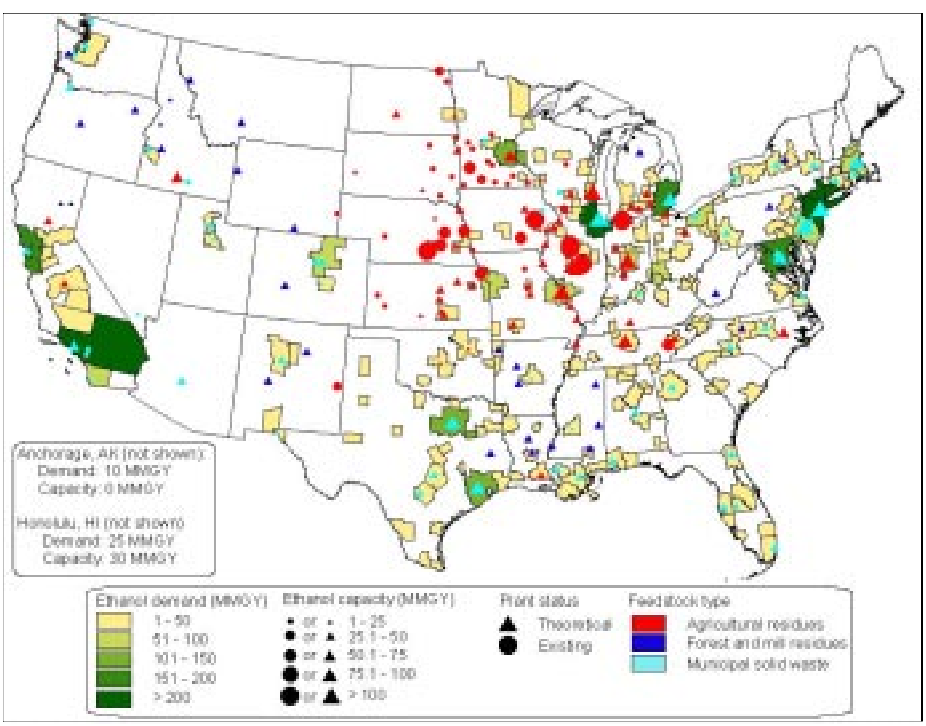


Figure ES-2. Ethanol plant location and size (existing and theoretical) and ethanol demand by metropolitan area in million gallons per year (MMGY) – Scenario C

Ethanol Use in E-85: Total use of ethanol in E-85 blends was assumed to be 0.3 bgy in Study Case B1 and 0.7 bgy in study Case C.

New Tanks Required: For Study Case B1 it was estimated that 181 terminals would need to add new ethanol tanks with a total capacity of 1,579,000 barrels. An additional 298 tanks totaling 2,836,000 barrels of capacity would need to be added in Study Case C. For the combined Study Cases, this represents the addition of 479 tanks totaling 4,415,000 barrels of capacity.

Tank Conversions Required: In addition to new tanks, conversion of some existing tankage would be necessary. In Study Case B1 an estimated 63 tanks, totaling 471,000 barrels of capacity, would be converted to ethanol use. In Study Case C an additional 44 tanks totaling 295,000 barrels of capacity, would be converted. For the combined Study Cases, this represents 107 tank conversions totaling 766,000 barrels of capacity.

Rail Spur Installations Required: In order to handle receipt of ethanol by rail tank car, a number of terminals would need to install rail spurs. An estimated total of 49 terminals would need to add rail spurs in Study Case B1, and an additional 27 terminals would need to add rail spurs in Study Case C, bringing the total rail spurs added to 76.

Blending Systems: It was assumed that all terminals converting to ethanol distribution, for the first time, would need to install new blending systems. In Study Case B1 287 terminals would need to add blending equipment, while in Study Case C an additional 379 terminals would need to add blending systems. For the combined Study Cases, a total of 666 terminals require new blending systems.

Miscellaneous Costs: Terminals converting to ethanol for the first time might have other minor miscellaneous expenses that are not included in equipment cost estimates. In this study we assume such costs to be $20,000 per terminal. An estimated 244 terminals would have such expenses in Study Case B1 and another 342 in Study Case C, bringing the combined total to 586 such terminals.

Operating Ethanol Terminals: Once terminal modifications are made there would be an estimated total of 495 terminals offering ethanol in Study Case B1, representing 58.6% of operating terminals in the designated market areas.. Of these, an estimated 126 could receive product by water (barge, ocean barge, or ship) and 130 could receive product by rail. In Study Case C, an estimated 908 terminals, 85.4% of operating terminals in the designated market areas, would handle ethanol, of which 177 could receive product by water and 181 by rail. Tables ES-4 and ES-5 provide a terminal profile for each study case, including the number of terminals with ethanol in each PADD and those with water and rail receipt capabilities.

**Table ES-4 Profile of Ethanol Terminaling Capabilities After Case B1 Conversions**

| PADD | Number of terminals with ethanol | Estimated number of water capable ethanol terminals | Estimated number of rail capable ethanol terminals |
|---|---|---|---|
| I | 96 of 261 | 44 | 42 |
| II | 228 of 311 | 40 | 37 |
| III | 87 of 158 | 32 | 27 |
| IV | 11 of 19 | 0 | 7 |
| V | 73 of 95 | 10 | 17 |
| Totals | 495 of 844 (58.6%) | 126 | 130 |

**Table ES-5 Profile of Ethanol Terminaling Capabilities After Case C Conversions**

| PADD | Number of terminals with ethanol | Estimated number of water capable ethanol terminals | Estimated number of rail capable ethanol terminals |
|---|---|---|---|
| I | 201 of 288 | 90 | 44 |
| II | 368 of 401 | 40 | 61 |
| III | 183 of 191 | 32 | 41 |
| IV | 39 of 40 | 0 | 11 |
| V | 117 of 143 | 15 | 24 |
| Totals | 908 of 1063 (85.4%) | 177 | 181 |

Retail Outlet Conversion E-10/E-5.7: When stations are converted to gasoline ethanol blends for the first time, certain preparatory steps must be taken and there are costs associated with such preparations. Consequently, an estimate of the number of retail facilities to be converted is necessary. In Study Case B1, an estimated 35,214 facilities would need to be converted to gasoline ethanol blends. An additional 61,528 facilities would need to be converted in Study Case C. With existing retail facilities offering gasoline ethanol blends estimated at 22,916, this would bring the total of retail operations offering these blends to 119,658, after Study Case C conversions. Table ES-5 provides a breakdown, of retail units by PADD, for each of the Study Cases.

**Table ES-6 Estimated Retail Unit Conversions**

| PADD | Existing | Conversions Case B1 | Conversions Case C1 | Total Facilities |
|---|---|---|---|---|
| I | 980 | 11,020 | 12,000 | 24,000 |
| II | 10,919 | 12,611 | 20,470 | 44,000 |
| III | 1,058 | 8,942 | 20,000 | 30,000 |
| IV | 725 | 525 | 3,750 | 5000 |
| V | 9,234* | 2,116 | 5,308 | 16,658 |
| Total | 22,916 | 35,214 | 61,528 | 119,658 |

* Includes California facilities to be converted by 2003

E-85 Installations: A small percentage of retail facilities may be able to convert existing tankage to E-85. Most will require a new underground tank, a dispenser, and attendant piping and electrical. A total of 2,556 E-85 equipment installations (new and converted) were required for Study Case B1. An additional 2,462 such facilities would be needed in Study Case C, bringing the total of new E-85 facilities to 5,018 for the combined Study Cases.

Terminal and Retail Investment for E-10/E-5.7: The above mentioned equipment investments and retail conversions total an estimated $153,575,260 in Study Case B1 and $207,352,110 in Study Case C. The two cases combined represent a total investment of $360,927,370 for the terminal and retail level investment.

Terminal and Retail Investments Amortized: When amortized across the equipment life cycle, on a per gallon of new ethanol volume basis, these investments represent $0.008 per gallon for Study Case B1 and $0.0072 per gallon for Study Case C†. The average amortized cost across both Study Cases is $0.0075 per gallon. Of course, these amortized costs would be one-tenth that amount if calculated on a per blended gallon basis. For the combined Study Cases, this would yield an amortized cost per blended gallon ranging from a low of $0.00052 per gallon in PADD V to a high of $0.00083 per gallon for PADD III. Table ES-7 recaps terminal investments, and E-10/E-5.7 retail conversion expenses, for each Study Case, and provides a comparative amortized cost on a dollars per gallon of new ethanol volume basis.

*† Amortization calculations are based on a 10% after tax ROI using a 34% tax rate and in constant dollar costs. See Appendix E.*

**Table ES-7 Case B1 + Case C - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7**

| | New ethanol Volume (bgy) | Cost of New Tanks | Cost of Tank Conversion | Cost of Blending Systems | Modification for Rail Receipt | Contingency | Retail Conversions | Total | Amortized Cost per Gallon |
|---|---|---|---|---|---|---|---|---|---|
| **PADD I** | | | | | | | | | |
| Case B1 | 1.102 | $8,850,000 | $645,000 | $24,300,000 | $7,100,000 | $1,260,000 | $6,501,800 | $48,656,800 | $0.0069 |
| Case C | 1.200 | $15,115,000 | $180,000 | $30,300,000 | $710,000 | $1,880,000 | $7,080,000 | $55,265,000 | $0.0072 |
| I Total | 2.302 | $23,965,000 | $825,000 | $54,600,000 | $7,810,000 | $3,140,000 | $13,581,800 | $103,921,800 | $0.0070 |
| **PADD II** | | | | | | | | | |
| Case B1 | 1.072 | $5,395,000 | $309,000 | $33,000,000 | $5,325,000 | $2,020,000 | $7,440,490 | $53,489,490 | $0.0078 |
| Case C | 1.300 | $9,950,000 | $375,000 | $35,700,000 | $3,550,000 | $2,140,000 | $12,077,890 | $63,792,890 | $0.0077 |
| II Total | 2.372 | $15,345,000 | $684,000 | $68,700,000 | $8,875,000 | $4,160,000 | $19,518,380 | $117,282,380 | $0.0077 |
| **PADD III** | | | | | | | | | |
| Case B1 | 0.626 | $5,735,000 | $340,000 | $22,200,000 | $3,550,000 | $1,240,000 | $5,275,780 | $38,340,780 | $0.0096 |
| Case C | 1.100 | $8,600,000 | $125,000 | $27,300,000 | $3,550,000 | $1,660,000 | $11,800,000 | $53,035,000 | $0.0075 |
| III Total | 1.726 | $14,335,000 | $465,000 | $49,500,000 | $7,100,000 | $2,900,000 | $17,075,780 | $91,375,780 | $0.0083 |
| **PADD IV** | | | | | | | | | |
| Case B1 | 0.042 | $750,000 | $20,000 | $2,400,000 | $1,065,000 | $120,000 | $309,750 | $4,664,750 | $0.0173 |
| Case C | 0.300 | $1,250,000 | $110,000 | $7,800,000 | $710,000 | $400,000 | $2,212,500 | $12,482,500 | $0.0065 |
| IV Total | 0.342 | $2,000,000 | $130,000 | $10,200,000 | $1,775,000 | $520,000 | $2,522,250 | $17,147,250 | $0.0078 |
| **PADD V** | | | | | | | | | |
| Case B1 | 0.145 | $2,325,000 | $55,000 | $4,200,000 | $355,000 | $240,000 | $1,248,440 | $8,423,440 | $0.0091 |
| Case C | 0.600 | $5,130,000 | $90,000 | $12,600,000 | $1,065,000 | $760,000 | $3,131,720 | $22,776,720 | $0.0059 |
| V Total | 0.745 | $7,455,000 | $145,000 | $16,800,000 | $1,420,000 | $1,000,000 | $4,380,160 | $31,200,160 | $0.0065 |
| **TOTAL B1** | 2.987 | $23,055,000 | $1,369,000 | $86,100,000 | $17,395,000 | $4,880,000 | $20,776,260 | $153,575,260 | $0.0080 |
| **TOTAL C** | 4.500 | $40,045,000 | $880,000 | $113,700,000 | $9,585,000 | $6,840,000 | $36,302,110 | $207,352,110 | $0.0072 |
| **TOTAL B1+C** | 7.487 | $63,100,000 | $2,249,000 | $199,800,000 | $26,980,000 | $11,720,000 | $57,078,370 | $360,927,370 | $0.0075 |

E-85 Retail Investments: The investments for a retail infrastructure to achieve the E-85 volumes studied are significant. In Study Case B1 those investments total $147,927,000 and in Study Case C, they are $140,004,000 bringing the total investment to $287,931,000.

E-85 Investment Amortized: If the investments for the E-85 retail infrastructure are amortized across equipment life cycles on a dollar per gallon of new ethanol volume basis, the amortized costs are $0.079 per gallon in Study Case B1 and $0.0546 per gallon in Study Case C. The amortized costs for the combined Study Cases is $0.0642 per gallon.

Waterborne Cargoes for PADD II Exports: In both Study Cases, a significant amount of the ethanol production in PADD II is exported to the other PADDs. A large portion of these PADD II exports are moved down the Mississippi River via river barge and staged (temporarily stored) in New Orleans. The ethanol would then be loaded onto ships for transport to the West Coast, and northern portions of the East Coast. A smaller amount would move by ocean barge to southern PADD I destinations and locations in PADD III. In Study Case B1 such shipments total 0.99 bgy and in Study Case C they increase to 1.415 bgy.

The estimated freight charges associated with these shipments total $111,055,000 in Study Case B1 and $148,390,000 in Study Case C.

Rail Tank Car Shipments for PADD II Exports: A significant volume of the ethanol exported from PADD II, to the other PADDs, will move by rail tank car. In Study Case B1 an estimated total of 43,665 rail cars would be shipped annually. In Study Case C these shipments increase to 49,499 rail car shipments annually.

The total freight charges associated with these product movements would be $142,675,000 in Study Case B1 and $170,500,000 in Study Case C.

Intra-PADD Ethanol Shipments: In addition to freight costs associated with PADD II exports, there are, of course, freight charges for intra-PADD shipments. These shipments include: delivery from a plant to a terminal in the same state, i.e., inner state shipments; delivery from a plant to a terminal in a different state within the same PADD, i.e., intra-PADD transfers; and shipments from a terminal to another terminal in the same PADD, i.e., intra-PADD redistribution. These shipments are made primarily by truck but include small amounts of rail and barge as well.

In Study Case B1, annual barge shipments for intra-PADD shipments require 726 barge movements at an estimated freight cost of $7,450,000. In Study Case C, annual barge shipments total 1,559 at an estimated freight cost of $13,975,000

Total annual rail car shipments for intra-PADD movements in Study Case B1 require 5,333 rail car shipments annually at a total freight cost of $12,800,000. In Study Case C those shipments increase to 23,666 annually at a total freight cost of $28,650,000.

Intra-PADD delivery by transport truck requires an estimated 399,375 shipments annually in Study Case B1 at an estimated freight cost of $117,090,000 In Study Case C, these annual shipments increase to 804,374 truck deliveries at an estimated cost of $206,417,750.

**Table ES-8 Total Freight For Cost All Categories**

| PADD | Case B1 | Case C |
|---|---|---|
| Ship | $105,000,000† | $140,290,000† |
| Ocean barge | $6,055,000† | $8,100,000† |
| River barge | $7,450,000 | $13,975,000 |
| Rail | $155,475,000 | $199,150,000 |
| Truck | $117,090,000 | $206,417,750 |
| Totals | $391,070,000 | $567,932,750 |
| Average per gallon | $0.0767 | $0.0568 |

*† The freight cost for river barges to ship to the Gulf Coast staging area for shipment to the East and West Coasts is added in the ship or ocean barge category as applicable.*

Total Freight Cost: When freight costs for all categories are combined, the total annual freight charges for Study Case B1 are $391,070,000 equating to an average of $0.0767 per gallon of ethanol shipped. In Study Case C the total annual freight cost is $567,932,750 equating to an average of $0.0568 per gallon of ethanol shipped. Table ES-8 provides a breakdown of freight costs by category for both Study Cases.

Freight costs by transportation category for each PADD, as well as average freight cost by PADD, for Study Case B1 are provided in Table ES-9. Table ES-10 provides the same information for Study Case C.

In Study Case B1, average ethanol freight cost by PADD ranges from a low of $0.0427 per gallon in PADD II to a high of $0.1273 in PADD V. In Study Case C, the average freight cost ranges from a low of $0.0239 per gallon in PADD II to a high of $0.107 per gallon in PADD IV.

Additional Transportation Equipment Requirements (Transport Trucks): In order to accommodate additional demand placed on transportation equipment, resulting from increased ethanol shipments, it will be necessary to add some additional equipment. In Study Case B1 it would be necessary to add 254 tractor trailer transports at an estimated cost of $29,210,000. An additional 309 tractor trailer transports would need to be added in Study Case C at an estimated cost of $35,535,000. This brings the total for the combined Study Cases to 563 tractor trailer transports costing a total of $64,745,000. When amortized across new ethanol volume and a 10 year equipment life, this equates to $0.0016 per gallon of new ethanol volume.

**Table ES-9 Study Case B1Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II: Ship/ barge | Ethanol Imported From PADD II: Rail | Intra-PADD Ethanol Shipments: Truck | Intra-PADD Ethanol Shipments: Rail | Intra-PADD Ethanol Shipments: Barge | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| I | 1.3 | $57,400,000 | $70,000,000 | $13,125,000 | - | $4,000,000 | $144,525,000 | $0.1112 |
| II | 2.2 | - | - | $77,940,000 | $12,800,000 | $3,150,000 | $93,890,000 | $0.0427 |
| III | 0.7 | $2,555,000 | $35,275,000 | $8,025,000 | - | $300,000 | $46,155,000 | $0.0659 |
| IV | 0.1 | | $4,500,000 | $200,000 | - | - | $4,700,000 | $0.0470 |
| V | 0.8 | $51,100,000 | $32,900,000 | $17,800,000 | - | - | $101,800,000 | $0.1273 |
| TOTAL | 5.1 | $111,055,000 | $142,675,000 | $117,090,000 | $12,800,000 | $7,450,000 | $391,070,000 | $0.0767 |

**Table ES-10 Study Case C Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II: Ship/ barge | Ethanol Imported From PADD II: Rail | Intra-PADD Ethanol Shipments: Truck | Intra-PADD Ethanol Shipments: Rail | Intra-PADD Ethanol Shipments: Barge | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| I | 2.7 | $80,040,000 | $61,875,000 | $49,562,500 | -- | $4,000,000 | $195,477,500 | $0.0724 |
| II | 3.7 | -- | -- | $71,231,500 | $13,500,000 | $3,675,000 | $88,406,500 | $0.0239 |
| III | 1.8 | $4,650,000 | $46,325,000 | $40,830,000 | $6,650,000 | $6,300,000 | $104,755,000 | $0.0582 |
| IV | 0.4 | -- | -- | $21,043,750 | $8,500,000 | -- | $29,543,750 | $0.0739 |
| V | 1.4 | $63,700,000 | $62,300,000 | $23,750,000 | -- | -- | $149,750,000 | $0.1070 |
| TOTAL | 10.0 | $148,390,000 | $170,500,000 | $206,417,750 | $28,650,000 | $13,975,000 | $567,932,750 | $0.0568 |

Given the time span over which the studied ethanol volumes would be achieved, these tractor trailer purchases would likely represent an addition of fewer than 50 units per year and would not place any strain on supply of transport tractor/trailers.

(Rail Cars): It would also be necessary to add new rail tank cars. In Study Case B1, an additional 2,549 cars would be required at a cost of $152,940,000. In Study Case C, an additional 923 rail tank cars would need to be added at a cost of $55,380,000. Total rail car additions for the combined Study cases are 3,472 cars at a total cost of $208,320,000. When amortized across the 15 year equipment life cycle, on a per gallon of new ethanol volume basis, this equates to $0.0040 per gallon.

Freight car builders produced 7,500 rail tank cars in the first three quarters of 2000 and about 43,850 cars of all types. With the required rail car additions spread out over several years, as plants are added, providing a total of 3,472 rail tank cars would not be a major challenge for the freight car builders.

(River Barges): Lastly, there would be a need to increase the river barge fleet to handle PADD II exports as well as some intra-PADD shipments. In Study Case B1 it would be necessary to add 21 river barges, of 30,000 barrel capacity, at a total cost of $33,600,000. Study Case C would also require addition of another 21 river barges (30,000 barrel capacity) at a cost of $33,600,000. The combined costs for the 42 barges added in the two Study Cases is $67,200,000, which when amortized across new ethanol volume equates to $0.0013 per gallon.

Lead time for the first barge in a series is typically 9 months with delivery capacity of about one per month thereafter. Over the time span to achieve the ethanol volumes studied, and the fact that volume additions would be spread out as new ethanol plants come on line, the requirement for an additional 42 barges, for the combined Study Cases, probably represents fewer than 4 barges per year. This is not a major addition to demand for new barges.

The tables at left provide a recap of required transportation equipment (Table ES-11)and their associated costs (Table ES-12) for each Study Case. Amortized cost on a dollar per gallon of new ethanol volume basis are also provided in Table ES-12.

**Table ES-11 Additional Transportation Equipment Required**

| PADD | Existing | Case B1 | Case C | Total Added from B1 & C |
|---|---|---|---|---|
| Tractor trailer rig | 173 | 254 | 309 | 563 |
| T108 rail car | 278 | 2,549 | 923 | 3,472 |
| 30 mbbl barge | 14† | 21 | 21 | 42 |

*† The 14 barges listed for existing use are actually 42 barges @ 10 mbbl but are projected as 30 mbbl equivalent for ease of comparison*

**Table ES-12 Total Amortized Transportation Equipment Costs (amortized cost per gallon)**

| PADD | Case B1 | Case C | Totals |
|---|---|---|---|
| Tractor trailer rig | $29,210,000 ($0.0015) | $35,535,000 ($0.0015) | $64,745,000 ($0.0016) |
| T108 rail car | $152,940,000 ($0.0067) | $55,380,000 ($0.0019) | $208,320,000 ($0.0040) |
| 30 mbbl barge | $33,600,000 ($0.0015) | $33,600,000 ($0.0012) | $67,200,000 ($0.0013) |
| Totals | $215,750,000 | $124,515,000 | $340,265,000 |

**Observations**

The purpose of this study was to assess the infrastructure requirements for an expanded ethanol industry. Part of this assessment included determining the improvements that would be necessary at the petroleum products terminal level, as well as conversion costs at retail facilities. An assessment was also made to determine the volume of ethanol that would be shipped by each available transportation mode. This included estimated freight costs and an estimate for increased equipment needs and cost. Part of the assessment was also to determine if any major infrastructure barriers would be encountered, and if economies of scale would develop with the higher level of ethanol production in Study Case C compared to Study Case B1. Some of the key observations of the study include:

- No major infrastructure barriers exist in Study Case B1. The volume of product moved by rail and river barge is a very small percentage of products moved by those modes. Furthermore, both the rail freight car building industry and the barge building industry have the capacity to build equipment at a faster pace than that of increasing ethanol shipments from new plants.

- The volume of ethanol shipped in Study Case B1 that would move in Jones Act/OPA90 compliant vessels is less than the volume of MTBE it would be replacing.

- No major infrastructure barriers exist for Study Case C although more detailed study is needed to provide an accurate assessment of how many Jones Act/OPA90 compliant vessels will be available by the time frame when Case C production levels would be reached (i.e., probably 2015 or later).

- Terminal improvements represent significant capital investments for terminal operators although on an amortized basis, they equate to less than $0.01 per gallon of new ethanol volume and, of course, a fraction of that on a blended gallon basis. Still, terminal operators will not make such expenditures without some guarantee of throughput volumes sufficient to warrant such investments.

- The costs of retail conversion for E-10/E-5.7 are modest on a per unit basis and present no major obstacle.

- E-85 retail station infrastructure costs are high, exceeding $0.06 per gallon of new ethanol volume, for the combined Study Cases, due largely to the need for new underground tanks and dispenser systems.

- Ethanol will not be routinely shipped by pipeline in either study case. Volumes are not sufficient to justify the extra handling procedures. Furthermore, there are no operating pipelines originating in the major ethanol production areas. Pipeline shipments of ethanol will be limited to niche situations where pipeline operators will move ethanol, over short distances, in privately owned and operated systems.

- The most significant program costs will be for freight charges which exceed $391 million in Study Case B1, averaging $0.0767 per gallon. In Case C, total freight charges exceed $567 million and average $0.0568 per gallon.

Total freight costs are obviously high compared to pipeline shipments. Here, it is worth mentioning that many industry observers have viewed ethanol's inability to move by pipeline (primarily for logistic reasons) as a handicap. Recently, however, several industry observers have indicated that some pipelines are nearing capacity. If demand continues to escalate as it has historically, some pipelines will have difficulty moving additional volumes of gasoline.

If, in fact, this occurs, the established movement of ethanol by these alternative transportation modes may prove to be a positive attribute. Moreover, in many cases the decentralized structure of ethanol production facilities, especially in Study Case C, would actually preclude the need to ship significant portions of increased gasoline demand by pipeline.

Demand on the U.S. Railway System: In Study Case B1 the total number of annual rail tank car shipments is 48,998 and in Study Case C there are 73,165 annual rail tank car shipments. These volumes represent a relatively modest traffic increase for the railroads.

For Study Case B1 rail car shipments represent only 3.2% of 1999 tank car loadings and only 0.2% of all cars originated on Class I railroads. In Study Case C, annual rail car shipments represent 4.75% of 1999 tank car loadings and only 0.33% of all cars originated on the Class I railroads.

Demand On the Inland and Intercoastal Waterway Systems: Ocean barge movements of ethanol are so minor in both study cases that additional analysis of the intercoastal waterways was not deemed necessary. A significant amount of ethanol will, however, traverse the Mississippi River to accommodate ethanol exports from PADD II to PADDs I, III, and V. Ethanol movements on the inland waterway system in Study Case B1 total 1.095 bgy equating to 3.6 million short tons. This represents only 0.58% of current tonnage shipped.

In Study Case C, 1.87 bgy move on the inland waterway system. This equates to 6.15 million short tons representing 0.98% of current tonnage moved on the system.

It should be noted that ethanol shipments will, however, originate and terminate in areas historically experiencing delays at locks.

Ocean Going Vessels: The Merchant Marine Act of 1920, referred to as the Jones Act, requires that product being shipped between U.S. ports must use vessels that were built in the U.S., are owned by a U.S. person or corporate entity, are manned by a certified U.S. crew, and are registered in the United States (U.S. flagged). The Oil Pollution Act of 1990 (OPA90) requires petroleum products and certain petrochemicals to be shipped in double hulled vessels and establishes a time line to phase out the use of single hulled vessels. Several single hulled vessels built prior to 1970 were recently retired from petroleum products service. Additional ships are scheduled to be retired from petroleum product service between 2002 and 2014.

Shipments of ethanol are subject to the Jones Act requirements and, depending upon the denaturant used, may be subject to OPA90 requirements.

In Study Case B1, denatured ethanol shipments will require use of the equivalent of 4.5 small Jones Act/OPA90 compliant vessels. In Study Case C, the equivalent is 7.7 such vessels. It is not possible to accurately assess the total impact of increased ethanol shipments without an analysis of all "clean product" shipments that would be competing for·this transportation mode (see recommendations).

Sections 4 and 5 of this report contain the following recommendations:

- The most expensive single category for the expansion of an E-10/E-5.7 blend program is the investment in blending systems for the terminals. Blending systems represent over 56% of the estimated terminal and retail expenditures in Case B1 and over 55% in Case C.
  Some terminal operators install prefabricated, skid mounted, blending systems. Others may elect to design their own systems (or have them designed) using a variety of computer controls and variable proportioning pumps. Of course, the cost of these systems may drop with quantity purchases, such as those that would be necessary for the ethanol industry expansion levels studied here. However, it is recommended various ways to reduce the costs of these systems be explored. As an example, two or three basic systems for the most common terminal configurations could be designed. These systems could be "minimalist" in nature providing only the basic needs of blending the most common blend ratios of E-10 and E-5.7, (and possibly E-75, E-80, and E-85 for those terminals handling the higher blend ratio fuels). Also, several terminals now blend the mid-grade on site, using a blending system to mix the correct portion of premium and regular unleaded. If a more economical design could be developed to utilize these blenders, or develop a system that covers all blend requirements at the terminal, this could dramatically reduce the program costs associated with this category.

- The costs of expanding the retail infrastructure for E-85 distribution are also quite high, especially for the volumes achieved. In our study we assume E-85 sales volume, at retail, are comparable to midgrade, i.e., 12,000 to 15,000 gallons per unit month. Obviously, if higher volumes are achieved, this would reduce the cost per gallon of new volume. However, given the size and distribution of the flexible fuel fleet, and simply the fact that these vehicles can also use gasoline, higher estimated volumes may be overly optimistic. With costs estimated to exceed $60,000 per system, it is difficult to find retail facility operators willing to invest such resources to dispense a fuel with future volume and profit margins, that cannot be accurately predicted based on historic trends. Consequently, anything that can be done to lower the expense of a retail E-85 installation would aid in more rapid expansion for this fuel.

It is recommended that the possibility of some type of modular, relocatable system, be explored. Systems being installed typically consist of an 8,000 to 10,000 gallon underground tank and a dispenser, usually located on an island separate from the gasoline dispensers, at an existing retail outlet. Perhaps a system with a 3,000 to 4,000 gallon skid mounted, above ground tank, could be designed. This would result in the installation of the underground piping being the only "below grade" work. The piping and the dispenser would be permanent. When volumes increase to a significant level, underground tanks could be installed and the skid mounted tank relocated to another start up facility. This would contribute to more rapid industry expansion and, in the mind of the retailer, lower the potential for a stranded investment for an underground tank.

The primary obstacle is likely to be local permitting, especially obtaining approval from fire prevention officials. Consequently, any system development should be closely coordinated with the National Fire Prevention Association (NFPA).

- A large portion of the ethanol transported in an expanded ethanol market would move in river barges on the inland waterway system. For Case B1 such shipments amount to only 0.58% of current tonnage moved on the inland waterway system, and only 0.98% in Case C, While this is a relatively modest volume increase, it would occur at a time when traffic is already projected to rise 1.3% yearly. Perhaps more importantly, the origination of these shipments will occur on portions of the system known to already be plagued by delays at some locks. In the case of shipments to the Gulf Coast (to stage product for loading onto ships), shippers may also experience delays at their unloading destination at certain times of the year.

Also, in the case of dry mills, coproducts such as Distillers Dried Grains & Solubles (DDGS) may result in increased shipments on the inland waterway system.

Based on the above, it is recommended that this issue be studied more closely. Specifically, a study should be undertaken to determine what impact the increased ethanol and coproduct shipments of an expanded industry would have on the inland waterway system's operability. Such a study could be done by a private firm or perhaps the Army Corps of Engineers. Regardless of who might do the study, it is recommended that the Army Corps of Engineers be kept in the information loop on any industry expansion so that they can contribute to various ethanol related assessments, and also to ensure they are apprised of any significant industry expansions that might impact their area of responsibility.

- One of the most difficult areas to assess in detail is the increased demand that ethanol shipments would place on Jones Act Vessels that are OPA90 compliant. As noted in the report, this is an area of some debate and difference of opinion. Recent studies show an increasing shortage of Jones Act/OPA90 compliant vessels. A number of smaller clean product vessels have recently been retired and several more will be retired between now and 2014. At the same time, the American Waterways Operators has said adequate shipping capacity exists for an anticipated 0.6 bgy to be shipped to California. Further complicating the assessment is the variety of projections used to estimate gasoline demand increases and by what mode of transport any increased gasoline volumes would be shipped, especially going out as far as the time line envisioned for Study Case C (i.e., more than 10 years out).

  In Study Case B1 a total of 0.855 bgy of ethanol is shipped to the East and West Coasts by ship. This equates to 2.81 million short tons. In Case C, 1.145 bgy is exported to the coasts equating to 3.77 million short tons. However in each case we have estimated the 0.252 bgy of ethanol would be shipped undenatured. These shipments would require a Jones Act vessel, but not an OPA 90 compliant vessel. This would reduce OPA90 vessel requirement use by 0.83 short tons in each Study Case. The result would be a requirement for 1.98 million short tons per year to move in OPA90 compliant vessels in Study Case B1 and 2.94 million short tons per year for Study Case C.

While ethanol shipments in OPA90 complaint Jones Act vessels may represent as little as 3% of total petroleum products shipped, it is not possible to assess the impact this has on the total demand picture for OPA90 vessels. This would require a detailed assessment not only of ethanol shipments but also of all clean products moving between U.S. ports. Such an assessment is beyond the scope of this study. If the availability of Jones Act/OPA90 compliant vessels becomes constrained, this could result in price spikes for chartering such vessels. These freight increases could result in a preference for rail shipments and a greater number of terminals would then need to add rail spurs.

It is recommended that a detailed assessment of Jones Act/OPA90 compliant vessels be undertaken. This should include OPA90 vessels in service and retiring, along with confirmed and projected ship orders. This, combined with projected "clean product" shipments, including ethanol, would yield a more accurate picture of demand for these vessels. Simply put, the demand for OPA90 compliant Jones Act vessels, created by ethanol shipments between U.S. ports, cannot be assessed singularly. It must be assessed in the context of all vessels and all clean products shipments.

A second recommendation is to explore an expansion of the shipment of ethanol in non-OPA90 vessels. This could be done by shipping more ethanol as pure spirits (i.e., undenatured) to properly permitted terminals on the East and West Coasts. Another option is to examine potential denaturants that, while meeting industry standards and Bureau of Alcohol Tobacco and Firearm (BATF) requirements, would not be listed as a cargo requiring OPA90 vessels.

# Section 1

# Background & Introduction

## 1.0 Background & Introduction

The U.S. Department of Energy's (DOE) Office of Transportation Technologies (OTT) through its Office of Fuels Development (OFD) is responsible for major planning and analysis to ensure consistency of various program objectives with the Energy Policy Act (EPACT). Oak Ridge National Laboratory (ORNL) is supporting OFD in its analysis of current and future ethanol demand for the transportation fuels market.

Downstream Alternatives, Inc. (DAI) was retained to provide technical expertise specifically related to ethanol transportation, distribution, and marketing issues. The work was divided into two phases. The first phase included three major tasks. The first task was a literature search and document review to identify documents and reports that could be used for other Phase I tasks. The literature search and document review were completed in December 1999. Task 2 required preparation of a report describing the current ethanol transportation, marketing, distribution, and technical issues related to the existing ethanol industry. That report entitled "The Current Fuel Ethanol Industry Transportation, Marketing, Distribution, And Technical Considerations" was completed in May 2000 and is available electronically at www.ott.doe.gov/biofuels/database.html. Task 3 utilized the Task 2 report and other information sources to identify an approach for analyzing transportation, marketing, and distribution costs and issues for an expanded ethanol industry.

Phase II of the project requires preparation of a report which analyzes the infrastructure requirements for an expanded ethanol industry. In particular, the report includes implementation of the recommendations set forth in Phase I Task 3 as modified after peer review and input from various biomass ethanol team members. This document represents the report/project deliverable for Phase II of the project.

The DOE is interested in the logistics of, and any constraints associated with, ethanol industry expansion because it is engaged in research and development work on cellulosic ethanol development. Understanding the infrastructure development necessary for an expanded ethanol industry is an important part of this work.

Two cases of expanded ethanol production are studied as discussed in the following sections.

## 1.1 Cases Studies

Four study cases were originally considered. They were entitled Cases A, B, B1, and C. From those, two different study cases were selected for this study. The first case (Case B1) was based on ethanol production of 5.1 billion gallons annually. The second case (Case C) was based on 10.0 billion gallons of annual production. These cases were selected because Case B1 equates roughly to the 2010 ethanol demand envisioned to result from some legislative proposals for a Renewable Fuels Standard being discussed at this projects inception. However, this study is not associated with any particular time frame or year. The reasoning for selection of the higher volume Study Case C for analysis was to see if efficiencies of scale would materialize, to determine if pipeline shipments of ethanol could result, and to identify any constraining infrastructure barriers.

The base assumptions for production by PADD, amounts imported or exported among PADDs and amount of ethanol used in each PADD were developed by Technology and Management Services Inc. (TMS). These base assumptions also included estimates for feedstocks used (i.e., grains or cellulosic feedstock). The study cases are not intended to be actual forecasts of ethanol production and consumption and are not associated with any particular future year. They are intended only to represent plausible scenarios for an expanded ethanol industry at some future time. The scenarios are based on Bioethanol Program estimates of key parameters, such as estimates of future demand for ethanol and R&D successes in the production of ethanol from cellulosic feedstocks, that were current at the initiation of DAI's Phase II work. The base assumptions for each case are provided in the following tables.

**Table 1-1 Ethanol Production, Exports, Imports & Use by PADD - 5.1 BGY (Case B1) (BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 0.2 | 0.2 | | 1.1 | 1.3 |
| 2 | 4.0 | 0.5 | 4.5 | 2.3 | | 2.2 |
| 3 | | 0.2 | 0.2 | | 0.5 | 0.7 |
| 4 | | | 0.0 | | 0.1 | 0.1 |
| 5 | | 0.2 | 0.2 | | 0.6 | 0.8 |
| | 4.0 | 1.1 | 5.1 | 2.3 | 2.3 | 5.1 |

**Table 1-2 Ethanol Production, Exports, Imports & Use by PADD - 10.0 BGY (Case C) (BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 1.4 | 1.4 | | 1.3 | 2.7 |
| 2 | 4.5 | 2.1 | 6.6 | 2.9 | | 3.7 |
| 3 | | 1.1 | 1.1 | | 0.7 | 1.8 |
| 4 | | 0.4 | 0.4 | | | 0.4 |
| 5 | | 0.5 | 0.5 | | 0.9 | 1.4 |
| | 4.5 | 5.5 | 10.0 | 2.9 | 2.9 | 10.0 |

## 1.2 Report Structure

This report is structured as follows:

- **Table of Contents**
- **Executive Summary** - provides overview of study findings
- **Section 1 - Background & Introduction** - brief background of previous related work and cases to be studied.
- **Section 2 - Market Uncertainties** - discusses the many market factors that impact, or could impact, the production and use of ethanol.
- **Section 3 - Methodology & Development of Production and Sales Volume by Geographic Area** - discusses preliminary assumptions developed to use in Study Cases B1 and C, and general methodology.
- **Section 4 - Study Case B1** - covers all details of Study Case B1 including placement of plants, ethanol markets, servicing terminals, tankage requirements, infrastructure costs, and a transportation analysis including modes used and projected cost.
- **Section 5 - Study Case C** - covers the above listed information for Study Case C.

- **Section 6 - Summary, Observations, and Recommendations**
- **Appendices -** appendices are included after the regular sections. These include various information sources and calculations that were developed and that are discussed in the text. A glossary of acronyms and frequently used terms is also included.

Note that throughout the report, specific references are noted by numbers in parenthesis when applicable. At the end of each section a listing of specific and general references is provided.

Finally, note that Appendix J contains certain information that, in light of heightened national security, is deemed sensitive and not included in the report. Readers who desire to obtain a copy of Appendix J should send a written request to:

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# Section 2

# Market Uncertainties

## 2.0 Market Uncertainties

The projections in this study are a representation of what might happen given the specific assumptions and methodologies used. Real world data were used as a starting point. Such information includes historic gasoline sales, current ethanol production, and actual terminal locations. However, the actual projections for where new ethanol production would be located and where future ethanol sales increases would develop are highly dependent on the assumptions and methodologies used. Many developments that will shape the future of the ethanol industry cannot be anticipated with certainty.

Therefore it is important to note that there are a number of issues which could affect the demand for, and production levels of, ethanol. In this study the assumption is made that demand for, and production levels of, ethanol are as stated in the TMS scenarios. No study is made of the specific impact that certain issues may have on the supply and demand of ethanol. The study is focused on logistic issues, concentrating primarily on transportation and storage demand from an expanded ethanol industry.

Prior to covering the case studies and findings, the report authors feel these issues warrant a brief description. Such issues include the following.

## 2.1 Public Policy Issues and Regulatory Barriers

As has always been the case, the growth of the ethanol industry is dependent, to a great degree, on the direction of various public policy initiatives and the regulatory mechanisms developed to achieve them. Some of the more important issues are listed below:

**MTBE Phaseout/Oxygen Requirement:** Due to concerns about groundwater contamination, California, New York, and several other states have passed legislation banning the use of methyl tertiary butyl ether (MTBE) after certain dates, usually in the 2003/2004 time frame. Other states have considered, or are considering, such legislation and bills have also been introduced at the federal level to ban the use of MTBE.

To the extent that the oxygen requirement for oxygenated fuels and reformulated gasolines (RFG) remains in tact, the reduced use of MTBE will result in the increased use of ethanol, as it is currently the only other widely available, competitively priced, oxygenate.

On June 11, 2001, the U.S. EPA denied California's request for a waiver from the federal oxygen requirement in reformulated gasoline [1, 2]. This does not, however, mean that further requests from California and other areas would be denied by this, or future administrations. It should be noted that on August 13, 2001 California Governor Gray Davis announced that California is suing EPA over their denial of the oxygen waiver request.[3]

The Northeast States for Coordinated Air Use Management (NESCAUM) has recommended that congress take action to lift the oxygen mandate for RFG.[4] At the same time, the expanding phaseout of MTBE has led some to call for a removal of the oxygen requirement applicable to all reformulated gasoline. If the oxygen requirement for RFG is removed or waived, it is likely that ethanol would still be used to some degree, due to the need to replace octane and volume lost as a result of MTBE phaseout. However, such volumes would clearly be less than the volume needed were the oxygen requirement to stay in place. In the 107th Congress, the House voted against an amendment to HR4 to grant California a waiver from the RFG oxygen requirement. The sentiment to revise the RFG oxygen requirement as a stand alone bill also seems to be lacking in Congress at this time. Finally, many in industry believe that any elimination or reduction in the requirement to use oxygenates would likely be replaced by a renewable fuels standard requiring expanded use of ethanol and other renewable fuels.

It should also be noted that so called "Opt In" areas which joined the RFG program on a voluntary basis may "Opt Out" of the program beginning on January 1, 2004.

**USEPA Complex Model/CARB Predictive Model:** The effect oxygenates have on exhaust and evaporative automobile emissions is calculated through a series of complicated equations that were developed based on actual tests on vehicles of various technology classes. Certain aspects of these computer models affect ethanol's flexibility of use and its value as a blending component. As an example, USEPA's Complex Model projects a NOx reduction at 3.5 wt%

oxygen (equating to 10 v% ethanol) while CARB's Predictive Model shows NOx increasing as oxygen content increases. These variations result from the different test data and vehicle technologies used to construct the models (5). Future changes in computer models used to determine compliance with RFG programs could impact ethanol in either a positive or negative fashion.

Other issues may pertain to the EPA's decision to recognize that carbon monoxide (CO) plays a role in ozone formation. On July 12th, EPA announced it would utilize enforcement discretion (pending a final rule) to allow an offset in the Complex Model which provides a credit for CO reductions at higher oxygen levels. This would give refiners the flexibility to raise vapor pressure slightly. However EPA limited this flexibility to the Chicago and Milwaukee RFG areas(6). This was due to concerns about the commingling effect of gasoline ethanol blends. The term "commingling effect" describes a scenario where an ethanol blend and non-ethanol blend are commingled in the vehicle's fuel tank. Since ethanol increases fuel volatility (as measured by RVP) at volumes as low as 3 v%, the resulting commingled blend could have an RVP higher than that of the hydrocarbon fuel (i.e., enough ethanol exists in the ethanol blend to increase the volatility of the commingled hydrocarbon fuel).

As MTBE is phased out in such areas as New York, and greater portions of the fuels contain ethanol, the potential for increased volatility as a result of commingling is greatly reduced. EPA could therefore choose to grant those areas similar adjustments in the future. In any event, when various aspects of these models affect ethanol's value as a blending component, it could affect the volume of ethanol produced and consumed in different regions of the country.

**Federal Excise Tax Exemption/Blenders Tax Credit:** Ethanol currently enjoys a partial exemption from the federal motor fuels excise tax of $0.053 for 10 v% ethanol blends. Lower blend levels of 5.7 v% and 7.7 v% qualify for lower prorated exemption levels. Alternatively, blenders can use the blenders tax credit of $0.53 per gallon of ethanol used. Essentially these tax credits all equate to $0.53 per gallon of ethanol used and generally allow ethanol to remain competitive with gasoline.

This credit is scheduled to be reduced by small amounts through 2007 at which time it is scheduled to expire.

At current gasoline prices it is unlikely that the majority of the ethanol industry could continue to survive, much less grow, without some portion of the exemption being extended. This exemption has been key to the survival and expansion of the industry. However, Congress has renewed or extended this federal excise tax exemption on numerous occasions and it is probable, if not likely, that some form of exemption will continue past 2007. In fact, the National Energy Policy document of the Bush Administration (7) calls for extending these exemptions.

**Highway Trust Fund:** It should be noted that ethanol's current partial exemption of the motor fuels excise tax is funded from the Highway Trust Fund. This has been a subject of controversy in the past and has resulted in attempts to prematurely end the credit. The ethanol exemption was extended in the Transportation Equity Act for the 21st Century (TEA-21). Under TEA-21, 10 v% ethanol blends currently receive a $0.053 per gallon exemption from the $0.184 per gallon motor fuel excise tax on gasoline. This rate changes to $0.52 per gallon on 01/01/2003 and $0.051 per gallon on 01/01/2005. Unless extended, exemptions would expire on September 30, 2007. The impact on the Highway Trust Fund is more complicated than just calculating gallons sold times the exemption.

Appendix G contains a recap of Federal Highway User Taxes under TEA-21. Because gasoline/ethanol blends contribute $0.031 per gallon of this tax to the general fund, such blends actually contribute only $0.074 per gallon to the Highway Trust Fund Highway Account. Gasoline however does not contribute any amount to the general fund resulting in contributions to the Highway Account of $0.1544 per gallon. Both gasoline and gasoline ethanol blends contribute $0.0286 per gallon to the mass transit account and $0.001 per gallon to the Leaking Underground Storage Tank Trust Fund. This results in 10 v% ethanol blends contributing $0.084 per gallon less to the Highway Account. Consequently the impact on the Highway Account is greater than just the amount of the exemption. The impact on distribution of funds from the Highway Account is also complicated by complex formulas incorporating many components. There have been attempts at legislation to reimburse the Highway Trust Fund from other revenue sources (8). However, at the current time no such effort has been successful. In Study Case B1 ethanol's tax exemptions would exceed $2.5 billion and in Study Case C they would exceed $5.0 billion (at current exemption levels). Under TEA-21's tax distribution schedule, the impact on the Highway Account would be even greater. Such increases will likely result in more pressure to reduce, rescind, or consider non-renewal of the exemption, in part or in its entirety, unless a mechanism to reimburse the Highway Trust Fund is developed.

**Agricultural Policy:** It has often been argued that the cost of the partial federal motor fuels excise tax exemption results in a net gain to the treasury. Various studies have confirmed that there is a net gain to the treasury due to offsetting savings in agricultural subsidies (as well as increased tax revenues in other areas). To the extent that future farm subsidies are increased or decreased, this would impact the net effect that ethanol tax exemptions have on the U.S. Treasury.

**Energy Policy:** Over the past few years there has been increased price volatility for transportation fuels. This is in large part because U.S. refineries are operating at near maximum capacity at many times. No new refineries have been built in the U.S. since the mid 1970s. While some refineries have undergone some level of expansion, other refineries have been shut down. Occurrences such as refinery breakdowns/problems or disruptions in the transportation of gasoline and diesel fuel (e.g., hurricanes, river congestion impeding barge movements, pipelines off-line due to repairs) result in significant price spikes. This, along with recent news coverage of California's electricity shortage and temporary but major increases in natural gas prices has brought energy policy to the forefront with both elected officials and the public. Additionally our nation's reliance on fossil fuels, especially for the transportation sector, is of growing concern.

The Bush administration released their "National Energy Plan" in May, 2001 (7). This package of initiatives to increase the nation's energy independence is, of course, only a starting point for what may transpire over the next several years. In addition to the National Energy

Plan, legislation has been introduced to require increased use of renewable fuels. (9, 10) Obviously any requirement for expanded use of renewable fuels would be beneficial to an ethanol industry expansion.

Another area of policy is how to address "Boutique Fuels". Boutique fuels are fuels which are required by state and local governments. These fuels typically have specification requirements different than either reformulated or conventional gasoline. The state's motive for requiring such fuels is to utilize the emissions reduction credits in their state implementation plans. Unfortunately with different states adopting different standards, the result is that there are now over 40 different types of gasoline. These islands of "boutique fuels" fragment the distribution system increasing logistic complexity. Further, when such fuels drop to low inventory levels, replacement fuel from neighboring markets cannot be brought in. Consequently, price increases are used to reduce demand, resulting in price spikes during periods of low inventory.

The elimination of boutique fuels, and resulting increase in tankage availability, would also likely be beneficial to ethanol industry expansion providing any final legislation retains, or expands, the use of oxygenates. One of the recommendations contained in The National Energy Policy document was "that the President direct the administrator of EPA to study opportunities to maintain or improve the environmental benefits of state and local clean fuel programs while exploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity." The wording chosen (i.e. flexibility, fungibility, and market flexibility) seem to imply consideration of fewer fuels. EPA has since initiated a study of boutique fuels and is evaluating a range of options covering the recommendations from various stakeholders.

Other energy policy initiatives that have been suggested include investment tax credits or other favorable tax treatment for projects that would decrease the nation's dependence on imports and/or fossil fuels. The Bush Administration's National Energy Policy document supports extension of ethanol tax incentives.

Also, within the category of Energy Policy, there could be alterations or alternatives to the current Corporate Average Fuel Economy (CAFE) program. Currently, automakers enjoy certain CAFE credits for producing alternative and/or flexible fuel vehicles. As a result, the automakers have produced over a million E-85 capable flexible fuel vehicles in the past two years. If the CAFE system is replaced, or the credits for building flexible fuel vehicles are removed, automakers may well choose not to manufacture such autos. This would, of course, end any hope of developing an E-85 fueling infrastructure.

CAFE credits for flexible fuel vehicles have come under attack by some environmentalists because the vehicles produced to generate the credits seldom operate on the alternative fuel. This has been due, in large part, to a lack of fueling infrastructure. However, even if a sufficient infrastructure develops, there are no requirements for flexible fuel vehicles to operate on their respective alternative fuels.

While this study examines some of the costs and challenges of an E-85 infrastructure, the costs for terminaling and transportation are largely the same for E-10, so the actual market penetration of E-85 does not significantly affect the study results since any slack in E-85 sales would be taken up by E-10 blends.

**Cellulosic Biomass Issues:** For the ethanol industry to expand significantly above the five billion gallon annual production level would almost certainly require the use of some form of cellulosic feedstocks. In some cases there may be environmental concerns about how such materials (e.g. agricultural residues, forest thinnings) can safely be removed without impacting erosion, soil nutrients, and natural growth cycles, to cite a few issues. However the amount of materials for sustainable removal of surface residue has been researched and is well defined. Models have been developed which have been validated by the U.S. Department of Energy (DOE). Also, in some cases, certain types of feedstocks such as corn stover may have a short harvest window due to weather conditions which could present unique challenges.

In addition there could be competing uses for feedstocks. For instance certain wood wastes and materials from municipal solid waste may have other feedstock uses such as for particle board or recycled paper. The value of such uses could be higher than the material's value as an ethanol feedstock, potentially reducing availability of cellulosic feedstocks at economically viable costs.

The U.S. DOE is sponsoring ongoing research to reduce the cost of converting biomass feedstocks to ethanol as well as to lower the cost of the feedstock supplies. Previous work has lowered such costs dramatically from those of only a few years ago. However, for biomass feedstock to be competitive, further advancements are needed. The DOE projects that with recent advancements in biotechnology and directed evolution, [11] conversions cost will continue to be reduced. These issues are well beyond the scope of this work and in this study the assumption is made that biomass conversion cost issues will be favorably resolved.

The potential for using Municipal Solid Waste as feedstock, as noted above, also introduces uncertainties since there may be competing uses. However there are also other components of MSW that would be available such as green wastes (lawn clippings, prunings, etc.).

**Volatility Controls:** Currently, when ethanol is blended into conventional summer grade gasoline (at 9-10 v%) its vapor pressure may exceed the applicable vapor pressure standard by 1.0 psi (6.9 kPa). If for some reason this 1.0 psi vapor pressure waiver were rescinded, it would require a specialty base fuel with reduced vapor pressure similar to Reformulated Blendstock for Oxygenate Blending (RBOB) in the federal RFG program. Such a development would result in fuel manufacturing difficulties and logistic problems that could preclude ethanol blending in many areas. Similarly, controls on $T_{50}$, TV/L-20 (used in the ASTM Vapor Lock Protection Classes), or Driveability Index could present potential difficulties. Ethanol reduces $T_{50}$, in some cases to unacceptable levels. Refiners typically compensate for this by altering the fuel to accommodate ethanol. More restrictive $T_{50}$ limits (i.e., higher than current minimum standards included in ASTM D 4814) could reduce the flexibility and value of ethanol.

Ethanol also alters the TV/L20 (temperature for a vapor liquid ratio of 20 as determined by ASTM D 2533 or calculated by ASTM guidelines). Current work indicates TV/L20 may not be a good indicator of fuel performance in modern vehicles. It is therefore possible that future ASTM standards may utilize some other measurement for its vapor lock protection class.

Current ASTM standards also include a Driveability Index (DI). Driveability Index is used to ensure good cold start and warm up performance. Lower DI generally indicates better cold start performance. ASTM D 4814 includes requirements for a DI ranging from 1200 to 1250 based on the season and altitude of the area in which the gasoline will be used. $T_{50}$ receives a weighting of 3x in the DI formula. Consequently a lower $T_{50}$ significantly lowers DI. However, excessively low $T_{50}$ (i.e. below 170˚F) may contribute to hot start/hot driveability problems especially during warmer seasons or at higher altitudes, So while a lower $T_{50}$ improves DI, a measure of cold start/warm up performance, too low a $T_{50}$ creates other problems that DI does not control, i.e. hot restart/hot driveability. The DI is calculated from the distillation properties of the fuel using the following formula:

$DI = (1.5 \times T_{10}) + (3 \times T_{50}) + T_{90}$

where $T_{10}$ = distillation temperature, (˚F), at 10% evaporated, $T_{50}$= distillation temperature (˚F), at 50% evaporated, and $T_{90}$ = distillation temperature (˚F), at 90% evaporated

Automakers have agreed that an offset is needed for oxygenate content. The data support some level of offset. However, the formula for such an offset is the subject of some debate. The most often cited adjustment is to add 20 points for each weight percent oxygen from ethanol resulting in the following variation of the DI formula:

$DI = (1.5 \times T_{10}) + (3 \times T_{50}) + T_{90} + (\text{wt\% O2E} \times 20)$

where $T_{10}$ = distillation temperature, (˚F), at 10% evaporated, $T_{50}$ = distillation temperature (˚F), at 50% evaporated, $T_{90}$ = distillation temperature (˚F), at 90% evaporated, and wt% O2E = weight percentage oxygen from ethanol

Since $T_{50}$ is weighted heavily in the formula, and ethanol impacts $T_{50}$, any changes in the formula could impact the value of ethanol as a blending component. Similarly, an oxygen offset in the formula could also impact ethanol's value.

**Climate Change:** While climate change and how to deal with it continues to stimulate great debate, there seems to be a growing consensus that biofuels, including ethanol from both grain and cellulosic feedstock, significantly reduce emissions of $CO_2$. Numerous studies in recent years indicate that, compared to fossil fuels, the use of ethanol will reduce emissions of green house gases. While early studies were somewhat conflicting, some studies dating to 1989 [12] indicated that the use of ethanol resulted in lower emissions of green house gases. A 1991 paper [13] from Oak Ridge National Laboratory (ORNL) indicates that the net savings of $CO_2$ for ethanol production from corn was in the range of 20%-40% depending on how by-product credits are allocated.

The most recent and comprehensive work in this area has been done by Argonne National Laboratory using the GREET Model (greenhouse gases, regulated emissions and energy uses in transportation). This work was done in conjunction with General Motors Corporation, BP, ExxonMobil, and Shell. The study analyzed the "Well to Wheel" emissions of several fuels.[14] On a "Well to Tank" basis, GHG emissions values for ethanol are actually negative because of carbon sequestration during growth of corn plants, trees, and grasses. This translates through to significant GHG reductions on a "Well to Wheel" basis. Herbaceous type crops offer the greatest benefit since they do not require the fossil fuel inputs associated with grain crops. But even grain crops provide significant GHG reduction compared to fossil fuels.[15, 16] As more emphasis is placed on addressing global warming, it is likely our government will continue to explore various strategies to reduce emissions of green house gases. This will result in initiatives that would be favorable to increased ethanol production and use.

**State Regulations/Initiatives:** In some cases state policy/regulations are negative for ethanol market development (e.g., labeling requirements, volatility requirements). In other cases they are positive (e.g., producer credits, motor fuel tax incentives, flexible fuel vehicle purchases).

In any event, the actions taken by state governments in the future could indeed impact the production and use of ethanol. Additionally, states may adopt various fuel programs and regulations into their State Implementation Plan (SIP) and such plans could include provisions for the use of ethanol, vapor pressure restrictions, and other requirements that could increase or decrease ethanol usage.

## 2.2 Technical Issues/Refinery Issues

Ethanol has various attributes, both positive and negative, as a fuel blending component. For instance, it increases octane and is near sulfur-free. Conversely, it increases fuel volatility by increasing vapor pressure and depressing $T_{50}$. Refiners must consider all of these factors, comparing ethanol to all other available components, and their costs, in their linear programming models, and determine the most cost effective strategy to make fuels that meet performance standards and various fuel requirements.

## 2.3 Unocal Corporation Patent

Unocal has patented a series of gasoline compositions covering a range of individual gasoline properties. The patented compositions increase gasoline manufacturing costs by forcing refiners to pay a licensing fee, or by reducing the refiners' flexibility by forcing them to "blend around" the patented compositions. In the latter case, there is generally a loss in gasoline volume.

The Unocal patents could have a particularly significant impact on reformulated gasoline (RFG) containing ethanol. Thus, they can be a deterrent to greater ethanol use. The impact is primarily due to the following:

- RVP: Gasoline volatility, as measured by Reid Vapor Pressure, is tightly controlled in RFG due to the need to achieve substantial mandated reductions in volatile organic compounds (VOCs) to help reduce ozone. Since ethanol blending increases RVP, the gasoline that it is blended into must be a special lower volatility gasoline. The Unocal patent particularly targets low RVP gasolines, making it more likely that a gasoline made for ethanol blending will fall within the range of patented compositions.

- $T_{50}$: The midpoint in a fuel's distillation curve, known as $T_{50}$, is also an important consideration in determining RFG emissions in order to comply with EPA regulations. Ethanol's distillation characteristics tend to lower the $T_{50}$ of the final gasoline-ethanol blend. The range of $T_{50}$ temperatures covered by the Unocal patents again covers an area that could especially affect ethanol blending. It is more likely that the final gasoline containing ethanol will fall within the Unocal patent parameters.

The particular impact of the Unocal patents on RFG blends with ethanol has been noted in several analyses of the summer 2000 gasoline price spikes in the Midwest. The Federal Trade Commission's investigation, issued in March 2001 included a note indicating,

"Most refiners and experts seem to believe that the production of RFE (reformulated ethanol gasoline) more directly implicates the Unocal patent than RFM (reformulated MTBE gasoline), because the extremely low RVP required in refining RBOB (reformulated blendstock) for ethanol blending reduces refiners' flexibility to produce RBOB blends without following Unocal's formula."

A Congressional Research Service study (June 2000) noted that, "Refiners contend that, while they can often avoid the patent issue, "blending around" can cost them as much as 5 cents per gallon in higher manufacturing costs. But the patents might be a factor in the manufacture of RBOB suitable for ethanol blending. Because of RBOB's low volatility, it may well be dependent on Unocal's process."

The Unocal patents have been challenged in the courts and have, thus far, been upheld. Several oil companies have entered into non-exclusive licensing agreements giving them the right to produce gasolines using Unocal patented formulas. At least five companies had entered such agreements by August 2001. [17] There licensing agreement is reported to range from 1.2 to 3.4 cents per gallon for volumes that fall under the Unocal patent.

Refiners will, therefore, need to determine if their decision to use ethanol would require a licensing agreement, or payment under an existing licensing agreement. If so, such costs would need to be considered against the costs of "blending around" the patent.

## 2.4 Petroleum Industry Attitudes Toward Ethanol

It is also important to note that the petroleum industry has not traditionally embraced the use of ethanol. Many reasons have been cited including the following:

- Ethanol production volumes have not always been sufficient by petroleum industry standards.

- In the past there have been concerns about all ethanol production facilities meeting the highest quality standards. Now, of course, there are ASTM standards for ethanol. Also, many smaller producers have entered into marketing agreements with larger producers which will further help ensure fuel quality due to more frequent testing when product is commingled.

- Since ethanol moves by barge and rail, there are concerns that severe weather could cause delivery delays. However, more geographic dispersion of plants should address these concerns since supply would be available from a greater number of producers spread across a larger geographic area.

- Grain based ethanol production is dependent upon grain availability and price which could be affected by drought, world grain import/export policies, and public policy programs.

- Current production is economically feasible only as a result of the motor fuels excise tax exemption. This tax exemption is usually only extended for a few years at a time. Consequently, refiners and terminal operators are hesitant to make infrastructure investments which could be stranded if the credit expires without renewal, or is otherwise rescinded.

- Ethanol's sensitivity to water requires blending at the terminal and other special handling which requires more effort than petroleum products.

- Ethanol's unique blending properties require the use of a specially tailored fuel (e.g. RBOB, CaRBOB). This in turn may result in rejection of other refinery blend streams such as butanes/pentanes.

- Because of water sensitivity, as well as tax credits, ethanol programs must be longer term (i.e. several months). Its use cannot be switched in and out of daily or weekly to take advantage of economics that may temporarily favor other components.

- Ethanol is an outside stream and must be purchased by the refiner.

- In the early years of the current ethanol program some poorly designed plants could not cope with higher grain prices and operational problems, resulting in temporary or permanent cessation of operations thereby creating concerns about industry stability.

- Of course, there are also some cultural differences between the petroleum and refining industries. There are 100 operating refineries in the U.S. that produce over 98 percent of domestically produced gasoline. The ethanol industry on the other hand currently has around 60 plants producing the equivalent of about 2% of the gasoline pool.

On a more positive note, there are also developments that may result in refiners viewing the use of ethanol more favorably in the future. Key among these are the following:

- OPEC has demonstrated new resolve in achieving targeted production quotas of its member producers. This in turn has resulted in higher crude prices which in turn improves the economics of using ethanol. Conversely, the price of producing ethanol has dropped and will likely continue to do so.

- Refiners can certainly see that public policy is again leaning in the direction of alternative fuels and especially renewable fuels. They are beginning to develop a mentality of "we are an energy provider" and will provide whatever fuels the market dictates.

- No new refineries have been built in the U.S. since the mid 1970s. Many believe that most production capacity creep (as a result of existing refinery projects and debottlenecking) has already been realized. Refiners are often running at near maximum operable capacity during certain times and the need to import finished products is therefore increasing. If refiners are net buyers, they are more inclined to view ethanol as just another option in the mix. In the past, the use of ethanol could have resulted in reduced refinery runs which, today, may not be the case for many refiners.

- While the refining industry has not built any new plants in years, the ethanol industry has continued to expand with a growing number of plants going on line in recent years and several new plants are currrently under construction.

## 2.5 Other Transportation Fuel Uses Of Ethanol

There are other potential uses for ethanol in the transportation sector which are more in the research and development stages. The highest profile of these uses is E-diesel, a blend of standard diesel fuel containing up to 15v% ethanol. This fuel is being used in various demonstration projects but has not yet been approved for commercial distribution for on-road vehicles. There are a number of technical issues currently under study. Successful resolution of technical issues could result in more widespread use of ethanol in diesel fuel. Similarly, ethanol has been approved for use in certain piston engine aircraft although commercial reality has not been achieved.

Finally, ongoing work suggests that ethanol may find a role as a fuel for use in fuel cells. This could also result in ethanol being used in stationary applications such as electric generators, in addition to transportation applications. The introduction of fuel cell vehicles is many years off and there are a number of technical issues to be resolved. These other transportation fuel uses of ethanol are well beyond the scope of this work but are mentioned here since they could impact the long term use of ethanol, as well as other transportation fuels.

**Section 2: Market Uncertainties**

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ASTM D 4814 Standard Specification for Automotive Spark-Ignition Engine Fuel

# Section 3

## Methodology and Development of Production and Sales Volume by Geographic Area

## 3.0 Methodology and Development of Production and Sales Volume by Geographic Area

While TMS provided the volume scenarios for the two cases studied, it was necessary for DAI to develop certain assumptions about where plants would likely be located and where the ethanol volume designated for each PADD could most likely be used. These steps were necessary because markets define which terminals would be involved. Plant locations and terminal locations define the modes of transportation. Development of assumptions required a number of interrelated analytical steps as follows:

### 3.1 Assumptions-Ethanol Production

**Case B1:** For case B1 total production is 5.1 billion gallons annually. Note that all ethanol production volume figures are for finished denatured fuel grade ethanol. Of this, 4 billion gallons of production is grain based and 1.1 billion gallons is based on cellulosic feedstocks. In order to select probable locations of production facilities, the following assumptions are made.

1. First, existing production locations (as of 12/2000) are subtracted from the total to determine new production needed. It was also assumed that larger scale existing plants will be expanded by 30% of existing capacity.

2. While refineries require significant downtime for maintenance resulting in annual capacity being based on 330 stream days, ethanol plants require much less downtime. Ethanol plants often require as little as 2 weeks per year of downtime. (1) Consequently, we have based annual volumes on 350 stream days per year.

3. Grain based production increases in PADD II are based on a) increased production at existing facilities, and b) new plants geographically dispersed in major agricultural areas.

4. It is assumed that new grain plants will range from 10 to 100 million gallons of annual production. Cellulosic plants are sized at 8 to 60 million gallons of annual production.

5. It is further assumed that, where possible, new plants of greater than 40 million gallons annual production will also be located on, or very near, navigable waterways. The limitation here is that plant placement is based on feedstock availability, which in some cases may preclude location near navigable waters. All plants would have rail and truck access.

6. For cellulosic production, it is obvious that all plants will be new and further that:

   a) Plants in PADD II would be based on corn stover. Plants therefore would be in close proximity to grain based plants.

   b) Feedstock for cellulosic plants in PADDs 1, 3, and 5 are assumed to be based on agricultural residue (cheese whey, potato waste, corn stover, rice waste, sugar cane, etc.), municipal solid waste (MSW), or forest thinnings/residue.

7. In the case of all theoretic plants, it should be noted that the hypothetical placement of plants was based on likely availability of feedstock and to coincide to the production volumes, by PADD, in the scenarios developed by TMS. No feasibility studies for plant placement were undertaken. Such detail is not necessary for this work. Approximate plant locations are sufficient to render reasonably accurate projections for transportation demands and costs. Similarly, some production in the Midwest which we list as projected new plants could actually turn out to be expansions at existing plants in the same geographic area. In fact, several farmer co-op owned production plants have been designed for such future expansion. Again, this does not significantly alter projections for transportation demands or for storage requirements.

**Case C:** For Study Case C total production is 10 billion gallons annually with 4.5 billion gallons based on grain production and 5.5 billion gallons based on cellulosic production. For this scenario the following assumptions are used.

1. First existing production locations (as of 12/2000) are subtracted from the total to determine

new production needed. Production increases at existing plants and production from new plants used in Study Case B1 were then subtracted, leaving the additional production requirements for Study Case C.

2. Grain based production increases in PADD II that are over and above Study Case B1 are based on new plants geographically dispersed in major agricultural areas.

3. It is assumed that new grain plants added in Study Case C will range from 30 to 100 million gallons of annual production. Cellulosic based plants are assumed to range from 20 to 100 million gallons of annual production.

4. It is further assumed that new plants of greater than 40 million gallons annual production will also be located on, or very near, navigable waterways when feedstock limitations permit. All plants have rail and truck access.

5. For the 4.4 billion gallons of increased cellulosic production over Study Case B1, it is obvious that all plants will be new and further that:

   a) Plants in PADD II would be based on corn stover. Plants therefore would be in close proximity to grain based plants.

   b) Feedstock for cellulosic plants in PADDs 1, 3, 4, and 5 would be agricultural residue (cheese whey, potato waste, corn stover, rice waste, sugar cane, etc.), municipal solid waste (MSW), or forest thinnings/residue.

6. In the case of all theoretic plants, it should be noted that the hypothetical placement of plants was based on likely availability of feedstock and to coincide to the production volumes, by PADD, in the scenarios developed by TMS. No feasibility studies for plant placement were undertaken. Such detail is not necessary for this work. Approximate plant locations are sufficient to render reasonably accurate projections for transportation demands and costs. Like-

wise, some production in the Midwest which we list as projected new plants could actually turn out to be expansions at existing plants in the same geographic area. In fact, several farmer co-op owned production plants have been designed for such future expansion. Again, this does not significantly alter projections for transportation demands or cost or for storage requirements.

## 3.2 Assumptions - Geographic Distribution of Ethanol Sales

1. The first major assumption is that, due to investments required at the terminal level to blend ethanol (tanks, blending equipment, etc.) and various technical and logistic challenges, the targeted volume would be achieved by converting as few terminals as possible. This in turn means that ethanol volumes would be directed to the larger population centers within each PADD and the terminals that service those areas.

2. Demand for gasoline ethanol blends have been developed based on population estimates (1999 Census estimates). This assists in determining more detailed gasoline distribution within each PADD. Since this study is supply driven (i.e. a need to increase demand) it is assumed that all blended gasoline, whether conventional or reformulated, is blended to the currently permitted maximum 10v% level and that ethanol would be used in all three grades. The exception to this is California where it is assumed that ethanol will be blended at 5.7 v% due to NOx limitations in the California Predictive Model for CaRFG3. This was accomplished as follows:

   Step 1: Cities, or Metropolitan Statistical Areas (MSAs), were broken down into two groups. Group I was cities/MSAs with populations exceeding 250,000. Group II was for cities exceeding 100,000 population but less than 250,000. These calculations were based on 1999 U.S. Census Bureau estimates. The cities/MSAs were also separated by PADD. See Appendix A.

Step 2: Total population for each PADD was determined by combining total state populations for each PADD, again using US Census Bureau data. See Appendix B.

Step 3: Gasoline sales for each PADD were totaled using the December 1999 "Monthly Motor Fuel Reported by State, Monthly Gasoline Reported by State-1998" figures from the Department of Transportation Federal Highway Administration (FHA) reports. Utilizing projected gasoline demand from the FHA reports and the ethanol use volumes from the scenarios developed by TMS, a factor was developed to calculate the amount of ethanol that would need to be sold in each PADD for each study case. As an example, gasoline demand in PADD I was 45,786,939,655 annual gallons. The volume of ethanol to be used in PADD I for Study Case B1 was 1.3 billion gallons. Dividing 1.3 billion gallons by the 45,786,939,655 gallons of gasoline yields a factor of 2.839 indicating that 2.839% of all fuel sold in PADD I - Study Case B1 would need to be ethanol. (This would also mean that sales of gasoline ethanol blends at 10v% ethanol content would need to be 28.39% of the total gasoline market. A factor for each PADD and each study case was developed (see Appendix C). Since the E-85 volumes were small, we did not subtract these volumes before developing the demand factor. In reality, the percentage of ethanol blends sold would be lower than that indicated. This is because the percentages are based on 1998 gasoline sales and sales will increase each year. Also, the addition of ethanol will typically result in a 2% to 3% fuel economy penalty which will increase total demand slightly.

Step 4: A spreadsheet was developed to accomplish the following:

a) Estimate each city's/MSA's percentage of the total population for the PADD in which it was located.

b) The projected gasoline demand for each city/MSA was estimated by multiplying its percentage of PADD population times total gasoline demand within its PADD.

Note that the intent here was to identify a reasonable cap for the ethanol market, to limit the percentage of blend sales to under 100%, or in some cases slightly over, since some gasoline demand increase will occur compared to the 1998 sales figures used.

c) The factor was then applied to each city/MSA's gasoline demand to develop a minimum ethanol usage volume. The above referenced estimates and calculations are included as Appendix D.

Step 5: Of course if only the factor is used, ethanol volumes would not reach the TMS use volumes unless applied market-wide, not just high gasoline volume cities and MSAs with populations over 100,000. So the next step was to adjust the ethanol use volumes upwards (above the factored volumes) so that the highest volume of ethanol use possible/reasonable could be achieved in the most widely populated areas. This also results in fewer small terminals requiring alterations such as additional tanks or blending equipment. Similarly, fewer low volume retail locations would incur conversion costs. These calculations were done manually and are presented in the sections on each of the study cases. Note that the base gasoline numbers are from 1998. Gasoline demand is generally increasing at a rate of 1.5% to 2.0% annually. In some areas for Study Case C, gasoline ethanol blends exceed 100% market share. However, it is assumed that gasoline demand will increase during the time frame it takes to reach the higher ethanol production volumes in Study Case C. Also the 2-3% fuel economy penalty of ethanol blends will itself cause some demand increase as ethanol blend sales increase. The percentages were simply used as guidelines to make sure that we were not putting to much ethanol in each market area (i.e., no more than slightly over 100% in a given market area).

3. In addition, a small percentage of the ethanol volume required is achieved by the sale of E-85 blends in PADDs I and II. The assumption for sales volumes and associated distribution costs are discussed in the applicable study case sections.

4. Other assumptions such as those affecting transportation modes and cost, terminal alterations and costs, and retail unit conversion costs are more study case specific and therefore discussed

separately under each study case.

**Section 3: Methodology and Development of Production and Sales Volume by Geographic Area**

**References**

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**General References**

# Section 4

## Study Case B1

## 4.0 Study Case B1

Information developed for Study Case B1 is included in this section.

### 4.1 Ethanol Production

Study Case B1 is based on a total ethanol production scenario of 5.1 billion gallons of annual ethanol production. The production of ethanol by PADD and feedstock type as well as the amount exported/imported and used in each PADD is recapped in the following table.

**Table 4-1 Ethanol Production, Use, Import and Export by PADD (Case B1 - 5.1 BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 0.2 | 0.2 | | 1.1 | 1.3 |
| 2 | 4.0 | 0.5 | 4.5 | 2.3 | | 2.2 |
| 3 | | 0.2 | 0.2 | | 0.5 | 0.7 |
| 4 | | | 0.0 | | 0.1 | 0.1 |
| 5 | | 0.2 | 0.2 | | 0.6 | 0.8 |
| | 4.0 | 1.1 | 5.1 | 2.3 | 2.3 | 5.1 |

The scenario generated by TMS for Case B1 is schematic in design and does not attempt to capture the small volumes of existing production in PADD IV. Actually there is 0.0125 bgy of ethanol production already in PADD IV, so for Study Case B1 we have raised the total targeted production to 5.1125 bgy. This was done so as not to distort other PADD production in relationship to the total in the plant listing. The small amount of existing PADD IV production is assumed to be used in PADD IV as is currently the case. No additional terminals or transportation demands are necessary for this small volume.

In Study Case B1 the majority of increased ethanol production is in PADD II and is grain based. In order to develop transportation cost information and assess transportation demand, it is necessary to hypothesize where increased production may be located. There are, of course, already existing plants with nominally 1.8 billion gallons of annual capacity so these can be discussed first. These plants are listed in Table 4-2A. It is likely that larger scale producers would expand existing production in an increased production/demand situation. Some production increases may come from technology advances such as new enzymes. In addition, ethanol plants are largely modular so it takes less lead time and capital to expand an existing facility. Consequently, Table 4-2A also lists the plants most capable of expansion and assumes these plants will expand production by 30%. Total projected annual capacity is listed in the last column. This is also a good point to note that there are significant differences in volume scales between ethanol plants and petroleum refineries. Where a 250,000 barrel per day (bpd) refinery might produce nearly two billion gallons of gasoline annually, an ethanol plant rated at 50 million gallons annually would only produce slightly over 2,000 bpd. Consequently, the ethanol industry tends to express volumes and transactions in gallons while the petroleum industry generally uses barrels or barrels per day. Where appropriate annual volume in barrels or barrels per calendar day (bcd) are provided for the convenience of the reader.

## Table 4-2A Annual US Ethanol Production Capacity - Existing Plants

| Company | City | State | Feedstock | Current Rated Capacity mmgy | Total Projected Capacity (1) (mmgy) |
|---|---|---|---|---|---|
| A.E. Staley | Loudon | TN | grain | 45.0 | 58.5 |
| AGP | Hastings | NE | grain | 52.0 | 67.6 |
| Agri-Energy | Luverne | MN | grain | 17.0 | 17.0 |
| Alchem | Grafton | ND | grain | 10.5 | 10.5 |
| Al-Corn | Claremont | MN | grain | 17.0 | 17.0 |
| Archer Daniels Midland | Decatur | IL | grain | 750.0 | 975.0 |
| (total capacity) | Peoria | IL | grain | | |
| | Cedar Rapids | IA | grain | | |
| ADM | Walhalla | ND | grain | 28.0 | 36.4 |
| Broin Enterprises | Scotland | SD | grain | 7.0 | 7.0 |
| Cargill (total capacity) | Blair | NE | grain | 100.0 | 130.0 |
| | Eddyville | IA | grain | | |
| Central Minnesota | Little Falls | MN | grain | 18.0 | 18.0 |
| Chief Ethanol | Hastings | NE | grain | 62.0 | 80.6 |
| Chippewa Valley Ethanol | Benson | MN | grain | 19.0 | 19.0 |
| Corn Plus | Winnebago | MN | grain | 20.0 | 20.0 |
| DENCO, LLC. | Morris | MN | grain | 15.0 | 15.0 |
| ESE Alcohol | Leoti | KS | grain | 1.1 | 1.1 |
| Ethanol2000 | Bingham Lake | MN | grain | 28.0 | 28.0 |
| Exol, Inc. | Albert Lea | MN | grain | 17.0 | 17.0 |
| Georgia-Pacific | Bellingham | WA | waste | 7.0 | 7.0 |
| Golden Cheese | Corona | CA | waste | 2.8 | 2.8 |
| Golden Triangle | Craig | MO | grain | 15.0 | 15.0 |
| Gopher State Ethanol | St. Paul | MN | grain | 15.0 | 15.0 |
| Grain Processing Corp. | Muscatine | IA | grain | 10.0 | 10.0 |
| Heartland Corn Products | Winthrop | MN | grain | 17.0 | 17.0 |
| Heartland Grain Fuel | Aberdeen | SD | grain | 8.0 | 8.0 |
| | Huron | SD | grain | 14.0 | 14.0 |
| High Plains Corporation | York | NE | grain | 50.0 | 61.0 |
| (total capacity) | Colwich | KS | grain | | |
| | Portales | NM | grain | 20.0 | 30.0 |
| J.R. Simplot (total capacity) | Caldwell | ID | waste | 6.0 | 6.0 |
| | Burley | ID | waste | | |
| Kraft, Inc. | Melrose | MN | waste | 2.6 | 2.6 |
| Manildra Ethanol | Hamburg | IA | grain | 7.0 | 7.0 |
| Merrick/Coors | Golden | CO | waste | 1.5 | 1.5 |
| Midwest Grain (total capacity) | Pekin | IL | grain | 108.0 | 140.4 |
| | Atchison | KS | grain | | |
| Minnesota Corn Processors | Columbus | NE | grain | 110.0 | 143.0 |
| | Marshall | MN | grain | | |
| Minnesota Energy | Buffalo Lake | MN | grain | 12.0 | 12.0 |
| New Energy Corp. | South Bend | IN | grain | 85.0 | 110.5 |
| Northeast MO Grain Processors | Macon | MO | grain | 15.0 | 15.0 |
| Pabst Brewing | Olympia | WA | waste | 0.7 | 0.7 |
| Parallel Products | Louisville | KY | waste | 3.0 | 3.0 |
| | Barstow | FL | waste | 5.0 | 5.0 |
| | R. Cucamonga | CA | waste | 4.0 | 4.0 |
| Permeate Refining | Hopkinton | IA | waste | 1.5 | 1.5 |
| Pro-Corn | Preston | MN | grain | 18.0 | 18.0 |
| Reeve Agri-Energy | Garden City | KS | grain | 10.0 | 10.0 |
| Sunrise Energy | Blairstown | IA | grain | 7.0 | 7.0 |
| Sutherland Associates | Sutherland | NE | grain | 15.0 | 15.0 |
| Williams Energy Services | Pekin | IL | grain | 100.0 | 130.0 |
| Nebraska Energy (Williams Energy) | Aurora | NE | grain | 30.0 | 30.0 |
| Wyoming Ethanol | Torrington | WY | grain | 5.0 | 5.0 |
| **Total Existing Capacity** | | | | 1837.7 | |
| **Total Capacity with Expansion (56.3 mm barrels annual - 154 mbcd)** | | | | | **2364.7** |

(1) Total projected capacity assumes 30% increase in existing production at selected facilities



*Source: BBI International – November 2000*

Existing plants with applicable expansion would result in ethanol production by PADD as listed in Table 4-2B.

**Table 4-2B Annual US Ethanol Production Capacity by PADD Existing Plants with Expansion (mmgy)**

| | PADD I | PADD II | PADD III | PADD IV | PADD V | TOTALS |
|---|---|---|---|---|---|---|
| Grain | 0.0 | 2295.6 | 30.0 | 5.0 | 0.0 | 2330.6 |
| Cellulose | 5.0 | 7.1 | 00.0 | 7.5 | 14.5 | 34.1 |
| TOTAL | 5.0 | 2302.7 | 30.0 | 12.5 | 14.5 | 2364.7 |
| **Cumulative Grain** | **0.0** | **2295.6** | **30.0** | **5.0** | **0.0** | **2330.6** |
| **Cumulative Cellulose** | **5.0** | **7.1** | **0.0** | **7.5** | **14.5** | **34.1** |
| **Cumulative Total** | **5.0** | **2302.7** | **30.0** | **12.5** | **14.5** | **2364.7 (154 mbcd)** |

## Plants Under Construction

The next step was to add plants that are already known to be under construction. These plants include those listed in Table 4-3.

**Table 4-3 A Plants Under Construction**

| Company | City | State | Feedstock | mmgy |
|---|---|---|---|---|
| Adkins Energy | Lena | IL | grain | 30.0 |
| BC International | Jennings | LA | rice waste | 20.0 |
| Lake Area Corn Processors | Wentworth | SD | grain | 15.0 |
| Tri County Corn Processors | Rosholt | SD | grain | 15.0 |
| Plover Ethanol | Plover | WI | grain | 4.0 |
| Spring Green Ethanol | Spring Green | WI | waste | 0.7 |
| Subtotal Capacity Under Construction | | | | 84.7 (5.5 mbcd) |

*Source: BBI International - November 2000*

Adding plants under construction would result in ethanol production capacity by PADD as listed in Table 4-3B.

**Table 4-3 B Annual US Ethanol Production Capacity by PADD (with Plants Under Construction) mmgy**

| | PADD I | PADD II | PADD III | PADD IV | PADD V | TOTALS |
|---|---|---|---|---|---|---|
| Grain | 0.0 | 64.0 | 0.0 | 0.0 | 0.0 | 64.0 |
| Cellulose | 0.0 | .7 | 20.0 | 0.0 | 0.0 | 20.7 |
| TOTAL | 0.0 | 64.7 | 20.0 | 0.0 | 0.0 | 84.7 |
| **Cumulative Grain** | **0.0** | **2359.6** | **30.0** | **5.0** | **0.0** | **2394.6** |
| **Cumulative Cellulose** | **5.0** | **7.8** | **20.0** | **7.5** | **14.5** | **54.8** |
| **Cumulative Total** | **5.0** | **2367.4** | **50.0** | **12.5** | **24.5** | **2459.4 (160 mbcd)** |

## Proposed Plants

There are also a number of proposed ethanol plants that are under consideration. The future of these plants is obviously somewhat uncertain. However, since assumptions are already being made about plant development and placement, we have chosen some of these plants to be used in this work. Plants chosen are selected based on their potential after discussion with industry personnel and where they fit the geographic and feedstock criteria for the cases studied. Plants under consideration are listed in Table 4-4A. Plants listed in **bold** will be used as plants in this study.

## Table 4-4A Proposed Ethanol Plants/Under Consideration, March 2000

| City | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| **Grain** | | | |
| Undisclosed | CO | 20.0 | grain |
| **Des Moines** | **IA** | **15.0** | **grain** |
| **Spencer** | **IA** | **40.0** | **grain** |
| **Cascade** | **IL** | **100.0** | **grain** |
| **Pratte** | **KS** | **15.0** | **grain** |
| Undisclosed | KS | 40.0 | grain |
| Undisclosed | KY | 20.0 | grain |
| **Lansing** | **MI** | **40.0** | **grain** |
| **St. Paul** | **MN** | **30.0** | **grain** |
| **Cape Girardo** | **MO** | **30.0** | **grain** |
| Great Falls | MT | 75.0 | grain |
| **Neely** | **NE** | **15.0** | grain |
| Central State | NJ | 10.0 | grain |
| Clatskanie | OR | 80.0 | grain |
| **Milbank** | **SD** | **40.0** | **grain** |
| **Platte** | **SD** | **15.0** | **grain** |
| **Rosholt** | **SD** | **15.0** | **grain** |
| Undisclosed | TX | 30.0 | grain |
| Moses Lake | WA | 40.0 | grain |
| **Lacrosse** | **WI** | **20.0** | **grain** |
| Subtotal all | | 690.0 | |
| **Subtotal plants used in this study** | | **375.0** | |
| **Biomass Conversion** | | | |
| SE Region | AL | 8.0 | **forest** |
| **Susanville** | **CA** | **15.0** | **forest** |
| **Gridley** | **CA** | **20.0** | **rice waste** |
| **Mission Viejo** | **CA** | **8.0** | **rice waste** |
| **Chester** | **CA** | **20.0** | **forest** |
| Onslow County | NC | 60.0 | sweet potatoes |
| **Greene County** | **NC** | **60.0** | **sweet potatoes** |
| Martin County | NC | 60.0 | sweet potatoes |
| Middle Town | NY | 10.0 | MSW |
| **Bend** | **OR** | **30.0** | **forest** |
| **Philadelphia** | **PA** | **15.0** | **MSW** |
| Black Hills | WY | 12.0 | forest |
| Subtotal all | | 318.0 | |
| **Subtotal plants used in this study** | | **168.0** | |
| Total New Capacity Under Consideration | | | 1,008.0 |
| **Total New Capacity Under Consideration Used in This Study** | | | **543.0** (35.4 mbcd) |

Total of plants under consideration used in this study - 19.

Adding the selected proposed plants would bring the total U.S. ethanol production by PADD to the totals listed in Table 4-4B.

**Table 4-4B US Ethanol Production Capacity by PADD - mmgy (with Selected Proposed Plants)**

| | PADD I | PADD II | PADD III | PADD IV | PADD V | TOTALS |
|---|---|---|---|---|---|---|
| Grain | 0.0 | 375.0 | 0.0 | 0.0 | 0.0 | 375.0 |
| Cellulose | 75.0 | 0.0 | 0.0 | 0.0 | 93.0 | 168.0 |
| TOTAL | 75.0 | 375.0 | 0.0 | 0.0 | 93.0 | 543.0 |
| **Cumulative Grain** | **0.0** | **2734.6** | **30.0** | **5.0** | **0.0** | **2769.6** |
| **Cumulative Cellulose** | **80.0** | **7.8** | **20.0** | **7.5** | **107.5** | **222.8** |
| **Cumulative Total** | **80.0** | **2742.4** | **50.0** | **12.5** | **107.5** | **2992.4** |
| | | | | | | **(195.2 mbcd)** |

Based on the previous table this provides a starting point of 2,992,400,000 gallons of annual ethanol production (195.2 mbcd) before making broader assumptions about plant placement.

The remaining plants must be positioned to achieve the assigned production case in each PADD. Beyond that, assumptions must be made about where, in each PADD, these plants will be located. This is done based on availability of feedstock, proximity to the demand set forth in the cases provided, and transportation modes available. In the case of grain based production, plants are simply located in major grain markets and where possible, on navigable waters. Positioning of cellulosic based plants is more complicated because the transportation cost of feedstock is greater than for ethanol transportation. Plants must therefore be placed relatively close to their feedstock source. In determining such placement, the following assumptions are used.

**For Corn Stover Based Plants** - We assume 1.7 Bone Dry Tons (BDT) of feedstock per acre. Yield 80 gallons per bone dry ton.

**For Forest Residue/Thinnings Based Plants** - We assume a 40 mile radius wooded area would equate to 520,000 BDT yielding 60 gallons per BDT.

**For Agricultural Residue Based Plants** - We assume a 40 mile radius would provide 640,000 BDT. Yield of 71 gallons per BDT.

**For Urban Waste Based Plants** - We use a yield of 70 gallons per BDT and assume that an area could not generate more than 285,000 BDT per year for each 400,000 residents including related industry.

Based on this, we are including theoretical plants in the following locations:

**Table 4-5A: Location of Theoretic Plants and Volumes**

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD I | Miami | FL | MSW | 20.0 | |
| | New York City | NY | MSW | 50.0 | |
| | Philadelphia | PA | MSW | 50.0 | |
| | TOTAL | | Cellulosic | 120.0 | (7.8 mbcd) |
| | TOTAL | | grain | 0.0 | |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD II | Indianapolis | IN | grain | 50.0 | |
| | Mt. Carmel | IL | grain | 50.0 | |
| | Burlington | IA | grain | 35.0 | |
| | Davenport | IA | grain | 30.0 | |
| | Des Moines | IA | grain | 50.0 | |
| | Waterloo | IA | grain | 30.0 | |
| | Salinas | KS | grain | 50.0 | |
| | Topeka | KS | grain | 50.0 | |
| | Witchita | KS | grain | 50.0 | |
| | Louisville | KY | grain | 50.0 | |
| | Bowling Green | KY | grain | 50.0 | |
| | Jackson | MI | grain | 45.0 | |
| | Kalamazoo | MI | grain | 50.0 | |
| | Mankato | MN | grain | 30.0 | |
| | St. Paul | MN | grain | 40.0 | |
| | Jefferson City | MO | grain | 50.0 | |
| | St. Louis | MO | grain | 50.0 | |
| | Springfield | MO | grain | 40.0 | |
| | Sioux City | NE | grain | 33.4 | |
| | Auburn | NE | grain | 50.0 | |
| | Omaha | NE | grain | 50.0 | |
| | Bismarck | ND | grain | 30.0 | |
| | Fargo | ND | grain | 17.0 | |
| | Cincinnati | OH | grain | 50.0 | |
| | Mansfield | OH | grain | 50.0 | |
| | Oklahoma City | OK | grain | 25.0 | |
| | Tulsa | OK | grain | 20.0 | |
| | Rapid City | SD | grain | 20.0 | |
| | Sioux Falls | SD | grain | 30.0 | |
| | Memphis | TN | grain | 50.0 | |
| | Milwaukee | WI | grain | 40.0 | |
| | Decatur | IL | corn stover | 50.0 | |
| | Peoria | IL | corn stover | 50.0 | |
| | South Bend | IN | corn stover | 50.0 | |
| | Cedar Rapids | IA | corn stover | 50.0 | |
| | Eddyville | IA | corn stover | 50.0 | |
| | Louisville | KY | corn stover | 50.0 | |
| | Twin Cities | MN | corn stover | 50.0 | |
| | St. Louis | MO | corn stover | 50.0 | |
| | Omaha | NE | corn stover | 50.0 | |
| | Cincinnati | OH | corn stover | 42.2 | |
| | TOTAL | | Cellulosic | 492.2 | (32.1 mbcd) |
| | TOTAL | | Grain | 1265.4 | (82.5 mbcd) |

**Table 4-5A: Location of Theoretic Plants and Volumes (continued)**

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD III | Houston | TX | MSW | 50.0 | |
| | New Orleans | LA | MSW | 50.0 | |
| | Baton Rouge | LA | MSW | 50.0 | |
| | TOTAL | | Cellulosic | 150.0 | (9.7 mbcd) |
| | TOTAL | | Grain | 0.0 | |
| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
| PADD IV | --- | --- | --- | --- | |
| | TOTAL | | Grain/Cellulosic | 0.0 | |
| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
| PADD V | Los Angeles (south) | CA | MSW | 52.5 | |
| | San Francisco | CA | MSW | 40.0 | |
| | TOTAL | | Cellulosic | 92.5 | (6.0 mbcd) |
| | TOTAL | | Grain | 0.0 | |
| TOTAL ALL | | | Cellulosic | 854.7 | (55.8 mbcd) |
| TOTAL ALL | | | Grain | 1265.4 | (82.5 mbcd) |
| **GRAND TOTAL ALL PADDS** | | | | **2120.1** | **(138.3 mbcd)** |

After adding in theoretical plant locations, the production by PADD meets the criteria for Study Case B-1 as depicted in Table 4-5B.

**Table 4-5B: US Ethanol Production Capacity by PADD - mmgy (with Theoretical Plant Locations)**

| | PADD I | PADD II | PADD III | PADD IV | PADD V | TOTALS |
|---|---|---|---|---|---|---|
| Grain | 0.0 | 1265.4 | 0.0 | 0.0 | 0.0 | 1265.4 |
| Cellulose | 120.0 | 492.2 | 150.0 | 0.0 | 92.5 | 854.7 |
| TOTAL | 120.0 | 1757.6 | 150.0 | 0.0 | 92.5 | 2120.1 |
| **Cumulative Grain** | **0.0** | **4000.0** | **30.0** | **5.0** | **0.0** | **4035.0** |
| **Cumulative Cellulose** | **200.0** | **500.0** | **170.0** | **7.5** | **200.0** | **1077.5** |
| **Cumulative Total** | **200.0** | **4500.0** | **200.0** | **12.5** | **200.0** | **5112.5** |
| **MBCD** | **13.0** | **293.5** | **13.0** | **0.8** | **13.0** | **333.5** |

Collectively, including the above hypothetical plants would bring total ethanol production capacity to the 5.1125 billion gallons of annual production (333.5 mbcd) required in Study Case B1. (After adding the 0.0125 bgy of production in PADD IV not included in the TMS scenario.)

The plants separated by PADD would be as listed in Table 4-6. Note than a company listing in bold indicates total production for more than one plant.

**Table 4-6: Final Plant Count By PADD- Study Case B1 -mmgy**

**PADD I**

| Plant location | State | Capacity | Feedstock |
|---|---|---|---|
| Parallel Products | FL | 5.0 | waste |
| Miami | FL | 20.0 | MSW |
| Greene County | NC | 60.0 | sweet potatoes |
| New York City | NY | 50.0 | MSW |
| Philadelphia | PA | 15.0 | MSW |
| Philadelphia | PA | 50.0 | MSW |
| Total Grain | | 0.0 | |
| Total Cellulosic | | 200.0 | |
| Grand Total - 6 production facilities | | 200.0 | (13.0 mbcd) |

**PADD II**

| Plant location | State | Capacity | Feedstock |
|---|---|---|---|
| **ADM, Decatur** | **IL** | **975.0** | **grain** |
| ADM, Peoria | IL | | grain |
| **Midwest Grain, Pekin** | **IL** | **140.4** | **grain** |
| Williams Energy Services, Pekin | IL | 130.0 | grain |
| Adkins Energy, Lena | IL | 30.0 | grain |
| L Cascade | IL | 100.0 | grain |
| Mt. Carmel | IL | 50.0 | grain |
| New Energy Corp., S. Bend | IN | 110.5 | grain |
| Indianapolis | IN | 50.0 | grain |
| ADM, Cedar Rapids | IA | | grain |
| Cargill, Eddyville | IA | | grain |
| GPC. , Muscatine | IA | 10.0 | grain |
| Manildra Ethanol , Hamburg | IA | 7.0 | grain |
| Sunrise Energy, Blairstown | IA | 7.0 | grain |
| Des Moines | IA | 15.0 | grain |
| Spencer | IA | 40.0 | grain |
| Burlington | IA | 35.0 | grain |
| Davenport | IA | 30.0 | grain |
| Des Moines | IA | 50.0 | grain |
| Waterloo | IA | 30.0 | grain |
| ESE Alcohol , Leoti | KS | 1.1 | grain |
| High Plains Corporation, Colwich | KS | | grain |
| Midwest Grain, Atchison | KS | | grain |
| Reeve Agri-Energy, Garden City | KS | 10.0 | grain |
| Pratte | KS | 15.0 | grain |
| Salinas | KS | 50.0 | grain |
| Topeka | KS | 50.0 | grain |
| Witchita | KS | 50.0 | grain |
| Louisville | KY | 50.0 | grain |

**PADD II con't.**

| | | | |
|---|---|---|---|
| Bowling Green | KY | 50.0 | grain |
| Lansing | MI | 40.0 | grain |
| Jackson | MI | 45.0 | grain |
| Kalamazoo | MI | 50.0 | grain |
| Al-Corn, Claremont, | MN | 17.0 | grain |
| Central MN , Little Falls | MN | 18.0 | grain |
| Chip. Valley Ethanol , Benson | MN | 19.0 | grain |
| Corn Plus , Winnebago | MN | 20.0 | grain |
| DENCO, LLC. , Morris | MN | 15.0 | grain |
| Ethanol2000 , Bingham Lake | MN | 28.0 | grain |
| Exol, Inc. , Albert Lea | MN | 17.0 | grain |
| Gopher State Eth, St. Paul | MN | 15.0 | grain |
| Heartland Corn Pdts ,Winthrop | MN | 17.0 | grain |
| Agri-Energy , Luverne, | MN | 17.0 | grain |
| MPC, Marshall | MN | | grain |
| MN Energy, Buffalo Lake | MN | 12.0 | grain |
| Pro-Corn, Preston | MN | 18.0 | grain |
| St. Paul | MN | 30.0 | grain |
| Mankato | MN | 30.0 | grain |
| St. Paul | MN | 40.0 | grain |
| NE MO Grain Processors, Macon, MO | MO | 15.0 | grain |
| Golden Triangle, St. Joseph | MO | 15.0 | grain |
| Cape Girado | MO | 30.0 | grain |
| Jefferson City | MO | 50.0 | grain |
| St. Louis | MO | 50.0 | grain |
| Springfield | MO | 40.0 | grain |
| AGP , Hastings , | NE | 67.6 | grain |
| **Cargill , Blair** | **NE** | **130.0** | **grain** |
| **MPC, Columbus** | **NE** | **143.0** | **grain** |
| **High Plains Corporation , York** | **NE** | **61.0** | **grain** |
| Chief Ethanol , Hastings | NE | 80.6 | grain |
| Sutherland Associates, Sutherland | NE | 15.0 | grain |
| Williams Energy, Aurora | NE | 30.0 | grain |
| Sioux City | NE | 33.4 | grain |
| Lincoln | NE | 50.0 | grain |
| Omaha | NE | 50.0 | grain |
| Neely | NE | 15.0 | grain |
| ADM, Walhalla | ND | 36.4 | grain |
| Alchem , Grafton | ND | 10.5 | grain |
| Bismarck | ND | 30.0 | grain |
| Fargo | ND | 17.0 | grain |
| Cincinnati | OH | 50.0 | grain |
| Mansfield | OH | 50.0 | grain |
| Oklahoma City | OK | 25.0 | grain |
| Tulsa | OK | 20.0 | grain |

**PADD II con't.**

| | | | |
|---|---|---|---|
| Heartland Grain Fuel , Aberdeen | SD | 8.0 | grain |
| Heartland Grain, Huron | SD | 14.0 | grain |
| Lake Area Corn Processors, Wentworth | SD | 15.0 | grain |
| Tri County Corn Processors, Rosholt | SD | 15.0 | grain |
| Broin Enterprises, Scotland | SD | 7.0 | grain |
| Milbank | SD | 40.0 | grain |
| Platte | SD | 15.0 | grain |
| Rosholt | SD | 15.0 | grain |
| Rapid City | SD | 20.0 | grain |
| Sioux Falls | SD | 30.0 | grain |
| A.E. Staley , Loudon, | TN | 58.5 | grain |
| Nashville | TN | 50.0 | grain |
| Milwaukee | WI | 40.0 | grain |
| Plover Ethanol, Plover | WI | 4.0 | grain |
| Lacrosse | WI | 20.0 | grain |
| Decatur | IL | 50.0 | stover |
| Peoria | IL | 50.0 | stover |
| South Bend | IN | 50.0 | stover |
| Permeate Refining, Hopkinton | IA | 1.5 | waste |
| Cedar Rapids | IA | 50.0 | stover |
| Eddyville | IA | 50.0 | stover |
| Parallel Products, Louisville | KY | 3.0 | waste |
| Louisville | KY | 50.0 | stover |
| Kraft, Inc., Melrose | MN | 2.6 | waste |
| Twin Cities | MN | 50.0 | stover |
| St. Louis | MO | 50.0 | stover |
| Omaha | NE | 50.0 | stover |
| Cincinnati | OH | 42.2 | stover |
| Spring Green Ethanol, Spring Green | WI | 0.7 | waste |
| Total Grain | | 4000.0 | |
| Total Cellulosic | | 500.0 | |
| Grand Total - 103 production facilities | | 4500.0 | (293.5 mbcd) |

**PADD III**

| Plant location | State | Capacity | Feedstock |
|---|---|---|---|
| High Plains | NM | 30.0 | grain |
| BC International | LA | 20.0 | rice waste |
| New Orleans | LA | 50.0 | MSW |
| Baton Rouge | LA | 50.0 | MSW |
| Houston | TX | 50.0 | MSW |
| Total Grain | | 30.0 | |
| Total Cellulosic | | 170.0 | |
| Grand Total - 5 production facilities | | 200.0 | (13 mbcd) |

**PADD IV**

| Plant location | State | Capacity | Feedstock |
|---|---|---|---|
| Wyoming Ethanol | WY | 5.0 | grain |
| Merrick/Coors | CO | 1.5 | waste |
| **JR Simplot** | **ID** | **6.0** | **waste** |
| JR Simplot | ID | | waste |
| | | | |
| Total Grain | | 5.0 | |
| Total Cellulosic | | 7.5 | |
| Grand Total - 4 production facilities | | 12.5 | (0.8 mbcd) |

**PADD V**

| Plant location | State | Capacity | Feedstock |
|---|---|---|---|
| Parallel Products - Los Angeles | CA | 4.0 | waste |
| Golden Cheese-Corona | CA | 2.8 | waste |
| Susanville | CA | 15.0 | forest |
| Gridley | CA | 20.0 | rice waste |
| Mission Viejo | CA | 8.0 | rice waste |
| Chester | CA | 20.0 | forest |
| Los Angeles | CA | 52.5 | MSW |
| San Francisco | CA | 40.0 | MSW |
| Pabst Brewing | WA | 0.7 | waste |
| Georgia Pacific | WA | 7.0 | waste |
| Bend | OR | 30.0 | forest |
| Total Grain | | 0.0 | |
| Total Cellulosic | | 200.0 | |
| Grand Total - 11 production facilities | | 200.0 | (13.0 mbcd) |

**TOTAL ALL PADDS - 129 PRODUCTION FACILITIES 5112.5(333.5 MBCD)**

## 4.2 Ethanol Markets - Study Case B1

While the ethanol markets by PADD have been provided in the base assumptions, in order to determine the number of terminals and retail locations involved, it is necessary to make some additional assumptions about the most likely ethanol markets. These assumptions are also necessary to assess transportation modes and costs as well as identifying any shortfalls in current transportation capabilities.

Most ethanol is currently sold in PADD II. Case B1 reflects significant increased use in PADD II as well as increased use in other PADDs. To determine potential ethanol market scenarios, we started by determining the cities in each PADD that were in two population categories, those over 250,000 and those between 100,000 and 250,000 (see Appendix A). We then developed the population for each PADD (see Appendix B). Based on the targeted projected ethanol use, we developed a factor that would create the demand necessary (in each PADD) for each of the two cases studied (see Appendix C). A spreadsheet was developed to calculate gasoline demand within each area and apply the necessary factor to determine ethanol demand in each area. These various calculations are included as Appendix D. Unfortunately mathematics will only take things so far. It is safe to assume that in a supply driven scenario, with large ethanol volumes available, that petroleum marketers would seek to move the product through as few terminals as possible. This is due to the need to make investments at the terminal level for tankage (either conversion of existing tanks or new tanks) as well as blending equipment, piping modifications and changes to accommodate delivery by other than traditional modes (i.e. rail, truck).

Because of this, the next step was to try and direct higher volumes (above the factor used) of ethanol into the largest population centers since this would result in fewer terminal conversions. In addition these areas usually have several servicing terminals (usually with a greater number of tanks) making it easier to have only a portion of the terminals offer ethanol to achieve desired throughput. Moreover the greater number of terminals would provide more flexibility in adjusting for exchange agreements of blended product for non-blended product among companies.

Based on the aforementioned considerations and assumptions, ethanol demand by areas within each PADD is broken down in the following tables.

**Table 4-7A PADD I Ethanol Use Study Case B1**

PADD I Target Use: 1.3 billion gallon ethanol annually
.1 billion gallons ethanol in E-85 (.125 billion gallons E85)
1.2 billion gallons ethanol in E10 (12 billion gallons gasoline ethanol blend)

| Cities over 250,000 | Gasoline Demand | Case B1 (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Albany/Schenectady/Troy NY | 394,668,044 | 10 | 25.34% |
| Allentown/Bethlehem/Easton PA | 280,678,876 | 10 | 35.63% |
| Atlanta GA | 1,750,797,527 | 20 | 11.42% |
| Augusta/Aiken GA | 209,176,233 | 10 | 47.81% |
| Boston/Worcester/Lawrence MA | 2,572,443,347 | 100 | 38.87% |
| Buffalo/Niagra Fallsa NY | 518,426,843 | 20 | 38.58% |
| Charleston/North Charleston SC | 250,926,053 | 10 | 39.85% |
| Charleston WV | 114,023,212 | | |
| Charlotte/Gastonia/Rock Hill NC/SC | 643,297,283 | 20 | 31.09% |
| Columbia SC | 234,334,520 | | |
| Columbus GA | 123,200,483 | | |
| Daytona Beach FL | 215,478,855 | | |
| Erie PA | 125,731,518 | 5 | 39.77% |
| Fayetteville NC | 128,753,236 | | |
| Fort Myers/Cape Coral FL | 181,812,369 | 5 | 27.50% |
| Fort Pierce/Port St. Lucie FL | 136,159,781 | | |
| Greensboro/Winston Salem/High Point NC | 535,341,110 | 20 | 37.36% |
| Greenville/Spartanburg/Anderson SC | 421,944,302 | 15 | 35.55% |
| Harrisburg/Lebanon/Carisle PA | 280,690,224 | 10 | 35.63% |
| Hartford CT | 520,870,272 | 20 | 38.40% |
| Hickory/Morganton/Lenoir NC | 147,895,322 | | |
| Jacksonville FL | 479,485,855 | 15 | 31.28% |
| Lakeland/Winter Haven FL | 207,597,060 | 5 | 24.09% |
| Lancaster PA | 208,817,186 | 10 | 47.89% |
| Macon GA | 145,972,988 | | |
| Melbourne/Titusville/Palm Bay FL | 213,506,137 | | |
| Miami/Fort Lauderdale | 1,684,528,080 | 50 | 29.68% |
| New London/Norwich CT | 128,951,597 | 10 | 77.55% |
| New York/Long Island/et.al. NY/NJ/CT/PA | 9,167,579,432 | 300 | 32.72% |
| Norfolk/Virginia Beach/Newport News VA/NC | 709,304,820 | 30 | 42.29% |
| Orlando FL | 696,762,671 | 20 | 28.70% |
| Pensacola FL | 183,102,398 | 5 | 27.31% |
| Phil./Wilmington/Atl. City PA/NJ/DE/MD | 2,723,056,716 | 90 | 33.05% |
| Pittsburgh PA | 1,058,230,401 | 50 | 47.25% |
| Providence/Fall River/Warwick RI/MA | 510,945,402 | 15 | 29.36% |
| Raleigh-Durham/Chapel Hill NC | 501,819,877 | 15 | 29.89% |
| Reading PA | 162,597,656 | 10 | 61.50% |
| Richmond/Petersburg VA | 436,401,977 | 15 | 34.37% |

**PADD I con't.**

| | | | |
|---|---|---|---|
| Rochester NY | 489,808,356 | 20 | 40.83% |
| Sarasota/Bradenton FL | 249,688,678 | 5 | 20.02% |
| Savannah GA | 130,921,138 | | |
| Scranton/Wilkes-Barre/Hazelton PA | 277,565,921 | 10 | 36.03% |
| Springfield MA | 260,520,472 | 10 | 38.38% |
| Syracuse NY | 332,684,017 | 15 | 45.09% |
| Tallahassee FL | 118,019,487 | | |
| Tampa/St. Petersburg/Clearwater FL0 | 1,034,097,056 | 30 | 29.01% |
| Utica/Rome NY | 133,028,215 | 10 | 75.17% |
| Washington/Baltimore DC/MD/VA/WV/ | 3,340,386,834 | 160 | 47.90% |
| West Palm Beach/Boca Raton FL | 476,348,389 | 15 | 31.49% |
| York PA | 170,938,361 | 10 | 58.50% |
| | | | |
| PADD I TOTALS (used in E-10) (1) | 36,019,316,587 | 1200 | 33.32% |
| PADD I TOTALS (including E-85) (1) | | 1300 | 36.79% |
| | | (84.8 mbcd) | |

(1) NOTE: calculations are based on 1.2 bgy blended in E-10 yielding 12 billion gallons of E-10 blend or 33.52% of total 1998 gasoline sales. For E-85 the 0.1 bgy of ethanol yields 0.125 bgy of E-85 which when added to E-10 sales represents 36.79% of total gasoline sales for 1998.

**Table 4-7B PADD II Ethanol Use Study Case B1**

PADD II Target Use: 2.2 billion gallon ethanol annually
.2 billion gallons ethanol in E-85 (0.25 billion gallons E85)
2.0 billion gallons ethanol in E10 (20 billion gallons gasoline ethanol blend)

| Cities over 250,000 | Gasoline Demand(mmgy) | Case B1 | Market Share for Blended Fuel |
|---|---|---|---|
| Appleton/Oshkosh/Neehah WI | 172,925,305 | 12 | 69.39% |
| Canton/Massillon OH | 199,929,671 | 12 | 60.02% |
| Chattanooga TN | 224,556,500 | 16 | 71.25% |
| Chicago/Gary/Kenosha IL/IN/WI | 4,414,249,517 | 400 | 90.62% |
| Cincinnati-Hamilton OH/KY/IN | 974,161,618 | 70 | 71.86% |
| Cleveland/Akron OH | 1,445,903,938 | 100 | 69.16% |
| Columbus OH | 739,931,038 | 50 | 67.57% |
| Davenport/Moline/Rock Island IA/IL | 178,261,599 | 15 | 84.15% |
| Dayton/Springfield OH | 476,251,492 | 40 | 83.99% |
| Des Moines IA | 220,315,085 | 15 | 68.08% |
| Detroit/Ann Arbor/Flint MI | 2,716,984,912 | 200 | 73.61% |
| Evansville/Henderson IN/KY | 144,649,708 | 10 | 69.13% |
| Fort Wayne IN | 240,595,185 | 15 | 62.35% |
| Grand Rapids/Muskegon/Holland MI | 522,646,741 | 40 | 76.53% |
| Huntington/Ashland KY | 155,213,999 | 10 | 64.43% |
| Indianapolis IN | 763,367,608 | 60 | 78.60% |
| Johnson City/Kingsport/Bristol TN/VA | 229,889,315 | 15 | 65.25% |
| Kalamazoo/Battle Creek MI | 222,137,234 | 15 | 67.53% |
| Kansas City MO/KS | 872,276,274 | 60 | 68.79% |
| Knoxville TN | 333,872,019 | 25 | 74.88% |
| Lansing/East Lansing MI | 223,938,022 | 15 | 66.98% |
| Lexington KY | 226,336,423 | 15 | 66.27% |
| Louisville KY | 499,674,650 | 40 | 80.05% |
| Madison WI | 212,896,833 | 15 | 70.46% |
| Memphis TN/AR/MS | 548,958,610 | 40 | 72.87% |
| Milwaukee/Racine | 818,774,247 | 60 | 73.28% |
| Minneapolis/St. Paul MN | 1,426,774,852 | 135 | 94.62% |
| Nashville TN | 582,091,615 | 35 | 60.13% |
| Oklahoma City OK | 519,761,009 | 30 | 57.72% |
| Omaha NE/IA | 347,179,468 | 25 | 72.01% |
| Peoria/Pekin IL | 172,120,540 | 15 | 87.15% |
| Rockford IL | 178,161,251 | 15 | 84.19% |
| Saginaw/Bay City/Midland | 199,081,686 | 15 | 75.35% |
| St. Louis MO/IL | 1,276,214,089 | 90 | 70.52% |
| South Bend IN | 128,433,179 | 10 | 77.86% |
| Springfield MO | 153,169,794 | 10 | 65.29% |
| Toledo OH | 302,520,427 | 20 | 66.11% |
| Tulsa OK | 390,518,593 | 25 | 64.02% |
| Wichita KS | 272,584,131 | 15 | 55.03% |
| Youngstown/Warren OH | 292,714,206 | 20 | 68.33% |
| Total | 24,020,022,383 | 1825 | 75.98% |

**PADD II continued**

| | | | |
|---|---|---|---|
| Cities over 100,000/under 250,000 | | | |
| Benton Harbor MI | 79,338,488 | 5 | 63.02% |
| Bloomington IN | 58,083,727 | 5 | 86.08% |
| Bloomington/Normal I | 72,268,471 | 5 | 69.19% |
| Cedar Rapids IA | 91,848,126 | 7 | 76.21% |
| Champaign.Urbana IL | 84,585,859 | 5 | 59.11% |
| Clarksville/Hopkinsville TN/KY | 100,025,441 | 7 | 69.98% |
| Columbia MO | 64,668,898 | 5 | 77.32% |
| Decatur IL | 56,243,695 | 5 | 88.90% |
| Duluth/Superior MN/WI | 117,436,203 | 10 | 85.15% |
| Eau Claire WI | 71,764,747 | 5 | 69.67% |
| Elkhart/Goschen IN | 86,775,617 | 7 | 80.67% |
| Green Bay WI | 107,576,331 | 5 | 46.48% |
| Fargo/Moorehead ND/MN | 84,511,344 | 5 | 59.16% |
| Iowa City IA | 51,571,085 | 5 | 96.95% |
| Jackson MI | 78,127,365 | 5 | 64.00% |
| Jackson TN | 50,477,200 | 3 | 59.43% |
| Janesville/Beloit WI | 75,072,235 | 5 | 66.60% |
| Joplin MO | 74,505,919 | 5 | 67.11% |
| Kokomo IN | 49,864,187 | 3 | 60.16% |
| LaCrosse WI | 60,569,560 | 3 | 49.53% |
| Lafayette IN | 87,152,665 | 5 | 57.37% |
| Lawton OK | 52,966,013 | 3 | 56.64% |
| Lima OH | 76,534,723 | 5 | 65.33% |
| Lincoln NE | 118,060,642 | 10 | 84.70% |
| Mansfield OH | 87,737,859 | 5 | 56.99% |
| Muncie IN | 57,362,915 | 5 | 87.16% |
| Rochester MN | 59,153,768 | 5 | 84.53% |
| St. Cloud MN | 81,923,674 | 5 | 61.03% |
| Sheboygan WI | 54,712,156 | 2 | 36.55% |
| Sioux City IA/NE | 59,898,921 | | |
| Sioux Falls SD | 81,709,070 | | |
| Springfield IL | 101,355,789 | 5 | 49.33% |
| Stuebenville/Weirton OH/WV | 66,215,340 | 5 | 75.51% |
| Terre Haute IN | 73,624,153 | 5 | 67.91% |
| Topeka KS | 84,834,741 | 5 | 58.94% |
| Waterloo/Cedar Falls IA | 59,591,918 | | |
| Wausau WI | 61,392,706 | 5 | 81.44% |
| | | | |
| Total | 2,779,541,551 | 175 | 62.96% |
| PADD II TOTAL (used in E-10) (1) | 26,799,563,934 | 2000 | 74.63% |
| PADD II TOTALS (including E-85) (1) | | 2200 | 84.00% |
| | | (143.5 mbcd) | |

(1) NOTE: calculations are based on 2.0 bgy blended in E-10 yielding 20.0 billion gallons of E-10 blend or 74.93% of total 1998 gasoline sales. For E-85 the 0.2 bgy of ethanol yields 0.25 bgy of E-85 which when added to E-10 sales represents 84.0% of total gasoline sales for 1998.

**Table 4-7C PADD III Ethanol Use Study Case B1**

PADD III Target Use 0.7 billion gallon ethanol annually
0.0 billion gallons ethanol in E-85
0.7 billion gallons ethanol in E10 (7 billion gallons E70)

| Cities over 250,000 | Gasoline Demand | Case B1 (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Albuquerque NM | 360,480,175 | 30 | 83.22% |
| Austin/San Marcos TX | 608,597,720 | 30 | 49.29% |
| Baton Rouge LA | 307,443,144 | 15 | 48.79% |
| Beaumont/Port Arthur TX | 199,806,765 | 10 | 50.05% |
| Biloxi/Gulfport/Pascagoula MS | 187,565,776 | 10 | 53.31% |
| Birmingham Al | 485,941,953 | 25 | 51.45% |
| Brownsville/Harlingen/San Benito TX | 174,781,533 | 10 | 57.21% |
| Corpus Cristi TX | 205,568,012 | 10 | 48.65% |
| Dallas/Fort Worth TX | 2,607,150,213 | 140 | 53.70% |
| El Paso TX | 372,740,812 | 20 | 53.66% |
| Fayetteville/Springdale/Rogers AR | 151,355,260 | 8 | 52.86% |
| Houston/Galveston/Brazoria TX | 2,386,353,584 | 110 | 46.10% |
| Huntsville AL | 182,368,493 | 7 | 38.38% |
| Jackson MS | 229,752,609 | 10 | 43.53% |
| Killeen/Temple TX | 157,355,475 | 7 | 44.49% |
| Lafayette LA | 200,328,246 | 10 | 49.92% |
| Little Rock/North Little Rock AR | 296,890,329 | 15 | 50.52% |
| McAllen/Edinburg/Mission TX | 284,056,699 | 15 | 52.81% |
| Mobile AL | 284,356,737 | 15 | 52.75% |
| Montgomery AL | 171,228,879 | 10 | 58.40% |
| New Orleans LA | 693,260,802 | 45 | 64.91% |
| San Antonio TX | 831,049,599 | 40 | 48.13% |
| Shreveport/Bossier City LA | 200,559,248 | 10 | 49.86% |
| Total | 11,578,992,063 | 602 | 51.99% |
| **Cities over 100,000/under 250,000** | | | |
| Abilene TX | 65,040,645 | 4 | 61.50% |
| Alexandria LA | 67,322,522 | 4 | 59.42% |
| Amarillo TX | 110,823,146 | 6 | 54.14% |
| Anniston AL | 61,887,864 | 3 | 48.47% |
| Auburn/Opelika AL | 54,253,111 | 2 | 36.86% |

**PADD III continued**

| | | | |
|---|---|---|---|
| Bryan/College Station | 71,272,393 | 3 | 42.09% |
| Decatur AL | 76,187,694 | 3 | 39.38% |
| Dothan AL | 71,819,363 | 3 | 41.77% |
| Florence AL | 72,688,144 | 3 | 41.27% |
| Fort Smith AR | 103,843,164 | 4 | 38.52% |
| Gadsdden AL | 54,947,710 | 3 | 54.60% |
| Hattiesburg MS | 60,036,130 | 3 | 49.97% |
| Houma LA | 103,335,490 | 4 | 38.71% |
| Lake Charles LA | 95,909,435 | 4 | 41.71% |
| Laredo TX | 102,586,194 | 4 | 38.99% |
| Las Cruces NM | 90,468,405 | 4 | 44.21% |
| Longview/Marshall TX | 111,249,040 | 5 | 44.94% |
| Lubbock TX | 121018,572 | 5 | 41.32% |
| Monroe LA | 77,888,613 | 3 | 38.52% |
| Odessa/Midland TX | 128,637,925 | 5 | 38.87% |
| San Angelo TX | 54,325,332 | | |
| Santa Fe NM | 75,677,896 | 3 | 39.64% |
| Sherman/Denison TX | 55083,656 | 2 | 36.31% |
| Texarkana TX/AR | 65,257,309 | 3 | 45.97% |
| Tuscaloosa AL | 85,728,348 | 4 | 46.66% |
| Tyler TX | 90,113,671 | 4 | 44.39% |
| Waco TX | 108,461,614 | 4 | 36.88% |
| Wichita Falls TX | 72,483,163 | 3 | 41.39% |
| | | | |
| Total | 2,308,346,549 | 98 | 42.45% |
| PADD III Totals | 13,887,338,615 | 700 | 50.41% |
| | | (45.7 mbcd) | |

**Table 4-7D PADD IV Ethanol Use Study Case B1**

PADD IVTarget Use 0.1 billion gallon ethanol annually
0.0 billion gallons ethanol in E-85
0.1 billion gallons ethanol in E10 (1 billion gallons gasoline ethanol blend)

| Cities over 250,000 | Gasoline Demand | Case B1 (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Boise City ID | 204,660,663 | 10 | 48.86% |
| Colorado Springs CO | 250,902,560 | 15 | 59.78% |
| Denver/Boulder/Greeley CO | 1,213,333,175 | 55 | 45.33% |
| Provo/Orem UT | 174,126,961 | 5 | 28.71% |
| Salt Lake City/Ogden | 639,847,344 | 15 | 23.44% |
| Totals | 2,482,870,703 | 100 | 40.28% |
| TOTALS PADD IV | 2,482,870,703 | 100 (6.5 mbcd) | 35.82% |

**Table 4-7E  PADD V Ethanol Use Study Case B1**

PADD V Target Use     0.8 billion gallon ethanol annually
0.0 billion gallons ethanol in E-85
0.8 billion gallons ethanol in E10 (1)

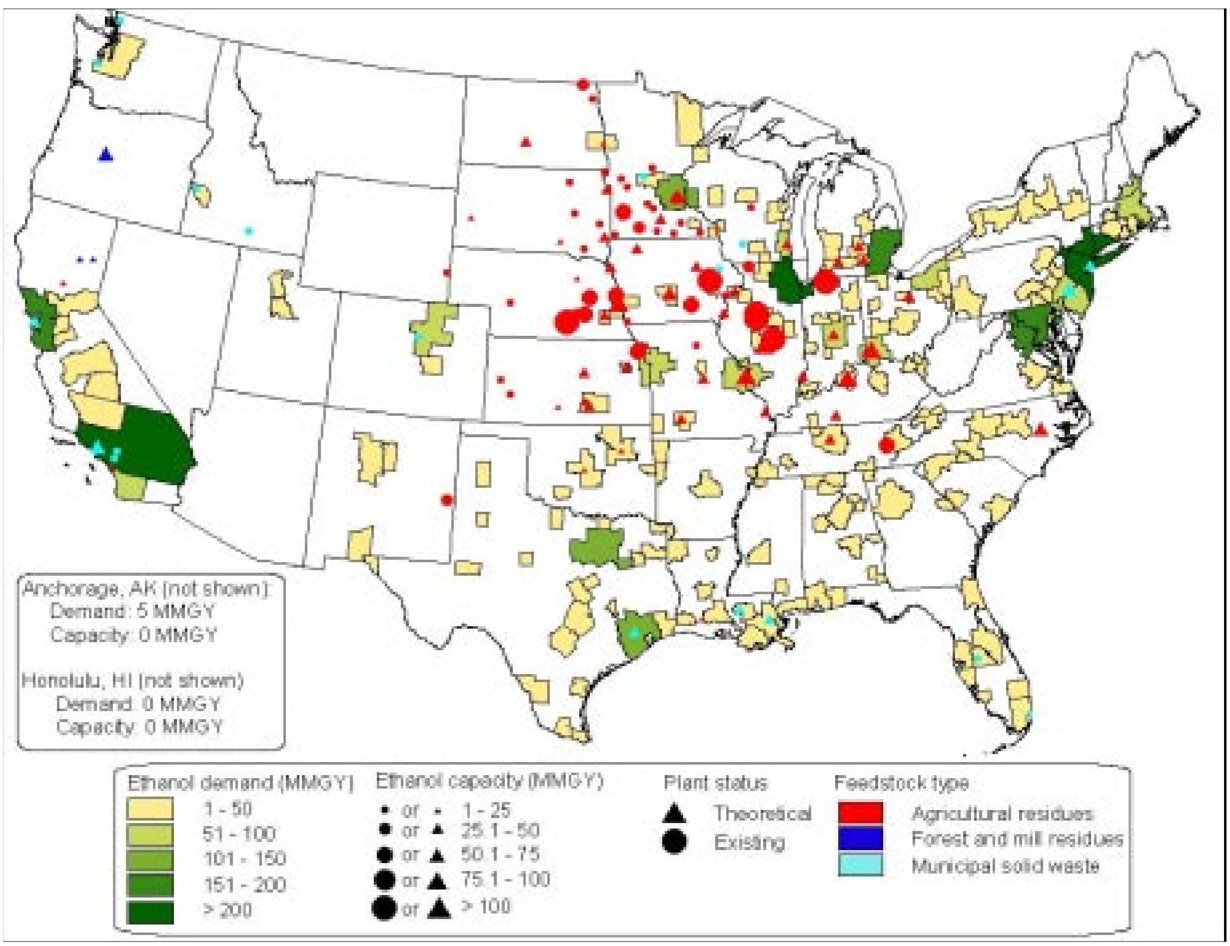
(1) California areas assumed to blend at 5.7v% ethanol per gallon

| **Cities over 250,000** | **Gasoline Demand** | **Case B1 (mmgy)** | **Market Share for Blended Fuel** |
|---|---|---|---|
| Anchorage AK | 112,683,836 | 5 | 44.37% |
| Bakersfield CA | 280,824,493 | 15 | 93.71% |
| Eugene OR | 137,638,291 | | |
| Fresno CA | 384,559,464 | 20 | 91.24% |
| Honolulu HI | 377,890,432 | | |
| Las Vegas NV/AZ | 603,651,042 | | |
| Los Angeles/Riverside/Orange Cty, CA | 7,009,340,798 | 400 | 100.00% |
| Modesto CA | 190,914,062 | 10 | 91.89% |
| Phoenix/Mesa AZ | 1,317,239,281 | | |
| Portland/Salem OR/W 953,279,164 | | | |
| Reno NV | 139,786,560 | | |
| Sacramento/Yolo CA | 760,964,683 | 45 | 103.75% |
| Salinas | 162,488,720 | | |
| San Diego CA | 1,232,946,695 | 70 | 100.40% |
| San Francisco/Iakland/San Jose CA | 3,004,362,483 | 160 | 93.43% |
| Santa Barbara/Santa Maria/Lompoc CA | 170,931,004 | | |
| Seattle/Tacoma/Bremerton WA | 1,514,829,369 | 50 | 33.01% |
| Spokane WA | 179,089,183 | | |
| Stockton-Lodi CA | 246,158,461 | 15 | 106.91% |
| Tucson AZ | 351,248,831 | | |
| Visalia/Tulare/Pottersville CA | 156,681,618 | 10 | 74.46% |
| PADD V TOTAL E-5.7 (1) | | 745 | 67.75% |
| PADD V TOTAL E-10 (1) | | 55 | 28.52% |
| PADD V TOTALS | 19,287,508,470 | 800 (52.2 mbcd) | 96.26% |

(1) Calculations are based on 0.745 bgy of ethanol used in E-5.7 yielding 13.067 bgy of E-5.7 blends and 0.055 bgy of ethanol used in E-10 blends yielding 0.55 bgy of E-10 blends.

Figure 4-1 prepared by McNeil Technologies Inc. of Lakewood, Colorado provides the reader with a graphic depiction of the location of ethanol production facilities and key ethanol markets developed for Study Case B1.

**Figure 4-1: Study Case B1 Ethanol Plant Locations and Key Ethanol Markets**




**Ethanol plant location and size (existing and theoretical) and ethanol demand by metropolitan area in million gallons per year (mmgy) – Scenario B1**

With plants assigned actual or theoretical locations and the ethanol production assigned to designated market areas, it is possible to proceed to a terminal analysis which in turn will allow development of projected transportation demands.

## 4.3 Terminal Analysis

Once the market areas for ethanol use were determined, the next step was to identify petroleum products terminals that service each market area. This was done by researching maps and terminal listings. The primary reference used was the P*etroleum Terminal Encyclopedia (10th edition, 1999-OPIS Directories)*. We would note that there are some glaring inaccuracies in the directory, such as terminal duplications and also especially when comparing terminal listings to OPIS's own terminal maps. Where possible we utilized pipeline maps/atlases and other sources to help clarify any suspect data. It should also be noted that industry consolidation and asset rationalization has resulted, and continues to result, in changes in terminal ownership and operational status. For purposes of listing terminal ownership we listed the terminals as listed in the *Petroleum Terminal Encyclopedia* even though in some instances ownership is known to have changed. Once all terminals were identified we then checked available data in the listings and where possible categorized terminal size into one of three categories. We also listed information on rail and water capabilities if it was provided. Finally, any terminal that did not handle gasoline (i.e. distillates only, asphalt terminals, etc.) was eliminated.

Next we entered the total number of servicing terminals and the required ethanol demand and percent of market share for ethanol blends to the terminal analysis tables. Analyzing the size of the terminals we estimated the number of terminals that would need to handle ethanol and the appropriate tank size for ethanol storage needed for each terminal. While these estimates were based largely on market share projections for ethanol use/blend use, some adjustments to the estimates were made based on other considerations. As an example if there were only a few terminals servicing a market area, we were more likely to project all terminals handling ethanol. Conversely, in an area where there were larger numbers of terminals, this would not be necessary.

Required tank size was based on estimated throughput volume. In outlying PADDs that would be receiving product largely by rail or barge/ship, we assumed 24 inventory turns per year (i.e. two turns per month). If necessary to accommodate shipment size and working inventory, the size of the tank was increased to a larger size.

In the case of the Midwest where plants are in close proximity to the markets, a great deal of ethanol is delivered by truck and working inventory is often only a few days volume. Here we made judgement calls based on proximity to plants versus volume demand.

As discussed in the Transportation Analysis section, it is assumed that none of the ethanol moved between PADDs was done so via pipeline.

There were also some special considerations for transshipment points or special receiving tankage which, when applicable, are discussed in that PADDs report section or the Transportation Analysis section.

The analysis results are discussed in the next section. The actual tables summarizing the analysis are included in Appendix H, Table H-1A through H-1E. Note that various estimates for terminal and retail equipment and retail unit conversion costs are based on estimates from recently completed work in calendar year 2000. Procedures used for amortization are discussed in Appendix E. Furthermore, amortization is calculated on a cost per gallon basis across the volume of increased ethanol use compared to 1999 levels reported in the Federal Highway Administration (FHA) reports. The FHA reports appear to understate actual ethanol sales volumes compared to the volumes reported by the Energy Information Administration (EIA) by approximately 0.2 billion gallons. However, since the FHA volumes were reported by state they were used as the basis for the terminal analysis and are therefore used for determining ethanol volume increases by PADD.

## 4.4 Discussion of Projected Terminal Tankage and Equipment Requirements by PADD - Study Case B1

The information included in the *Petroleum Terminal Encyclopedia* is often somewhat sketchy. Some terminals do not disclose capabilities as they perceive such information (especially storage capabilities) as proprietary. In addition, some terminals have idle tankage but do not routinely disclose this information. Similarly some terminals disclose that they have ethanol or ethanol storage available while others do not. This necessitates making some assumptions which are discussed in the following sections of this analysis. Note that the estimates in the following sections are likely upper bound costs because, over time, more excess tank capacity could become available. Also since ethanol is to some degree replacing a portion of gasoline volume, this in and of itself may result in some existing tankage being made available.

**Study Case B1 - PADD I:** Analysis of PADD I indicates a total of 261 terminals servicing the designated market areas. Of these, 116 are indicated to have water access while 22 have rail capability. A total of 11 terminals list ethanol storage as being available. Of the 212 terminals listing size, 10 were under 100m bbl of storage, 86 were 100m to 250m bbl, and 116 were over 250m bbl of storage. Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 4-8 Study Case B1 - PADD I Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 13 | 5 |
| 44 | 10 |
| 5 | 20 |
| 23 | 25 |

PADD I tankage in some areas is under-utilized as evidenced by closed terminals. Therefore the following assumptions were used. Using the above listing of tankage requirements, revised estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification, and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.). The balance of necessary storage is assumed to require installation of new tanks.

**Table 4-9 Study Case B1 - PADD I Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 5 | 13 | 1 | 3 | 3 | 6 |
| 10 | 44 | 2 | 10 | 10 | 22 |
| 20 | 5 | 0 | 1 | 1 | 3 |
| 25 | 23 | 1 | 4 | 4 | 14 |
| Total | 85 | 4 | 18 | 18 | 45 |

Based on the above estimates, PADD I would require modifications to 18 tanks ranging in size from 5m to 25m bbl and the installation of 45 tanks in the same size range. In addition, since only four of the terminals are estimated to already have ethanol in use, a total of 81 terminals would require installation of blending units and attendant piping modification.

A discussion of estimates for building new tanks, converting currently existing tanks, and the cost of other terminal equipment is included in Appendix E. The following table provides a breakdown of costs for new tankage.

**Table 4-10 Study Case B1 - PADD I Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 6 | 5 | $15 per steel barrel = | $450,000 |
| 22 | 10 | $15 per steel barrel = | $3,300,000 |
| 3 | 20 | $15 per steel barrel = | $900,000 |
| 14 | 25 | $12 per steel barrel = | $4,200,000 |
| 45 | Totals | | $8,850,000 |

Expenses for converting currently existing tankage were estimated to cost 20% of the cost of installing new tanks (see Appendix E). This number would include floating internal covers, piping changes, etc. These conversions are covered in the following table.

**Table 4-11 Study Case B1 - PADD I Cost Estimate for Converting Existing Tanks**

| Total # Of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 3 | 5 | $45,000 |
| 10 | 10 | $300,000 |
| 1 | 20 | $60,000 |
| 4 | 25 | $240,000 |
| 18 | Totals | $645,000 |

It is also estimated that the installation of computer controlled in-line injection blending equipment will be required at all terminals except those already estimated to be using ethanol. This would impact 81 terminals. Some of the smaller terminals have only one loading rack but most terminals (especially with more than 100m bbl storage) will likely have two or more truck loading racks and may therefore require two or more blending systems per terminal. Here we have assumed an average of two truck racks per terminal to arrive at the following estimate (development of cost estimates for blending system installation is discussed in Appendix E).

**Table 4-12 Study Case B1 - PADD I Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of tanks requiring blending systems | 81 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $24,300,000 |

In Study Case B1 almost all ethanol used in PADD I will be imported from PADD II. Therefore some infrastructure improvements will be needed to accommodate rail and/or water delivery.

Because a number of terminals on the east coast are water accessible (at least 116), a large portion of the ethanol will be shipped by water to larger "hub terminals" for redistribution to smaller terminals via transport trucks. Some ethanol will also be shipped by rail. The impact on transportation demand is discussed in more detail in the appropriate section of this report. Here we assume a 50/50 split between rail and water delivery or 550 million gallons (13.1mm bbl) annually by each mode.

**Table 4-13 Study Case B1 - PADD I Transportation Modes Estimate**

| bgy (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Ocean barges annual/monthly | Ships annual/monthly |
|---|---|---|---|---|
| 0.55 (13.1 mmbbl) | 18,333 | 1527 | -- | -- |
| 0.55 (13.1 mmbbl) | -- | -- | 327/27 | 52.3/4.4 |

The method of waterborne cargos will vary depending on destination. In all cases, ethanol from PADD II would be shipped to New Orleans via river barge (and in some cases by rail) where it would be staged for delivery to PADD I. Shipments to the southern ports on the East Coast would be by ocean-going barge. Industry sources indicate that from the Carolinas north, using ships (or compartments of ships) is more feasible. We have therefore assumed that waterborne cargoes will be split equally between 5.25 million gallon (125m bbl) cargoes on ships and 840m gallons (20m bbl) cargoes on ocean-going barges. Note that major hub terminals are not included in cost estimates for capital expenditures. In the case of large ship cargoes, the ethanol will be shipped to existing tankage in areas such as the New York Harbor where it would be reshipped to other terminals via barge, truck, and in rare instances rail. Such terminals and tankage already exist and are available for a fee based on product throughput or on a shell capacity basis. These costs are included in the transportation cost analysis since they are largely to accommodate transfer of product in intermodal shipment scenarios.

Based on the terminal assessment a sufficient number of terminals with water receipt capabilities are available. However to handle 1527 rail cars per month across the geography of PADD I would likely require at least 20 more major rail accessible terminals serving as hub terminals (in addition to those already with rail capabilities). This would require the installation of rail spurs and piping/headers to accommodate rail delivery. Installation of track spurs is estimated to cost between $75 and $95 per track foot (see Appendix E). Here we assume each of the 20 terminals would need to install a 3/4 mile rail spur at a total cost of $340,000 plus an additional $15,000 for attendant headers and piping (for off-loading) bringing the total cost to $355,000 per terminal.

**Table 4-14 Study Case B1 - PADD I Estimated Cost of Rail Spur Installation**

| No. of terminals requiring rail | Average cost per terminal | Total Cost |
|---|---|---|
| 20 | $355,000 | $7,100,000 |

We have also included a contingency amount for other terminal expenses for terminals requiring new tanks or tank conversions. These are included in the following table.

**Table 4-15 Study Case B1 - PADD I Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 63 | $20,000 | $1,260,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing an E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Included in the ethanol market volume for PADD I are sales of 0.1 bgy (6.5 mbcd) of ethanol annually for use in E-85 blending. In order to provide proper seasonal volatility characteristics, E-85 is actually blended at 85v% ethanol levels in the summer. In winter it is blended at 75v% ethanol, and in the spring and fall at 80v% ethanol. For purposes of our calculations, we have assumed an annual average of 80v% ethanol in E-85. There are no terminal requirements for E-85 since it would presumably be blended and distributed from a terminal that is already blending E-10.

If 0.1 bgy of ethanol are used in E-85 in PADD I, this would equate to 0.125 bgy of E-85 (8.1 mbcd). Assuming vehicles travel 12,000 miles per year and average 20 mpg, the average vehicle would purchase 600 gallons per year (50 gallons per month). Based on these averages it would take 208,333 vehicles to support these volume projections. However before estimating infrastructure costs, it is important to recognize that these vehicles may not operate exclusively on E-85. Here we are making the assumption that vehicles using E-85 will be mostly fleet vehicles, centrally located, and fueling on E-85 at least 75% of the time. This would raise the number of vehicles required to support these volumes to higher levels but still within projected sales figures for such vehicles.

We also assume that E-85 fueling facilities will be selectively placed to accommodate a high level of fleet use and in locations with very high traffic counts (e.g., airport corridors). The average gasoline sales volume for a retail outlet in PADD I is 743,523 gallons (49 bcd) annually. Inner-city locations are generally higher as are superpumpers and hypermarts. Some E-85 facilities may be located in such outlets while others will be located in fleet operation locations.

Of course, E-85 sales cannot be expected to be in line with gasoline sales. Instead it is more likely to be similar to the sales of midgrade unleaded, around 10%-15% of total facility volume. We are assuming that the average outlet will dispense 11,000 gallons of E-85 monthly/132,000 gallons annually. This would necessitate placement of 947 E-85 fueling facilities in PADD I. These items are recapped in Table 4-16.

**Table 4-16 Study Case B1 - PADD I E-85 Infrastructure Requirements (Initial)**

| | |
|---|---|
| Total targeted sales | 125 million gallons annually |
| Total annual sales per facility | 132,000 gallons |
| Total number of facilities required | 947 |
| (serving approximately 300,000 vehicles) | 10 gallons per fueling event=<br>1100 fueling events per unit month or 36<br>per unit day |

Whether at retail or commercial fleet fueling facilities, the dispensing of E-85 requires a dedicated tank and certain special equipment [1, 2]. In some cases E-85 could displace a low sales volume grade such as diesel or heating oil. However, this would still require retrofitting the tank. Depending on the type of tank, retrofitting could cost $19,000 to $30,000 based on estimates for M-85 which has near identical requirements [3]. It is unlikely that many facility operators would chose to displace a grade providing a known revenue stream for a product that would provide low volume sales in its initial years. We are therefore assuming that only 10% of E-85 fueling facilities will be retrofits at an average cost of $25,000 each.

If the decision is made to install new tankage, it may be possible to install above ground tanks in a few cases, but in most cases underground tanks will be required. Estimated cost for a new underground tank system is $62,407 [3] and some estimates are higher. [4] In this study we used $62,000 per unit as the average cost for a new system.

Yet another system for E-85 fueling is “Mobile Fueling”. This is when a truck comes to the fleet facility and fuels vehicles at the end of the day, or overnight. This is done using metered fuel delivery providing the fleet operator with detailed information. This system is already being successfully used in some cases. For instance, Streicher Mobile Fueling Inc.(5) provides such services for certain fleets in Florida. Here we assume that mobile fueling will displace approximately 10% of the facility requirement or 95 facilities. The revised breakdown would then be as follows.

**Table 4-17 Study Case B1 - PADD I E-85 Infrastructure Requirements (Revised)**

| | |
|---|---|
| Initial fueling facility requirement | 947 |
| Less Mobile Fueling (facility equivalent) | 95 |
| Revised fueling facility requirements | 852 |
| Retrofits at existing facilities | 95 |
| New installations at existing facilities | 757 |

Based on the estimate in Table 4-17, the infrastructure costs for retail and fleet E-85 facilities are estimated in Table 4-17.

**Table 4-18 Study Case B1 - PADD I E-85 Infrastructure Cost Estimate**

| | | | | |
|---|---|---|---|---|
| 95 retrofits | @ | $25,000 per | = | $2,375,000 |
| 757 new installations | @ | $62,000 per | = | $46,934,000 |
| Total | | | | $49,309,000 |

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However, when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD I in 1998 was 45,786,939,655 gallons (2987 mbcd). The retail outlet count in PADD I is 61,581 (6). This indicates a per unit average volume annually of 743,523 gallons. Because we have directed ethanol distribution into major metropolitan areas (i.e. eliminating lower volume facilities in outlying areas), it is assumed here that the average facility volume is 1.0 million gallons annually. Targeted ethanol volume for use in E-10 in PADD I is 1.2 bgy and sales in 1998 were 0.098 bgy (7). Therefore the remaining volume required is 11.02 billion gallons of blend sales. This is recapped in Table 4-20.

**Table 4-19 Study Case B1 - PADD I Station Retail Conversion Requirements (bgy)**

| | Blend sales | Ethanol required |
|---|---|---|
| Targeted volumes | 12.00 | 1.20 |
| Less existing sales | .98 | .098 |
| Balance new sales | 11.02 | 1.102 |
| Number of facilities required for new blend sales @ average volume of 1 mmgy per unit | (17.9% of station population) | 11,020 |

Using the cost estimates from Appendix E of $590 per facility, retail cost conversion in PADD I for Study Case B1 then equates to $6,501,800 as indicated in Table 4-20.

| Table 4-20 Study Case B1 - PADD I Retail Unit Conversion Cost Estimate | |
|---|---|
| Number of facilities converted | 11020 |
| Estimated cost per facility | $590 |
| Total cost | $6,501,800 |

Table 4-21 recaps all of the estimated terminal and retail expenses associated with distributing 1.3 bgy of ethanol in PADD I based on 1.2 bgy being sold in E-10 blends and 0.1 bgy sold in E-85 blends. Capital investments at the terminal level are estimated to be $42,155,000 while the capital costs for the retail infrastructure for E-85 are $49,309,000. One time costs for converting retail units to E-10 blends are estimated to be $6,501,800.

| Table 4-21 Study Case B1 - PADD I Cost for All Ethanol Infrastructure and Conversions | |
|---|---|
| Terminaling Costs | |
| Cost for additional new tankage | $8,850,000 |
| Cost for conversion of existing tankage | $645,000 |
| Cost for blending systems | $24,300,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $7,100,000 |
| Contingency-Piping/site work etc. | $1,260,000 |
| Total capital expenditure at terminal level for E-10 blending | $42,155,000 |
| E-10 conversion costs (one-time costs at retail level) | $6,501,800 |
| E-85 infrastructure (capital expenditure at the retail level) | $49,309,000 |
| TOTAL COSTS | $97,965,800 |

**Table 4-22 Study Case B1 - PADD I Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 1.102 bgy | $48,656,800 | $0.0069 |
| Total cost for E-85 infrastructure | 0.100 bgy | $49,309,000 | $0.0769 |
| Total all | 1.202 bgy | $97,965,800 | $0.0127 |

Table 4-22, above, calculates the cost on an amortized dollars per ethanol gallon basis using a 20 year equipment life cycle. (See appendix E for discussion of amortization).

Note that the costs are amortized over the gallons of ethanol that represent new sales compared to 1999 volumes as reported in FHA reports (FHA Web site table MF=33E). Since volumes have increased fairly dramatically in the last two years, this will result in a slight overestimate of total costs for new volume. Also note that although 0.1 bgy of the ethanol terminaled is actually for use in E-85 while all terminal equipment charges are assigned to the E-10 category. Ethanol used in E-85 equates to 8.32% of new ethanol volume in PADD I.

The total amortized cost for ethanol used in E-10 and E-85 combined is $0.0127 per gallon. However, if E-10 costs are split from E-85, the amortized cost for ethanol used in E-10 equates to only $0.0069 per gallon of ethanol. This compares to $0.0769 per gallon of ethanol used in E-85, reflecting the higher cost of retail infrastructure for this fuel.

Note that there are additional expenses associated with tankage to stage product for shipment to coastal areas. These expenses are discussed as part of transportation expenses and are covered in the Transportation Analysis section. Likewise, tanks in coastal areas used solely for storing and staging product to be sent to other areas are discussed in the Transportation Analysis section.

**Study Case B1 - PADD II:** Analysis of PADD II indicates a total of 311 terminals servicing the designated market areas. Of these, 56 are indicated to have water access while 22 have rail capability. A total of 61 terminals list ethanol storage as being available. Of the 247 terminals disclosing size, 6 were under 100m bbl of storage, 133 were 100m to 250m bbl, and 108 were over 250m bbl storage. Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 4-23 Study Case B1 - PADD II Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size(mbbl) |
|---|---|
| 4 | 1 |
| 36 | 2 |
| 36 | 3 |
| 42 | 5 |
| 4 | 10 |
| 2 | 15 |
| 2 | 20 |

There are a few unique factors for PADD II ethanol distribution. First, a much larger number of terminals than indicated in the *Petroleum Terminal Encyclopedi*a are known to have ethanol. This is especially so in the case of the Chicago/Milwaukee RFG markets and the Minnesota market where nearly all gasoline sold contains ethanol. Those market areas encompass 40 terminals. So no additional terminaling facilities are needed in those areas. The number of terminals handling ethanol in the remainder of the PADD is also higher than indicated and we have made estimates for these. Another factor unique to PADD II is the close proximity of terminals to ethanol production facilities. Many terminals therefore receive product by transport truck which, combined with the numerous supply sources and ethanol supply at other nearby terminals, enables them to maintain inventory at very low levels, often only a few days worth of supply. This is reflected by the use of a greater number of small tanks required in PADD II. Revised estimates of tankage requirements recognizing the above considerations are included in Table 4-24.

| Table 4-24 Study Case B1 - PADD II Revised Tank Requirement Estimate | | | | | |
|---|---|---|---|---|---|
| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
| 1 | 4 | 1 | 1 | 1 | 1 |
| 2 | 36 | 3 | 3 | 10 | 20 |
| 3 | 36 | 3 | 3 | 10 | 20 |
| 5 | 42 | 8 | 2 | 5 | 27 |
| 10 | 4 | 1 | - | 1 | 2 |
| 15 | 2 | - | - | - | 2 |
| 20 | 2 | - | - | - | 2 |
| Total | 126 | 16 | 9 | 27 | 74 |

Based on the above estimates, PADD II would require modifications to 27 tanks ranging in size from 1m to 10m bbl and the installation of 74 tanks ranging from 10m bbl to 20m bbl capacity. It is assumed that all terminals not estimated to already have ethanol would also require installation of blending units and attendant piping modifications to the tank.

A discussion of cost estimates for building new tanks and converting existing tanks, as well as blending system equipment, is included in Appendix E. Estimates for new tank costs are included in the following Table.

| Table 4-25 Study Case B1 - PADD II Cost Estimate for New Tanks | | | |
|---|---|---|---|
| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
| 1 | 1 | $20 per steel barrel = | $20,000 |
| 20 | 2 | $20 per steel barrel = | $800,000 |
| 20 | 3 | $20 per steel barrel = | $1,200,000 |
| 27 | 5 | $15 per steel barrel = | $2,025,000 |
| 2 | 10 | $15 per steel barrel = | $300,000 |
| 2 | 15 | $15 per steel barrel = | $450,000 |
| 2 | 20 | $15 per steel barrel = | $600,000 |
| 74 | Total | | $5,395,000 |

Estimates for converting existing tankage are included in the following Table.

**Table 4-26 Study Case B1 - PADD II Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 1 | 1 | $4,000 |
| 10 | 2 | $80,000 |
| 10 | 3 | $120,000 |
| 5 | 5 | $75,000 |
| 1 | 10 | $30,000 |
| 27 | Total | $309,000 |

We assume that all terminals not estimated to currently have ethanol will require new blending systems. Estimates for terminal blending system costs are included in the following table.

**Table 4-27 Study Case B1 - PADD II Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 110 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $33,000,000 |

In the case of PADD II all ethanol is supplied from within the PADD, mostly by truck, except in areas more distant from the production facilities. Barge terminaling capability is already sufficient. Here we assume that 20% of intra-PADD movements are by rail car and 10% by river barge.

**Table 4-28 Study Case B1 - PADD II Transportation Modes Estimate (within PADD)**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of river barges | Monthly # of river barges |
|---|---|---|---|---|
| 0.44 bgy (10.5 mbbl) | 14,666 | 1222 | | |
| 0.220 bgy (5.2mbbl) | | | 523 | 44 |

With only 22 terminals offering rail capability we estimate another 15 terminals would need to add rail capabilities as estimated in the following Table.

**Table 4-29 Study Case B1 - PADD II Estimated Cost of Rail Spur Installation**

| No. of terminals requiring rail | Average cost per terminal | Total Cost |
|---|---|---|
| 15 | $355,000 | $5,325,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for terminals requiring conversion of tanks or new tanks.

**Table 4-30 Study Case B1 - PADD II Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 101 | $20,000 | $2,020,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing an E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Included in the market volume for PADD II are ethanol sales of 0.2 bgy (13 mbcd) for use in E-85 blending. In order to provide proper seasonal volatility characteristics, E-85 is actually blended at 85v% ethanol levels in the summer. In winter it is blended at 75v% ethanol, and in the spring and fall at 80v% ethanol. For purposes of our calculations, we have assumed an annual average of 80v% ethanol in E-85. There are no terminal requirements for E-85 since it would presumably be blended and distributed from a terminal that is already blending E-10.

If 0.2 bgy of ethanol are used in E-85 in PADD II, this would equate to 0.25 bgy of E-85 sales. Assuming vehicles travel 12,000 miles per year and average 20 mpg, the average vehicle would purchase 600 gallons per year (50 gallons per month). Based on these averages it would take 416,666 vehicles to support these volume projections. However before estimating infrastructure costs, it is important to recognize that these vehicles may not operate exclusively on E-85. Here we are making the assumption that vehicles using E-85 will be mostly fleet vehicles, centrally located, and fueling on E-85 at least 75% of the time. This would raise the number of vehicles required to support these volumes to higher levels but still within projected sales volume figures.

We also assume that E-85 fueling facilities will be selectively placed to accommodate a high level of fleet use and in locations with very high traffic counts. The average gasoline sales volume for retail outlets in PADD II is 717,477 gallons annually. Inner-city locations are generally higher as are superpumpers and hypermarts. Some E-85 facilities may be located in such outlets while others will be based in fleet locations.

Of course, E-85 sales cannot be expected to be in line with gasoline sales. Instead it is more likely to be similar to the sales of midgrade unleaded, around 10%-15% of total facility volume. We are assuming that the average outlet will dispense 11,000 gallons of E-85 monthly/132,000 annually. This would necessitate placement of 1894 E-85 fueling facilities in PADD II. These items are recapped in Table 4-31.

| **Table 4-31 Study Case B1 - PADD II E-85 Infrastructure Requirements (Initial)** | |
|---|---|
| Total targeted sales | 0.250 bgy |
| Total annual sales per facility | 132,000 gallons |
| Total number of facilities required | 1894 |
| (serving approximately 600,000 vehicles) | 10gallons per fueling event= 1100 fueling events per unit month/or 36 per unit day |

Whether at retail or commercial fleet fueling facilities, the dispensing of E-85 requires a dedicated tank and certain special equipment (1,2). In some cases E-85 could displace a low sales volume grade such as diesel or heating oil. However this would still require retrofitting the tank. Depending on the type of tank, retrofitting could cost $19,000 to $30,000 based on estimates for M-85 which has near identical requirements.(3) It is unlikely that many facility operators would chose to displace a grade providing a known revenue stream for a product that would provide low volume sales in its initial years. We are therefore assuming that only 10% of E-85 fueling facilities will be retrofits at an average cost of $25,000 each.

If the decision is made to install new tankage, it may be possible to install above ground tanks in a few cases, but in most cases underground tanks will be required. Estimated costs for a new underground tank system is $62,407 (3) and some estimates are higher. (4) We use an average cost of $62,000 per system in this study.

As discussed in the previous section on PADD I, another option for E-85 fueling is “Mobile Fueling”. Here we assume that mobile fueling will displace approximately 10% of the retail facilities requirement or 190 facilities. The aforementioned revised breakdown would then be as follows.

| **Table 4-32 Study Case B1 - PADD II E-85 Infrastructure Requirements (Revised)** | |
|---|---|
| Initial fueling facility requirement | 1894 |
| Less Mobile Fueling (facility equivalent) | 190 |
| Revised fueling facility requirements | 1704 |
| Retrofits at existing facilities | 190 |
| New installation at existing facilities | 1514 |

Cost estimates for E-85 infrastructure in PADD II are then estimated in the following Table.

| **Table 4-33 Study Case B1 - PADD II E-85 Infrastructure Cost Estimate** | | | | |
|---|---|---|---|---|
| 190 retrofits | @ | $25,000 per | = | $4,750,000 |
| 1514 new installations | @ | $62,000 per | = | $93,868,000 |
| Total | | | | $98,618,000 |

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD II in 1998 was 37,776,647,222 gallons (2464 mbcd). The actual retail outlet count in PADD II is 52,652 (6). Thus, average annual volume per unit was 717,477 gallons.

Although we have directed ethanol blend sales into major metropolitan areas we are not raising the average per unit sales as much as in PADD I. This is due to both the higher percentage of ethanol blend sales in PADD II as well as the smaller population areas. Therefore we have chosen to use an average sales volume of 850,000 gallons per unit year.

Targeted ethanol sales for use in E-10 blending for PADD II are 2.0 bgy and 1999 sales were estimated at 0.928 bgy. Therefore, the new E-10 sales required equates to 10.72 billion gallons annually. At 850,000 gallons of annual sales per unit, this would require conversion of 12,611 units. This is represented in the following Table.

**Table 4-34 Study Case B1 - PADD II Station Retail Conversion Requirements (bgy)**

| | Blend sales | Ethanol required |
|---|---|---|
| Targeted volumes | 20.00 | 2.0 |
| Less existing sales | 9.28 | 0.928 |
| Balance new sales | 10.72 | 1.072 |
| Number of facilities required for new blend sales @ average volume of 850 mgy per unit | (24.0% of station population) | 12,611 |

Using the estimates for applicable conversion costs from Appendix E equates to $7,440,490 as recapped in the following Table.

**Table 4-35 Study Case B1 - PADD II Retail Unit Conversion Cost Estimate**

| | |
|---|---|
| Number of facilities converted | 12,611 |
| Estimated cost per facility | $590 |
| Total cost | $7,440,490 |

Table 4-36 recaps all of the estimated terminal and retail expenses associated with distributing 2.2 bgy of ethanol in PADD II based on 2.0 bgy being sold in E-10 blends and 0.2 bgy sold in E-85 blends. This represents 1.072 bgy of new ethanol volume used in E-10 and 0.2 bgy of new ethanol volume used in E-85. Capital investments at the terminal level are estimated to be $46,049,000 while the capital cost for the retail infrastructure for E-85 is $98,618,000. One time costs for converting retail units to E-10 blends are estimated to be $7,440,490.

**Table 4-36 Study Case B1 - PADD II Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| <u>Terminaling Costs</u> | |
| Cost for new additional tankage | $5,395,000 |
| Cost for conversion of existing tankage | $309,000 |
| Cost for blending system | $33,000,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $5,325,000 |
| Contingency-Piping/site work etc. | $2,020,000 |
| Total capital expenditure at terminal level for E-10 blending | $46,049,000 |
| E-10 conversion costs (one time costs at retail level) | $7,440,490 |
| E-85 infrastructure (capital expenditure at the retail level) | $98,618,000 |
| PADD II TOTAL COSTS | $152,107,490 |

**Table 4-37 Study Case B1 - PADD II Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 1.072 bgy | $53,489,490 | 0.0078 |
| Total cost for E-85 infrastructure | 0.2 bgy | $98,618,000 | 0.0769 |
| Total all | 1.272 bgy | $152,107,490 | 0.0187 |

Table 4-37 calculates the costs on an amortized dollars per ethanol gallon basis, and using a 20 year equipment life cycle, for the new ethanol volumes (see Appendix E for discussion of amortization). The total amortized costs for ethanol used in E-10 and E-85 is $0.0187 per gallon. However, the E-85 portion of this is an amortized cost of $0.0769 per gallon of ethanol reflecting the high cost of the retail infrastructure needed for E-85. If the E-10 portion is broken out separately, the amortized cost for ethanol used in E-10 equates to only $0.0078 per gallon. Also note that although 0.2 bgy of the ethanol terminaled is actually for use in E-85, while all terminal equipment charges are assigned to the E-10 category. Ethanol used in E-85 equates to 15.72% of new ethanol volume in PADD II.

**Study Case B1 - PADD III:** Analysis of PADD III indicates a total of 158 terminals servicing the designated market areas. Of these, 42 are indicated to have water access while 17 have rail capability. A total of 10 terminals list ethanol storage as being available. Of the 113 terminals listing their size, 9 were under 100 mbbl of storage, 68 were 100m to 250 mbbl, and 36 were over 250 mbbl storage.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 4-38 Study Case B1 - PADD III Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 1 | 1 |
| 12 | 2 |
| 16 | 3 |
| 25 | 5 |
| 19 | 10 |
| 5 | 15 |
| 2 | 20 |
| 6 | 25 |

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedi*a, storage which could be used without modification, and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.). The balance is assumed to require installation of new tanks. The resulting revised terminal requirement estimate is listed in the following table.

**Table 4-39 Study Case B1 - PADD III Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 1 | 1 | 1 | - | - | - |
| 2 | 12 | 3 | 2 | 2 | 5 |
| 3 | 16 | 3 | - | 2 | 11 |
| 5 | 25 | 5 | 3 | 5 | 12 |
| 10 | 19 | - | 5 | 4 | 10 |
| 15 | 5 | - | 1 | 1 | 3 |
| 20 | 2 | - | - | - | 2 |
| 25 | 6 | - | 1 | 1 | 4 |
| Total | 86 | 12 | 12 | 15 | 47 |

Based on the above estimates, PADD III would require modifications to 15 tanks ranging in size from 2m to 25m bbl and the installation of 47 tanks in the same size range. In addition only 12 of the terminals were estimated to already have ethanol, so a total of 74 terminals would require installation of blending units and attendant piping modifications.

A discussion of cost estimates for building new tanks and converting existing tanks and terminal equipment is included in Appendix E. Estimates for new tank costs are included in the following table.

**Table 4-40 Study Case B1 - PADD III Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 5 | 2 | $20 per steel barrel = | $200,000 |
| 11 | 3 | $20 per steel barrel = | $660,000 |
| 12 | 5 | $15 per steel barrel = | $900,000 |
| 10 | 10 | $15 per steel barrel = | $1,500,000 |
| 3 | 15 | $15 per steel barrel = | $675,000 |
| 2 | 20 | $15 per steel barrel = | $600,000 |
| 4 | 25 | $12 per steel barrel = | $1,200,000 |
| 47 | Total | | $5,735,000 |

Estimates for converting existing tankage are included in the following Table.

**Table 4-41 Study Case B1 - PADD III Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 2 | 2 | $16,000 |
| 2 | 3 | $24,000 |
| 5 | 5 | $75,000 |
| 4 | 10 | $120,000 |
| 1 | 1 | $45,000 |
| 1 | 25 | $60,000 |
| 15 | Total | $340,000 |

We assume that all terminals not estimated to currently have ethanol will require new blending systems. Estimates for terminal blending system costs are discussed in Appendix E and estimated in the following table.

**Table 4-42 Study Case B1 - PADD III Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 74 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $22,200,000 |

In case B1 0.5 bgy of the 0.7 bgy of the ethanol used in PADD III will be imported from PADD II. A number of terminals (at least 42) in PADD III are water accessible and 17 have rail capability. We would therefore expect a large portion of ethanol to be barged to terminals and then transferred to other terminals via truck. However, we would expect at least a few additional terminals would need to install rail facilities given the expected 50/50 transportation split estimate which is covered in the next table.

| **Table 4-43 Study Case B1 - PADD III Transportation Modes Estimate** | | | | |
|---|---|---|---|---|
| bgy (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of river barges | Monthly # of river barges |
| .25 (6.0 mmbbl) | 8,333 | 694 | | |
| .25 (6.0 mmbbl) | | | 595 | 50 |

With only 17 terminals offering rail capability, an estimated 10 terminals would need to add rail capabilities with costs as estimated in the following table.

| **Table 4-44 Study Case B1 - PADD III Estimated Cost of Rail Spur Installation** | | |
|---|---|---|
| No. of terminals rail | Average cost per terminal | Total Cost |
| 10 | $355,000 | $3,550,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for all terminals requiring tank conversions or new tanks. The total expense is listed in the following table.

| **Table 4-45 Study Case B1 - PADD III Miscellaneous Contingency Cost** | | |
|---|---|---|
| No. of terminals | Average cost per terminal | Total Cost |
| 62 | $20,000 | $1,240,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

We have not estimated any use of E-85 for Case B1 - PADD III.

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD III in 1998 was 19,035,571,897 (1242 mbcd). The retail outlet count in PADD III is 35,656 (6). This indicates a per unit average annual volume of 533,867 gallons.

Since we have directed ethanol blend sales into major metropolitan areas we are raising the average per unit sales to an average volume of 700,000 gallons per unit year.

Targeted E-10 sales for PADD III are 7.0 bgy and 1998 sales were estimated at 0.740 bgy. Therefore the new sales of E-10 required equates to 6.26 bgy. This is represented in the following table.

**Table 4-46 Study Case B1 - PADD III Station Retail Conversion Requirements (bgy)**

| | Blend sales | Ethanol required |
|---|---|---|
| Targeted volumes | 7.00 | 0.7 |
| Less existing sales | 0.74 | .074 |
| Balance new sales | 6.26 | 0.626 |
| Number of facilities required for new blend sales @ average volume of 700 mgy per unit | (25.1% of station population) | 8,942 |

Using the cost estimates from Appendix E, conversion costs of $590 per facility are recapped in the following Table.

**Table 4-47 Study Case B1 - PADD III Retail Unit Conversion Cost Estimate**

| | |
|---|---|
| Number of facilities converted | 8,942 |
| Estimated cost per facility | $590 |
| Total cost | $5,275,780 |

Table 4-47 recaps all of the estimated expenses associated with distributing 0.7 bgy of ethanol in PADD III based on all ethanol being sold in E-10 blends. This represents 0.626 bgy in new ethanol volume. Capital investments at the terminal level are estimated to be $33,065,000. One time costs for converting retail units to E-10 blends are estimated to be $5,275,780.

| **Table 4-48 Study Case B1 - PADD III Cost for All Ethanol Infrastructure and Conversions** | |
|---|---|
| Terminaling Costs | |
| Cost for new additional tankage | $5,735,000 |
| Cost for conversion of existing tankage | $340,000 |
| Cost for blending system | $22,200,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $3,550,000 |
| Contingency-Piping/site work etc. | $1,240,000 |
| Total capital expenditure at terminal levelfor E-10 blends | $33,065,000 |
| E-10 conversion costs (one time cost at retail level) | $5,275,780 |
| PADD III TOTAL COSTS | $38,340,780 |

Table 4-49 below calculates the costs on an amortized dollars per ethanol gallon basis for new ethanol volume using a 20 year equipment life cycle (see Appendix E for discussion of amortization). Based on these calculations, the amortized cost in PADD III would be $0.0096 per gallon of new ethanol volume.

**Table 4-49 Study Case B1 - PADD IIIAmortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 0.626 bgy | $38,340,780 | $0.0096 |

**Study Case B1 - PADD IV:** Analysis of PADD IV indicates a total of 19 terminals servicing the designated market areas. Of these, only 1 is indicated to have water access. However we are assuming all ethanol imported from PADD II will be shipped by rail. There are 4 terminals that currently have rail capability. A total of 2 terminals list ethanol storage as being available. Of the 16 terminals listing their size, 4 are under 100 mbbl of storage, 3 are 100m to 250 mbbl, and 9 are over 250 mbbl storage. In Case B1, PADD IV imports all of its ethanol from PADD II and this volume totals only 0.1 bgy. However because of the number of geographic areas encompassed to reach the demand, several terminals would still need to be utilized.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 4-50 Study Case B1 - PADD IV Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 2 | 5,000 barrels |
| 7 | 10,000 barrels |

In the case of PADD IV, we assume larger tanks are required due to the need to mantain higher inventory due to potential delays in rail delivery from distant areas.

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.). The balance is assumed to require installation of new tanks. The resulting revised estimates are listed in the following table.

**Table 4-51 Study Case B1 - PADD IV Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 5 | 2 | 1 | 1 | -- | 0 |
| 10 | 7 | - | 1 | 1 | 5 |
| Total | 9 | 1 | 2 | 1 | 5 |

Based on the above estimates, PADD IV would require modifications to 1 tank of 10m bbl capacity and the installation of 5 tanks of the same size. In addition, 8 of the terminals would require installation of blending units and attendant piping modifications.

A discussion of cost estimates for building new tanks, converting existing tanks, and terminal equipment is included in Appendix E. Estimates for new tank costs are included in the following table.

**Table 4-52 Study Case B1 - PADD IV Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 5 | 10 | $15 per steel barrel = | $750,000 |
| Total | | | $750,000 |

Estimates for converting existing tankage (based on Appendix E) are included in the following table.

**Table 4-53 Study Case B1 - PADD IV Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 1 | 10,000 | $20,000 |
| 1 | Total | $20,000 |

We assume that all terminals not already estimated to handle ethanol will require new blending systems. Estimates for terminal blending system costs as described in Appendix E are included in the following table.

**Table 4-54 Study Case B1 - PADD IV Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 8 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $2,400,000 |

We estimate that all ethanol imported into PADD IV from PADD II would be shipped by rail. Four terminals already have rail access but we estimate an additional 3 terminals would need to install rail capabilities . Other terminals would truck product from these transfer points.

**Table 4-55 Study Case B1 - PADD IV Transportation Modes Estimate**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of river barges | Monthly # of river barges |
|---|---|---|---|---|
| 0.1 (2.4 mmbbl) | 3,333 | 277 | -- | -- |

Cost estimates to install rail capabilities as described in Appendix E are estimated in the following Table.

**Table 4-56 Study Case B1 - PADD IV Estimated Cost of Rail Spur Installation**

| No. of terminals requiring rail | Average cost per terminal | Total Cost |
|---|---|---|
| 3 | $355,000 | $1,065,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expenses of $20,000 per terminal for terminals installing new tanks or converting existing tanks as covered in the following table.

**Table 4-57 Study Case B1 - PADD IV Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 6 | $20,000 | $120,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Given the low population density and small number of fleets operating in PADD IV, we have not included any estimates for E-85 distribution.

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when a station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at the estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD IV in 1998 was 4,415,963,142 gallons (288 mbcd). The retail outlet count in PADD IV is 6,118 (6). This indicates a per unit average volume annually of 721,798 gallons.

We have directed ethanol blend sales into major metropolitan areas so we are raising the average per unit sales volume to 800m gallons per unit year.

Targeted ethanol volume for use in E-10 for PADD IV is 0.1 bgy. In 1998 E-10 sales were estimated at 0.58 bgy with the large majority of these sales occurring in Colorado. Therefore new E-10 sales required equates to 0.42 bgy. At 800m gallons of annual sales per unit, this would require the conversion of 525 facilities as listed in the following table.

**Table 4-58 Study Case B1 - PADD IV Station Retail Conversion Requirements (bgy)**

| | Blend sales | Ethanol required |
|---|---|---|
| Targeted volumes | 1.00 | 0.100 |
| Less existing sales | 0.58 | 0.058 |
| Balance new sales | 0.422 | 0.042 |
| Number of facilities required for new blend sales @ average volume of 800 mgy per unit | (8.6% of station population) | 525 |

Using the applicable estimates (addressed in Appendix E) the conversion costs equate to $309,750 as recapped in the following table.

| **Table 4-59 Study Case B1 - PADD IV Retail Unit Conversion Cost Estimate** | |
|---|---|
| Number of facilities converted | 525 |
| Estimated cost per facility | $590 |
| Total cost | $309,750 |

Table 4-60 recaps all of the estimated expenses associated with distributing 0.1 bgy of ethanol in PADD IV based on all ethanol being sold in E-10 blends. Capital investments at the terminal level are estimated to be $4,355,000. One time costs for converting retail units to E-10 blends are estimated to be $309,750 bringing the total cost to $4,664,750.

| **Table 4-60 Study Case B1 - PADD IV Cost for All Ethanol Infrastructure and Conversions** | |
|---|---|
| <u>Terminaling Costs</u> | |
| Cost for new additional tankage | $750,000 |
| Cost for conversion of existing tankage | $20,000 |
| Cost for blending system | $2,400,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $1,065,000 |
| Contingency-Piping/site work etc. | $120,000 |
| Total capital expenditure at terminal level | $4,355,000 |
| E-10 conversion costs (one time cost at retail) | $309,750 |
| PADD IV TOTAL COSTS | $4,664,750 |

Table 4-61 calculates the costs on an amortized dollars per ethanol gallon basis for new ethanol volume using a 20 year equipment life cycle (see Appendix E for discussion of amortization). The total amortized cost for PADD IV would be $0.0173 per gallon of new ethanol volume.

**Table 4-61 Study Case B1 - PADD IV Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 0.042bgy | $4,664,750 | $0.0173 |

**Study Case B1 - PADD V:** Analysis of PADD V indicates a total of 95 terminals servicing the designated market areas. Of these, 32 are indicated to have water access while 16 have rail capability. A total of 7 terminals list ethanol storage as being available. Of the 82 terminals disclosing size information, 22 were under 100m bbl of storage, 26 were 100m to 250m bbl, and 34 were over 250m bbl storage. In analyzing PADD V a few important assumptions need to be noted. First, all federal RFG oxygen requirement areas in California will have already converted to ethanol well in advance of any time where Case B1 volume production projections would be realized. These tanks are already being installed and converted and all terminals in those areas will have ethanol. The expenses incurred for these conversions will already have taken place and are not included in the cost figures for this analysis. Secondly, it is assumed that ethanol in California is blended at the 5.7v% level due to the NOx penalty for higher oxygen levels that is currently included in the CARB Predictive Model. Also, larger tank sizes will generally be needed due to the need to maintain higher inventory levels to prevent any problems that might arise from shipping or rail delays from the Midwest plants.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 4-62 Study Case B1 - PADD V Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 5 | 5 |
| 9 | 20 |

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.). The balance is assumed to require installation of new tanks. These revised tank requirement estimates are covered in the following table.

| Table 4-63 Study Case B1 - PADD V Revised Tank Requirement Estimate | | | | | |
|---|---|---|---|---|---|
| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
| 5 | 5 | - | 1 | 1 | 3 |
| 20 | 9 | - | 1 | 1 | 7 |
| Total | 14 | 0 | 2 | 2 | 10 |

Based on the above estimates, PADD V would require modifications to 2 tanks (1 - 5 mbbl and 1 - 20 mbbl) and installation of 10 tanks (3 - 5 mbbl and 7 - 20 mbbl). Installation of an estimated 14 blending systems would also be required.

A discussion of cost estimates for building new tanks, converting existing tanks, and terminal equipment is included in Appendix E. Estimates for new tank costs are included in the following table.

| Table 4-64 Study Case B1 - PADD V Cost Estimate for New Tanks | | | |
|---|---|---|---|
| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
| 3 | 5 | $15 per steel barrel = | $225,000 |
| 7 | 20 | $15 per steel barrel = | $2,100,000 |
| 10 | Total | | $2,325,000 |

Estimates for converting existing tankage are included in the following table.

**Table 4-65  Study Case B1 - PADD V Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 1 | 5 | $15,000 |
| 1 | 20 | $40,000 |
| 2 | Total | $55,000 |

We assume that all terminals not estimated to already have ethanol available will require new blending systems.  Estimates for terminal blending system costs which are discussed in Appendix E are calculated in the following table.

**Table 4-66  Study Case B1 - PADD V Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 14 |
| Estimated  cost per terminal | $300,000 |
| Total estimated cost for blending systems | $4,200,000 |

PADD V will import, from PADD II, 0.6 bgy of the total 0.8 bgy used.  Estimates for transportation demand splits are included in the following table.  For waterborne cargoes we assume an average of 125 mbbl cargoes (5.25 million gallons).

**Table 4-67 Study Case B1 - PADD V Transportation Modes Estimate**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of ship cargo | Monthly # of ships |
|---|---|---|---|---|
| 0.3 bgy (7.1 mmbbl) | 10,000 | 833 | -- | -- |
| 0.3 bgy (7.1 mmbbl) | -- | -- | 57 | 4.8 |

Sixteen terminals already have rail access so we estimate only one additional terminal would need to install rail. Other terminals would truck product from these or other transfer points. The cost of rail spur installations (as covered in Appendix E) are estimated in the following table.

**Table 4-68 Study Case B1 - PADD V Estimated Cost of Rail Spur Installation**

| No. of terminals rail | Average cost per terminal | Total Cost |
|---|---|---|
| 1 | $355,000 | $355,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for each terminal requiring installation of new tanks or conversion of tanks.

**Table 4-69 Study Case B1 - PADD V Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 12 | $20,000 | $240,000 |

### Retail Costs

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 or E-5.7 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

### E-85 Infrastructure

We have not estimated for any E-85 volume in PADD V. This is due to California's focus on other alternative fuels as well as the fact that many of the FFVs placed in the market thus far could not meet California's emissions standards.

### E-10 and E-5.7 Information

Once blended at the terminal, E-10 or E-5.7 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are discussed in Appendix E.

Gasoline demand in PADD V in 1998 was 22,120,932,954 (1443 mbcd). The retail outlet count in PADD V is 19,145 (6). This indicates a per unit average annual volume of 1,155,442 gallons.

We have directed ethanol blend sales into major metropolitan areas. Therefore we used an average sales volume of 1.2 million gallons per unit year reflecting the higher volumes of these units.

For PADD V, we are taking a slightly different approach to estimating retail conversion costs. First, California will soon be converted to ethanol. Indications are that refiners in California will blend ethanol at 5.7v% due to the NOx penalties assessed at higher oxygen levels in the CARB Predictive Model. This blend level will create a demand for 0.6 bgy (39 mbcd) of ethanol in 2003. Since these retail facilities will be converted prior to anything close to the time when Case B1 production volume is achieved, they are not in the total retail conversion cost estimates. The remaining cities in California are estimated to use 0.145 bgy of ethanol, also at the 5.7v% level. The remaining 0.055 bgy used in PADD V will be used in other states at the 10v% level.

| Table 4-70 Study Case B1 - PADD V Station Retail Conversion Requirements (bgy) | | |
|---|---|---|
| | Blend sales | Ethanol required |
| Targeted E-5.7 volumes | 13.07 bgy | 0.745 bgy |
| Less existing (2003) E-5.7 sales | 10.53 bgy | 0.600 bgy |
| Balance new E-5.7 sales | 2.54 bgy | 0.145 bgy |
| Targeted E-10 volumes | 0.55 bgy | 0.055 bgy |
| Less existing E-10 sales (1) | 0.85 bgy | 0.085bgy |
| Balance new E-10 sales | -- | -- |
| Number of facilities required post 2003 for E-5.7 based on 2.54 bgy @ average annual volume of 1.2 mmgy | | 2116 |

(1) Our assumptions include a temporary reduction of existing ethanol use in other PADD V states to accommodate growing demand in California while limiting total ethanol volumes to coincide with TMS PADD V scenario.

Table 4-70 above lists total targeted E-5.7 sales at 13.07 bgy. After deducting the 10.53 bgy for the existing oxygenate requirement, this leaves 2.54 bgy of new E-5.7 sales which at an annual average of 1.2 mmgy would require 2116 retail conversions.

Using the estimates for applicable conversion costs (see Appendix E) equates to $1,248,440 as recapped in the following table.

| Table 4-71 Study Case B1 - PADD V Retail Unit Conversion Cost Estimate | |
|---|---|
| Number of facilities converted | 2116 |
| Estimated cost per facility | $590 |
| Total cost | $1,248,440 |

Table 4-72 recaps all of the estimated expenses associated with distributing 0.8 bgy of ethanol in PADD V based on 0.745 bgy being sold in E-5.7 blends and 0.055 bgy being sold in E-10 blends. Capital investments at the terminal level are estimated to be $7,175,000. One time costs for converting retail units to E-5.7 blends are estimated to be $1,248,440.

**Table 4-72 Study Case B1 - PADD V Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| <u>Terminaling Costs</u> | |
| Cost for new additional tankage | $2,325,000 |
| Cost for conversion of existing tankage | $55,000 |
| Cost for blending system | $4,200,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $355,000 |
| Contingency-Piping/site work etc. | $240,000 |
| Total capital expenditure at terminal level | $7,175,000 |
| E-5.7 conversion costs (one time expenditure at retail level) | $1,248,440 |
| Total | $8,423,440 |

The amortized cost for PADD V on a dollars per gallon of new ethanol basis is $0.0091. Much of California's market will be converted to ethanol (due to the current oxygen requirement for RFG) by 2003. Consequently the amortized cost represents only the expense of the 0.145 bgy increase over the anticipated demand for ethanol in 2003. This is recapped in the following table.

**Table 4-73 Study Case B1 - PADD V Amortization Costs for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10/E-5.7 investments/conversion | 0.145 bgy | $8,423,440 | $0.0091 |

Note that in the case of PADD V, there are also considerations such as tankage for staging product in New Orleans or other Gulf Coast locations as well as tankage to receive ships. These considerations and their costs are covered in the Transportation Analysis section.

## 4.5 Study Case B1 Summary of Expenses at the Terminal and Retail Levels

The collective terminal totals for all PADDs indicate there are at least 844 terminals servicing the targeted ethanol markets. Of these, at least 247 have water access and at least 81 have rail access. While the *OPIS Petroleum Terminal Encyclopedia* lists 91 as having ethanol storage available, the number is known to be much higher. For instance, nearly all terminals in the Chicago and Milwaukee markets have ethanol, as do all Minnesota terminals. Additionally, by the time Study Case B1 production volumes could be achieved, most California terminals (in federal RFG markets) will have ethanol storage. These factors have all been taken into account.

Not all terminals provide information on total storage capability. Among those that do there are 51 with storage of less than 100m bbl, while 316 list storage capabilities of 100m to 250m bbl , and 303 terminals list storage of over 250m bbl. The aforementioned details are recapped in the following table.

**Table 4-74 Overview of Terminal Operations - Case B1**

| | Operating Terminals | Water | Rail | Existing Ethanol | S1 | S2 | S3 |
|---|---|---|---|---|---|---|---|
| PADD I | 261 | 116 | 22 | 11 | 10 | 86 | 116 |
| PADD II | 311 | 56 | 22 | 61 | 6 | 133 | 108 |
| PADD III | 158 | 42 | 17 | 10 | 9 | 68 | 36 |
| PADD IV | 19 | 1 | 4 | 2 | 4 | 3 | 9 |
| PADD V | 95 | 32 | 16 | 7 | 22 | 26 | 34 |
| TOTALS | 844 | 247 | 81 | 91 | 51 | 316 | 303 |

Note: S1-terminals with under 100 mbbl storage capacity, S2-terminals with 100 mbbl to 250 mbbl storage capacity, S3-terminals with over 250 mbbl storage capacity

In order to develop estimates on tankage requirements a preliminary estimate was made of transportation mode splits for ethanol imported into each PADD and movements for use within PADD II. These initial numbers indicate a total of 54,665 rail car shipments annually (4555 monthly). Barge shipments equate to 1,118 annual river barge movements (93 monthly) and 267 ocean barge movements (22 monthly). Ship cargoes in 5.25mm gallons (125 mbbl) lots will require 109.3 shipments annually (9.1 monthly average cargoes).

The above figures do not include product movements within each PADD (other than rail and barge for PADD II). This is strictly an estimate of the shipment modes for product exported from PADD II to the other PADDs to facilitate analysis of terminal requirements. A more detailed analysis of movements to, and within, each PADD is included in the Transportation Analysis section. A recap of the above referenced shipments is included in the following table.

**Table 4-75 Preliminary Estimate of Transportation Modes (Shipped from PADD II) - Case B1**

| | Total Volume By Rail Cars Annual/Monthly | Total Volume by Barge or Ocean Barge Annual/Monthly | Total Volume by Ship Annual/Monthly |
|---|---|---|---|
| PADD I | 18333/1527 | 267/22 (20M) | 52.3/4.4 |
| PADD II | 14666/1222 | 523/44 (20M) | -- |
| PADD III | 8333/694 | 595/50 (10M) | -- |
| PADD IV | 3333/277 | -- | -- |
| PADD V | 10000/823 | -- | 57/4.7 |
| TOTALS | 54665/4555 | 1385/115 | 109.3/9.1 |

It is estimated that a total of 63 existing tanks, of various sizes, with 471m bbl of storage will need to be converted and placed into ethanol service. A total of 181 new tanks of various sizes, totaling 1.579 mmbbl of storage will need to be built. Collectively this equates to 86,100,000 gallons (2.050 mmbbl) of new storage which at an average of two turns per month could handle slightly over two billion gallons annually of new ethanol volume. However turns will be much higher in PADD II due to the close proximity to plants. This should therefore represent adequate tankage for the volumes in Study Case B1. Estimated conversion and new tankage needs by PADD are listed in the following table.

| Table 4-76 Total Estimated Tank Conversions & New Tank Installations - Case B1 | | | | |
|---|---|---|---|---|
| | Number of Conversion | Total Capacity (mbbl) of Tanks Converted | Number of New Tanks | Total Capacity (mbbl) of New Tanks |
| PADD I | 18 | 235 | 45 | 660 |
| PADD II | 27 | 86 | 74 | 326 |
| PADD III | 15 | 115 | 47 | 388 |
| PADD IV | 1 | 10 | 5 | 50 |
| PADD V | 2 | 25 | 10 | 155 |
| TOTALS | 63 | 471 | 181 | 1,579 |

A profile of the number of terminals with ethanol, water capabilities, and rail capabilities, after conversion for Study Case B1 is provided for each PADD in Table 4-77. This profile includes existing terminals as well as those converted in Study Case B1. In total, there are 844 terminals servicing the designated markets. Of these, 495 (58.6%) would have ethanol. Among the ethanol terminals, 126 would have water access although not all of these would necessarily choose to receive their ethanol by barge or waterborne cargo. Of the terminals handling ethanol, 130 (26.3%) would have rail capabilities.

| Table 4-77 Profile of Ethanol Terminaling Capabilities After Case B1 Conversions | | | |
|---|---|---|---|
| **PADD** | **Number of terminals with ethanol** | **Estimated number of water capable ethanol terminals** | **Estimated number of rail capable ethanol terminals** |
| I | 96 of 261 | 44 | 42 |
| II | 228 of 311 | 40 | 37 |
| III | 87 of 158 | 32 | 27 |
| IV | 11 of 19 | 0 | 7 |
| V | 73 of 95 | 10 | 17 |
| Totals | 495 of 844 (58.6%) | 126 | 130 |

Finally, there are the conversion steps to take at retail facilities. The following table provides a breakdown of the number of estimated retail conversions required to achieve the Study Case B1 ethanol volumes.

**Table 4-78 Estimated Retail Unit Conversions - Case B-1**

| | Number of Conversions |
|---|---|
| PADD I | 11,020 |
| PADD II | 12,611 |
| PADD III | 8,942 |
| PADD IV | 525 |
| PADD V | 2,116 |
| TOTALS | 35,214 |

After a total estimated conversion of 35,214 retail units, the retail unit profile would be as estimated in the following table.

**Table 4-79 Profile of Retail Units after Case B-1 Conversion**

| PADD | Estimating Existing Outlets | Case B1 Outlet Conversions | Total Estimated # of Retail Outlets Offering E-10/E-5.7 Blends |
|---|---|---|---|
| I | 980 | 11,020 | 12,000 |
| II | 10,919 | 12,611 | 23,530 |
| III | 1,058 | 8,942 | 10,000 |
| IV | 725 | 525 | 1,250 |
| V | 9,234 | 2,116 | 11,350 |
| Total | 22,916 | 35,214 | 58,130 |

Existing stations selling ethanol blends plus those converted to accomodate Study Case B1 volumes would equate to 58,130 or an estimated 33.2% of the U.S. retail gasoline outlet population.

Looking at total capital investments at the terminal level, expenditures for new tanks will total $23,055,000, while investments in tank conversions will cost $1,369,000. By far the largest expenditure at the terminals would be for blending equipment at a total of $86,100,000. In addition we estimate a need for $17,395,000 to be invested in rail receipt capabilities and an additional $4,880,000 for miscellaneous work at terminals for such things as piping reconfiguration, and product receipt modifications.

This brings the total capital investment required at the terminal level to $132,799,000. In addition there will be expenses incurred for the initial conversions of retail facilities totaling $20,776,260, bringing the total cost of E-10/E-5.7 investments to $153,575,260. The total new ethanol volume for E-10/E-5.7 blend use is 2.987 bgy. This volume does not include the 0.3 bgy used in E-85. Nor does it include the new ethanol demand created in California for RFG compliance/MTBE phase out since these volumes will be achieved by 2003 and the related costs were therefore not included in this study. Of course, these investments in infrastructure would not all be made at one time, but phased in over time as ethanol production capacity increases. The amortized cost on a dollars per gallon of new ethanol volume basis is $0.008. The above information is recapped by PADD in the following table.

**Table 4-80 Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7 - Case B1**

| | New ethanol Volume (bgy) | Cost of New Tanks | Cost of Tank Conversion | Cost of Blending Systems | Modification for Rail Receipt | Contingency | Retail Conversions | Total | Amortized cost per gallon |
|---|---|---|---|---|---|---|---|---|---|
| PADD I | 1.102 | $8,850,000 | $645,000 | $24,300,000 | $7,100,000 | $1,260,000 | $6,501,800 | $48,656,800 | $0.0069 |
| PADD II | 1.072 | $5,395,000 | $309,000 | $33,000,000 | $5,325,000 | $2,020,000 | $7,440,490 | $53,489,490 | $0.0078 |
| PADD III | 0.626 | $5,735,000 | $340,000 | $22,200,000 | $3,550,000 | $1,240,000 | $5,275,780 | $38,340,780 | $0.0096 |
| PADD IV | 0.042 | $750,000 | $20,000 | $2,400,000 | $1,065,000 | $120,000 | $309,750 | $4,664,750 | $0.0173 |
| PADD V | 0.145 | $2,325,000 | $55,000 | $4,200,000 | $355,000 | $240,000 | $1,248,440 | $8,423,440 | $0.0091 |
| TOTALS | 2.987 | $23,055,000 | $1,369,000 | $86,100,000 | $17,395,000 | $4,880,000 | $20,776,260 | $153,575,260 | $0.0080 |

Study Case B1 also looked at the expense of developing enough retail infrastructure to sell 0.1 bgy of ethanol for use in E-85 in PADD I and 0.2 bgy in PADD II. Our estimates indicate that after allowing some volume (10%) dispensed as mobile fueling, there would still be a need to convert 285 existing tanks/pumps and install 2271 new tanks/pumps at a cost of $147, 927,000. The following table recaps these expenses and the amortized cents per gallon of ethanol.

**Table 4-81 Estimated Cost for E-85 Retail Infrastructure - Case B1**

| | Number of New Facilities/Retrofit Conversions | Cost | Amortized Cost Per Gallon |
|---|---|---|---|
| PADD I | 757/95 | $49,309,000 | $0.0769 |
| PADD II | 1514/190 | $98,618,000 | $0.0769 |
| TOTALS | 2271/285 | $147,927,000 | $0.0769 |

Note: The cost estimates do not consider any federal or state incentives such as income tax credits or grants to install E-85 fueling facilities which may in some cases be available.

When included in the totals costs, the E-85 programs make total and amortized costs for PADD I and PADD II appear higher than the remaining PADDs. The following table lists amortized dollarsper gallon costs for ethanol (new volume) used in E-10/E-5.7, ethanol used in E-85 and total ethanol by PADD as well as providing national totals for each category.

**Table 4-82 Amortized Cost Per Gallon Recap - Case B1**

| PADD | Ethanol Volume E10/ E-5.7 BGY | Amortized Cost Per Gallon | Ethanol Volume E85 BGY | Amortized Cost Per Gallon | Total Ethanol Volume BGY | Total Ethanol Amortized Cost Per Gallon |
|---|---|---|---|---|---|---|
| I | 1.102 | $0.0069 | 0.1 | $0.0769 | 1.202 | $0.0127 |
| II | 1.072 | $0.0078 | 0.2 | $0.0769 | 1.272 | $0.0187 |
| III | 0.626 | $0.0096 | -- | -- | 0.626 | $0.0096 |
| IV | 0.042 | $0.0173 | -- | -- | 0.042 | $0.0173 |
| V | 0.145 | $0.0091 | -- | -- | 0.145 | $0.0091 |
| Total | 2.987 | $0.0080 | 0.3 | $.0769 | 3.287 | $0.0143 |

## 4.6 Operating Costs

It should be noted that there could be very modest increases in operating costs for some terminals to handle ethanol. Storage and load out of ethanol would basically be similar to gasoline so operating costs (utilities, personnel, etc.) should be the same. One possible area of increased operating expense may be for product receipt, especially for pipeline terminals. Pipeline terminals receive their gasoline by pipeline which is fairly automated. However, their ethanol would be delivered by rail or truck and could therefore necessitate more manpower to spot and unload rail cars or handle truck deliveries. Any such costs would depend on the current operational parameters of the terminal, the volume of ethanol received and the mode of ethanol delivery. Consequently, these costs cannot be accurately estimated and are not included here, but are likely to be on the order of hundreths of cents per gallon.

## 4.7 Discussion and Observations

This report section examines the terminal upgrade requirements, and retail unit conversion costs of distributing 4.8 bgy of ethanol for use in E-10 and E-5.7 blends, an increase of 2.987 bgy from currrent volumes. The requirements and costs of the retail infrastructure necessary to distribute 0.3 bgy for use in E-85 blends are also estimated. Clearly, ethanol plants will not be built in every identical location hypothesized in this study. However the locations used are sufficient to provide reasonably accurate estimates for the scenarios studied.

This exercise assesses the requirements, and their costs, ultimately reaching an amortized cost on a cents per gallon basis for new ethanol volumes.

The total terminal and retail costs for all 5.1 bgy of ethanol sales (3.287 bgy increase over current sales) in this section equates to $0.0143 per gallon of ethanol on an amortized basis. However breaking costs down by PADD or type of investment offers more detail.

The amortized cents per ethanol gallon costs for E-10/E-5.7 blends is $0.008 with PADD I being the lowest at $0.0069, followed by PADD II at $0.0078, PADD V at $0.0091, PADD III at

$0.0096, and PADD IV at $0.0173.

Examining E-85 expenses shows that this is by far the most expensive portion of the scenario studied. Just to achieve a volume of 0.3 bgy for use in E-85 through 2556 facilities (plus some mobile fueling) requires nearly the investment required for increasing the E-10/E-5.7 program by 2.987 bgy. The amortized cost for ethanol used in E-85 is $0.0769 per gallon of ethanol. Essentially, it raised PADD I amortized costs from $0.0069 for 1.102 bgy of E-10 to $0.0127 to achieve only an additional 0.1 bgy. In PADD II the amortized cost is increased from $0.0078 for 1.072 bgy of E-10 to $0.0187 per ethanol gallon when the 0.2 bgy of ethanol for E-85 is added. Even if the costs for the 0.3 bgy of ethanol in E-85 are spread across the entire 3.287 bgy volume increase of Study Case B1, it raises amortized costs from $0.008 for 2.987 bgy in E-10 to $0.0143 for the total increase which is inclusive of the ethanol used in E-85.

There are also certain expenses that may seem counter-intuitive to some readers. For instance, by far the largest total expense at the terminal level is for blending systems representing over half of E-10 blending costs. This is in part because, while many terminals may be able to use or convert existing tankage, nearly every terminal not already blending ethanol will need to install blending systems.

The cost of rail spur installation is nearly as much as the cost of new tankage. This is largely because a high number of terminals were estimated to require rail spur installation to accommodate the volumes studied.

In fact, the costs for retail conversion expenses are also nearly as much as the expense for new tanks. This is, of course, due to the greater number of retail facilities requiring conversion compared to terminals. Only 181 terminals were estimated to require new tanks. Retail conversion expenses while obviously much lower on a per unit basis, were required at over 35,214 facilities to accommodate the E-10/E-5.7 volumes in Study Case B1.

## 4.8 Study Case B1 Recommendations for the Terminal and Retail Levels

There are two areas which make up the largest portion of the costs associated with Study Case B1, E-85 retail infrastructure (49.1% of costs) and terminal blending systems (28.6% of total costs). Anything that could be done to bring these costs down would be beneficial in reducing overall program costs.

E-85: In the case of E-85, the high per unit expense not only increases program cost but it results in hesitation on the part of retailers to make the investments. One possible approach to solving this problem would be to develop some type of modular dispensing system for E-85. Perhaps some type of small above ground system that could be used until volumes are higher. As an example, typical cost projections for an E-85 dispensing system include an 8,000 to 12,000 gallon storage tank which equates to nearly a month's volume. If a 2,000-3,000 gallon above ground skid tank could be used and piped to a dispensing island this would lower costs dramatically. Moreover, as volumes increase at a given facility and installation of an underground tank could be justified, the skid system could be moved to another facility. The primary impediment to this approach is likely to be the local permitting process and resistance from local fire officials. However it may be possible to design a system that would be acceptable. Such a system would lower program costs and decrease the lead time of program expansion. If an E-85 program is to be pursued, it is recommended that such an approach be examined more closely.

Blending Systems: There are a variety of blending systems that could be used at the terminal level. Many companies may choose to design their own. Other companies will purchase skid-mounted blending systems. It is possible that the cost of these units would decrease with volume purchases such as those that would be necessary for the cases studied.

However, it might also be possible to reduce costs by redesigning skid-mounted units specifically for E-10/E-5.7 blending. Currently, some systems are designed for more than one blending use (i.e. they may be modified for other blending applications such as lube oil, additives, or mid-grade blending). As such, they may be over-engineered for ethanol blending applications. Design work to come up with a less expensive blending system could therefore be beneficial. Likewise, a system that was designed to handle both ethanol blending and mid-grade blending could be of lower total cost. It is recommended that these issues be examined in more detail.

## 4.9 Transportation Analysis and Costs - Study Case B1

### 4.9.1 Introduction

The terminal analysis section included preliminary estimates of transportation mode splits for ethanol imported into PADDs I, III, IV, and V (from PADD II) and also for intra-PADD movements in PADD II. These preliminary estimates were used primarily to help identify terminal requirements for rail and water receipt capabilities. In this section the analysis is much more detailed because the intent here is to determine the increased demands on the transportation infrastructure system itself. This includes projected rail use, barge traffic on the inland waterways, ocean-going shipments, and their related requirements and associated costs.

Moreover, this section includes not only analysis of ethanol transportation from PADD II to the other PADDs, but includes a review of intra-PADD movements. There are some additional assumptions incorporated into this section and they are covered below.

### 4.9.2 Additional Assumptions for Transportation Analysis

There are several basic modes of transportation that could be used for transporting ethanol to destination markets. These include truck, rail, inland waterway barge and coastal barge, ship, and pipeline, and in some cases, a combination of two or more modes. In addition, as the market expands, product exchanges and marketing agreements will be used to minimize unnecessary ethanol transportation and associated costs. These are discussed briefly below.

**Transport Truck:** Transport trucks are the same trucks one sees delivering gasoline to the local service station or convenience store. They typically haul 7,800 to 8,200 gallons of product. In the case of ethanol deliveries, transport trucks would be used to haul ethanol short distances (usually under 200-300 miles) from the ethanol plant to nearby terminals and also from larger hub terminals to smaller terminals (hub terminals receive product by barge, rail, or ship and redistribute the product by truck to other terminals that either cannot receive by these modes, or may not have tanks of sufficient size to receive these larger quantities). In this analysis we assume transport truck shipments average 8,000 gallons.

**Inland Waterway Barge:** Barges used on the inland waterways, primarily the Mississippi River and connecting navigable waters, are already widely used to deliver ethanol. These barges are typically of 10,000 barrels capacity and are moved in "tows" of 6 to 18 barges depending on the waterway traveled and prevailing conditions (e.g., water levels, lock size). Barges are used to move ethanol to terminals and hub terminal operations in PADDs II and III and are also used to transport ethanol to the Gulf Coast area (currently New Orleans) to be staged (temporarily stored) for shipment to the east and west coast markets. In the future, barges may also be used to move ethanol from hub terminal operations receiving ship quantities to other terminals capable of receiving barges, especially on the east coast.

**Coastal Barges:** Coastal barges of 20,000 barrels or more can be used to move product from the Gulf Coast staging areas to Gulf Coast terminals and to southern destinations in PADD I. The economics of shipping from the Gulf Coast to Northern PADD I destinations will normally dictate ships as compared to ocean barges.

**Ships:** There are various size ships that could move ethanol from the Gulf Coast to the northeast portions of PADD I and to the coastal markets in PADD V. In addition, such ships are compartmentalized so smaller shipments of ethanol could be sent as one compartment of a ship handling other petroleum products or petrochemicals.

Ships that are used to transport ethanol are subject to various regulations and requirements. The Merchant Marine Act of 1920, otherwise known as the Jones Act, requires that all ocean or waterway transportation from one U.S. port to another U.S. port be moved in a vessel built in the United States, owned by a U.S. person or corporate entity, manned by a certified U.S. crew and registered in the United States (U.S. flagged). Tankers meeting these specifications are known as Jones Act tonnage. Some U.S. registered ships which are not U.S. built or were built with Federal Government subsidies fly the U.S. flag, but are not Jones Act ships. Foreign flag ships, i.e. ships not registered in the United States, and non-Jones Act U.S. tonnage are precluded from moving cargo from a United States location to another United States location.

The combined source and destination of the cargo define the limitation. Items or materials which originate in the United States and are ultimately shipped to a United States location must be shipped in Jones Act tonnage. (8)

Ships moving product not subject to the Jones Act establish their tariffs in "World Scale". World Scale tariffs are produced annually by the World Scale Association Limited in London. The reference rate is called W100. The purpose of the World Scale system is to facilitate the process of tanker chartering.

Jones Act vessels, on the other hand, are chartered under the American Tanker Rate Schedule (ATRS) System. The Jones Act has created a unique niche market for ships meeting its requirements. Because U.S. costs differ from foreign ships and the market is restricted, a rate schedule similar to Worldscale has evolved.

ATRS is used in a similar fashion to Worldscale. Charter rates are expressed as AR50 or AR75 meaning 50% or 75% of the AR100 rate. U.S. flag charter rates are expressed in AR equivalents. The AR100 rates refer to dollars per long-ton (2240 pounds), not metric ton (2204.6 pounds), as is the case for Worldscale.

Vessels carrying petroleum products between U.S. ports are also subject to the Oil Pollution Act of 1990 (OPA 90). OPA 90 requires the use of double hulled vessels and further requires the retirement of single hulled vessels from petroleum product service by certain dates based on their manufacture or rebuild date.(8) For instance, several single hulled ships built in the 1950 to 1970 time range were retired from petroleum product service between 1996 and 2000. Additional ships are scheduled to be removed from petroleum products service between 2002 and 2014.

Many of these vessels are in the 25-50 Thousand Dead Weight Ton (MDWT) category that is thought to be more suitable for ethanol transport due to operational flexibility. They are also vessels that were in "clean product service" (i.e., transporting gasoline and distillates). Vessels move in and out of clean product service from "dirty product" and chemical product trading. Ships may be unexpectedly retired. Large ocean going barges may also move into and out of clean product service. Some larger and smaller ships beyond a certain size range may transport clean product in specialized situations. In addition, some vessels used to haul compressed gases could be converted to clean product service.

Because of ship retirements and vessels moving in and out of clean product service, predicting the long term availability of OPA90 compliant clean product vessels can be difficult. There is however a general consensus that OPA90 compliant Jones Act tonnage will be in increasingly short supply. Recent studies have confirmed this trend.[9]

On larger ships the cost difference between an OPA 90 vessel, compared to one that is not, can be as much as $10,000 per day.

While ethanol denatured with petroleum products must be transported in an OPA 90 vessel, undenatured ethanol is subject to no such requirement because it is not included in the OPA90 listing of products. Consequently, some scenarios are envisioned where undenatured ethanol may be sent to coastal markets and denatured there. These movements would require distilled spirit plant permits (DSPs) at origin and destination, and be subject to various Bureau of Alcohol, Tobacco, and Firearms (BATF) regulations.

Limited availability of OPA90 vessels will likely encourage the shipment of undenatured product, so called “pure spirits”. This approach results in not only lower freight rates from utilizing non-OPA90 vessels, but also allows more ethanol to be contained in each shipment. This is because on a typical 250 mbbl cargo, the 10.5 million gallons of denatured product contains approximately 500,000 gallons of gasoline used in denaturing the product. So each cargo of pure spirits results in 500,000 gallons more ethanol being delivered.

While shipping undenatured product may seem to provide the best economics, it will not be practical in every case due to logistic limitations. In many cases, a full ship may unload product at multiple terminals not all of which would have DSPs due to the smaller volumes involved. Likewise, smaller volume terminal requirements may result in the ethanol being shipped as a compartment on an OPA90 vessel.

We have assumed shipments will be small cargoes of 250 mbbl (~ 10.5 million gallons) or a ship compartment of 125 mbbl(~ 5.25 million gallons). Freight rates used are from year 2000. Specific shipping scenarios are discussed in the actual analysis.

**Rail Cars:** Rail cars of ~ 30,000 gallons capacity are currently used to move a significant volume of ethanol and this volume will increase significantly in both Study cases. Rail cars of various commodities, including ethanol, can be shipped in any quantity from a single car up to unit train capacity (unit trains consist of up to 100 rail cars pulled by a dedicated locomotive to and from the destination). While the economics favor unit train movements, there are impediments to using unit trains. Key among these are rail yard congestion on the West Coast and limited space to spot such a large quantity of rail cars at terminals, which typically can only spot 3 to 20 rail cars.

**Pipelines:** By far the most economical means of moving petroleum products over long distances is by pipeline. Unfortunately, ethanol's special handling requirements, and the location of pipelines in relationship to the ethanol plants, will result in no major movements of ethanol via pipeline. In both individual interviews/surveys (11) of industry personnel and our project colloquies (10) this issue was discussed in some detail. There are several considerations when ethanol is to be shipped by pipeline (10, 11, 12). These include:

- Ethanol absorbs moisture that builds up in the pipeline system from other products and could therefore arrive at its destination terminal off specification

- Ethanol has a solvency effect and may scour built up rust, sediment, and lacquers from the system, at least for initial shipments. This could result in contamination of ethanol shipments, as well as other products in the pipeline.

- Ethanol in the pipeline may mix with products sequenced before and after the ethanol shipment which may increase the amount of interfaces to be downgraded or processed.

- Some pipeline operations have also expressed concern for the potential of increased corrosion of pipelines if they are used to ship ethanol (11).

While none of the above technical issues are operationally insurmountable, economics will dictate that ethanol will not be shipped by pipeline except in unique situations. The report from our project colloquies provides additional details (See Appendix F). It should be noted that test shipments of ethanol and gasoline ethanol blends in pipelines have been made (13, 14, 15). The steps necessary to facilitate pipeline shipment of ethanol are reasonably well understood (12). However, the ongoing costs of the special handling procedures cannot be justified for the ethanol volumes projected for Study Case B1 or C. Perhaps more importantly, both Study Case B1 and C are based on only PADD II producing a sufficient volume of ethanol to export to other PADDs and there are no pipelines originating in PADD II that ship to the other PADDs.

It should, however, be noted that these issues are unique to the current logistics in the U.S. Both ethanol and gasoline ethanol blends are moved by pipeline in other countries. For instance, in Brazil, pipelines have been used to move ethanol for a number of years. Also, Sasol Oil of South Africa has moved gasoline ethanol blends over a 100 Km pipeline for the past several years. (16) Sasol also shipped ethanol via pipeline from 1980 to 1994. (16)

Finally the idea of building dedicated ethanol pipelines was examined. However, as noted in Appendix F, pipeline construction costs (including permitting and rights-of-way) would easily approach $500,000 per mile for a small size line. When one also considers the gathering lines from plants and main lines to major markets, this does not appear feasible for the volumes involved. Consequently our transportation analysis does not include any pipeline shipments of ethanol from PADD II to the other PADDs.

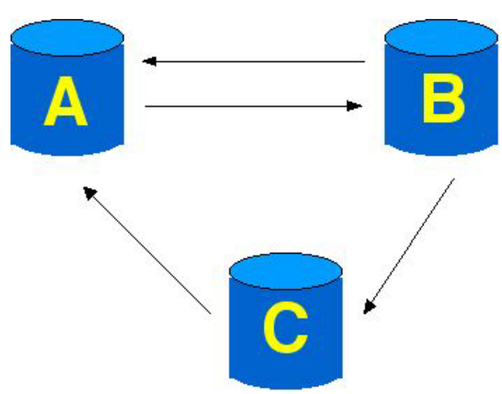
There are some instances where ethanol may be shipped via pipeline over short distances or where short sections of dedicated ethanol pipelines may be built. In California, some refiners have indicated they will move ethanol through short segments of their proprietary pipeline systems (17, 18). While such plans are situation specific, where used they will reduce the need for transport truck shipments between hub terminal operations and secondary destination terminals.

In the case of dedicated pipelines, the most likely feasible application would be a short line, i.e. under 50 miles that connects a plant to water access or to a major high volume terminal. Again, such uses would be very plant specific and the investment required would likely be part of the plant capital investment plan. Where such situations are known (e.g., California) or very likely, they are discussed in the appropriate sections of this report.

**Product Exchanges:** Recent increases in ethanol production, and expansion into new markets, have resulted in an increase in product exchanges of ethanol. Such exchanges will continue to grow in importance as ethanol production increases. While product exchanges are commonplace in the petroleum industry, they have not, in the past, been widely used in the ethanol industry. This was because most ethanol was produced and used in PADD II. However, in an expanded market with ethanol used in all PADDs, product exchanges should become the norm. In fact, exchanges might be promoted by regulation, if averaging, trading, and banking of renewable credits are features of any future regulation which mandates the use of renewable fuels in gasoline.

The traditional petroleum product exchange might be as simple as refiner A receiving product from one of refiner B's terminals in an area where A does not have a terminal. Refiner B would then receive an equal amount of like product at one of refiner A's terminals where B does not have a terminal. More complex exchanges involve multiple companies and numerous terminals (i.e., A to B, B to C, C to A without B actually returning product to A) such as the example in figure 4-2. Exchanges may also employ exchange differentials to address logistics/costs, product quality differences, and exchange imbalances.

**Figure 4-2 Product Exchange Agreements**

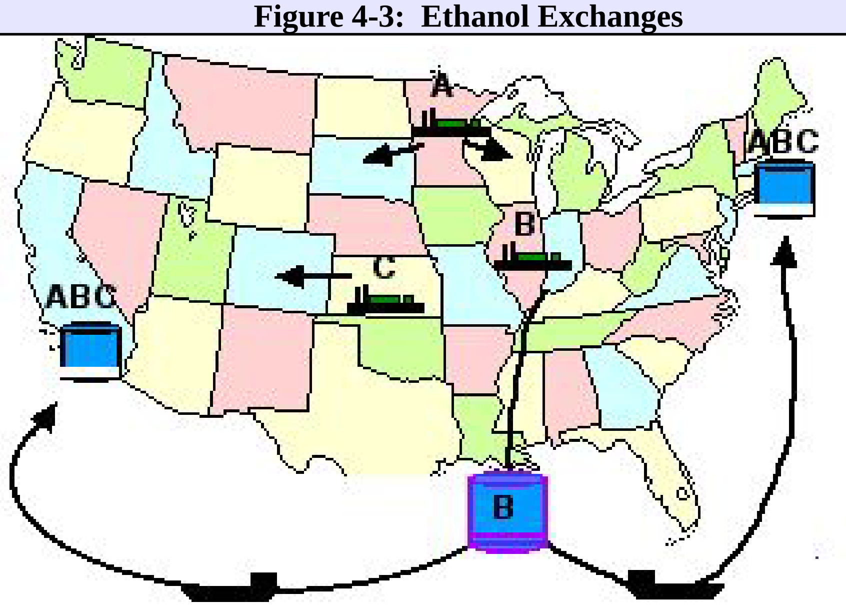


The benefits to the exchange partners include minimizing distribution costs and operating on their own product without increasing the number of terminals they operate. Ethanol exchanges would work in a similar fashion but in some cases for different reasons. As the geographic diversity of ethanol production facilities increases, there will be more opportunity for plant to plant exchanges.

Another consideration is that many ethanol plants are landlocked, or too small to ship the large quantities required for waterborne cargo. Here there may be opportunities to trade between plants with water access and take product back in a destination market such as California or New York, while returning product to the water accessible plant in one of its markets serviced by truck or rail.

Figure 4-3 depicts such exchanges. In this example ethanol producer B is a large plant located on navigable waters, while plants A and C are smaller and landlocked. Plant B would ship large volumes to New Orleans and on to the east and west coats. Plant B would allow plants A and C to lift product from its terminals on the east and west coasts. Plant A would give product back at their plant for truck distribution to B's customers in that area. Plant C could return product at their plant for shipment to Colorado by rail or truck. Differentials would be established to address freight differences and operating costs. This allows three plants to distribute product in coastal markets while only one plant is actually shipping product there.

**Figure 4-3: Ethanol Exchanges**



Also with limited tankage available, such exchanges will allow more companies to distribute from the same tank(s) within a terminal complex. Exchanges may also be used to address terminal receipt capabilities or storage limitations. Exchanges between ethanol producers and petroleum companies could also be utilized.

So the motivation for the ethanol industry to exchange product is not only to minimize freight. It is also to overcome transportation limitations and terminal restraints to enable ethanol to be shipped from the nearest location with the least amount of logistic difficulty and cost.

Product exchanges and other market conditions and logistics will generally dictate that ethanol supply to a given market will be provided by the closest production points. This assumption is used in our transportation analysis.

**Marketing Agreements:** Marketing agreements are also becoming quite commonplace. Many of the smaller plants (e.g. under 20-30 million gallons of annual ethanol production capacity) consider it more efficient to have a larger ethanol producer market their ethanol. This precludes the need for the smaller producers to have sales/marketing personnel, reduces or eliminates their need for transportation equipment and personnel, and reduces their need for accounts receivable personnel. In addition, it enables their product to be pooled, with portions of their production potentially sent to higher valued markets, thereby increasing revenues. A number of such agreements have already been announced (19, 20).

Properly structured, these agreements provide benefits to both the small ethanol producer and the larger producer who is responsible for marketing the production. More importantly, it allows one marketer to direct transportation, thereby moving product to market from the closest plant at the least transportation expense.

One other variant of the marketing agreement is the consortium. In this type of agreement, several smaller producers would pool their product to enable them to utilize less expensive transportation modes (e.g., unit trains or barges) that they could not otherwise utilize due to low production volume.

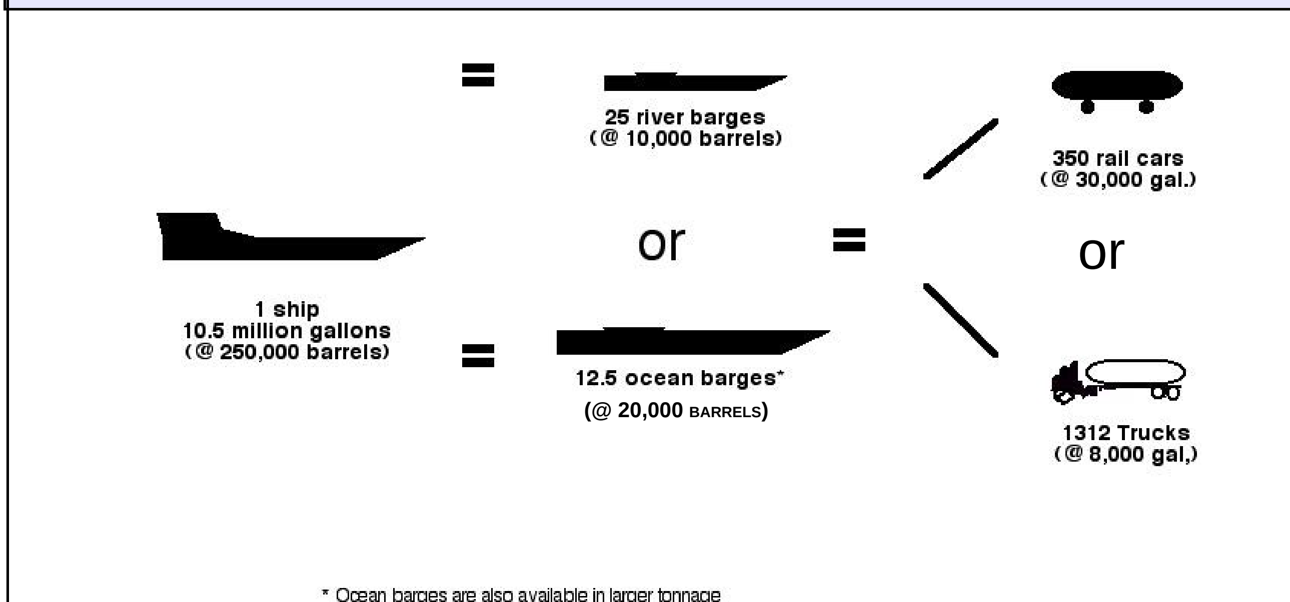
A consortium would also enable small producers to collectively provide the large supply quantities, per transaction, that some oil companies may prefer. Finally, a consortium might be able to utilize one marketing director although such an agreement could be fraught with problems from an antitrust perspective.

We have not assumed the widespread use of consortiums in our analysis, since it currently appears that marketing agreements between large and small producers are more prevalent and more advantageous.

**Impacts on Transportation Modes:** The impacts on each selected transportation mode are discussed in greater detail in the actual transportation analysis for each case.

**Preferred Transportation Mode:** The mode of preferred transportation depends on a number of variables including the size of the shipment, the shipping plants capability, the receipt capabilities and storage capacity at the destination terminal, and other operational factors. However as a general rule, larger quantities are generally moved by the mode that requires the least number of individual movements. A comparison of volume by ship, barge, truck, and rail is provided in Figure 4-4.

**Figure 4-4 Transportation Modes/Volumes**



**Composite Freight Rates:** For a project of this size it is obviously not possible to calculate the freight cost of every individual shipment. In order to provide a reasonably accurate estimate of freight costs, composite freight rates have been constructed for each shipment category.

Import/exports: In the case of product imported into PADDs I, III, IV, and V, from PADD II, the composite freight rate was calculated by first separating the shipment categories into rail, river barge, river barge/ship combinations, and ocean barge. In the case of product moving by river barge/ship combination, the composite freight rate includes barge transportation from the plants to the New Orleans staging areas, the cost of staging (i.e., tank lease), movement in ships to the designated destinations and a throughput charge to unload through a common carrier terminal. The composite freight rate was calculated by determining the volumes to key markets and the corresponding freight charges to determine the average for the PADD.

Similarly for rail, river barge, and ocean barge, the volumes shipped to key markets and the corresponding freight charged were compiled to determine an average for each of these modes.

Intra-PADD Movements: In the case of intra-PADD ethanol movements, there are three categories. Intra-PADD transfers represent shipments from one state to another within the same PADD. In-state shipments represent shipments from a plant to a destination in the same state, and Intra-PADD redistribution represents reshipment of product from a hub terminal to a secondary destination terminal. These categories move primarily by truck but also include a small amount of barge and rail. Here again, the freight rates from the plants to the primary markets were calculated and averaged across the volumes sent to these markets to determine a composite freight rate. In the case of intra-PADD redistribution, the composite freight rate represented the cost from the hub terminal operation to the destination terminal. Freight estimates used to construct the composite freight rates were calculated based on actual freight rates compiled in an earlier phase of this work.† Where rates to certain markets were not available, for the mode of transport, freight rates were estimated based on known rates for shipments of similar size and distance.

*† The Current Fuel Ethanol Industry-Transportation, Marketing, Distribution, and Technical Considerations, Appendix 3A Ethanol Transportation Costs*

## 4.10 Transportation Analysis Study Case B1

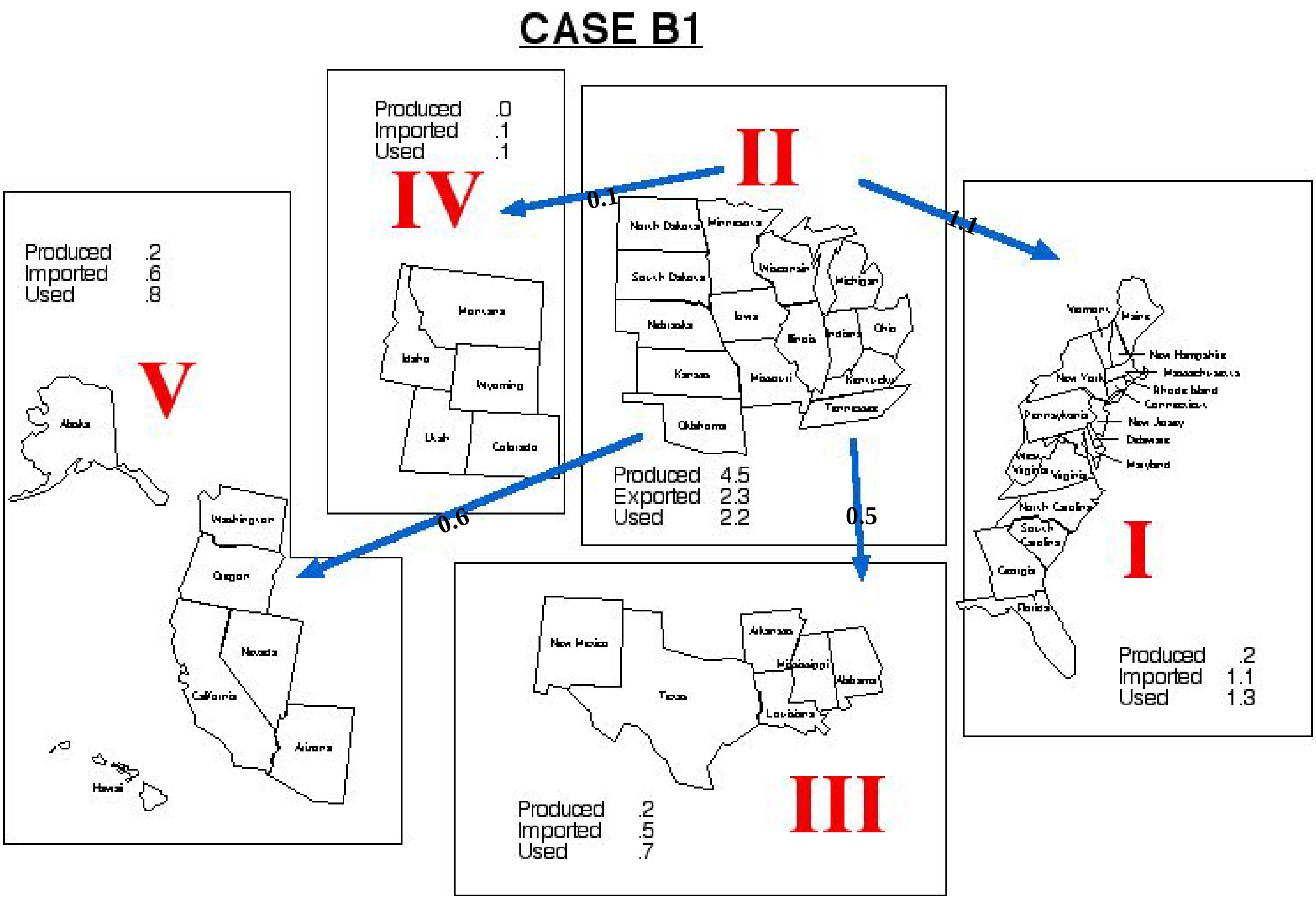
In assessing transportation demands for increased ethanol production, we have divided the assessment into two major areas, imports/exports between PADDs, and intra-PADD shipments (i.e. movements within each PADD). The latter category includes intra-PADD transfers, in-state shipments, and intra-PADD redistribution. In doing this we start with the following table.

**Table 4-83 Study Case B1 Annual Ethanol Use, Imports, Exports by PADD (bgy)**

| PADD | Ethanol Used in PADD | Ethanol Produced in PADD | Ethanol Imported | Ethanol Exported |
|---|---|---|---|---|
| I | 1.3 | 0.2 | 1.1 | 0.0 |
| II | 2.2 | 4.5 | 0.0 | 2.3 |
| III | 0.7 | 0.2 | 0.5 | 0.0 |
| IV | 0.1 | 0.0 | 0.1 | 0.0 |
| V | 0.8 | 0.2 | 0.6 | 0.0 |
| Total | 5.1 | 5.1 | 2.3 | 2.3 |

Here we assume that all ethanol produced in PADDs I, III, and V is used within the PADD where is it produced. The small amount of existing production in PADD IV, not picked up in the TMS scenarios, is assumed to be used in PADD IV as is currently the case. It is not analyzed due to the small volume, i.e., 0.0125 bgy. PADD II uses 2.2 bgy of ethanol production within the PADD and exports 2.3 bgy to the other PADDs to meet their import demand for ethanol. Study Case B1 ethanol movements between PADDs are depicted in Figure 4-5.

**Figure 4-5 Study Case B1 Ethanol Movements Between PADDS**



## 4.11 Study Case B1 Transportation Analysis-Mode of Transportation for Shipments

As noted earlier, the assumption is made that with the exception of PADD II all ethanol produced within a PADD is used there. This is done to conform to the TMS developed scenarios. This may create some minor anomalies because there could be some exports on fringes of the PADDs but these volumes, if any, would be minor and are not analyzed here.

In order to first determine where imports in a given PADD are needed, it is first necessary to determine where in-PADD production might be directed. The balance can then be presumed to be imported from PADD II. Note that this section focuses on imports/exports between PADDs. Consequently specific movements within PADDs are covered in more detail in the section on intra-PADD movements. However, the transportation demands to stage product shipped from PADD II to New Orleans for shipment to PADDs I and V are included here.

The following tables place product produced in each PADD into their closest logical market and are listed as Intra-PADD in the table below. The remaining imports from PADD II are then estimated by mode, i.e., ship (or compartment thereof), ocean or river barge, or rail. A discussion and recap of each PADD follows the tables.

### Table 4-84A Study Case B1 -PADD I Ethanol Import Movements

| Cities over 250,000 | Ethanol total Volume (mmgy) | Ship | Ocean Barge | River Barge | Rail | Truck | Intra- PADD |
|---|---|---|---|---|---|---|---|
| Albany/Schenectady/Troy NY | 10 | | | | 10 | | |
| Allentown/Bethlehem/Easton PA | 10 | | | | 10 | | |
| Atlanta GA | 20 | | | | 20 | | |
| Augusta/Aiken GA | 10 | | | | 10 | | |
| Boston/Worcester/Lawrence MA | 100 | 70 | | | 30 | | |
| Buffalo/Niagra Fallsa NY | 20 | | | | 20 | | |
| Charleston/North Charleston SC | 10 | | | | 10 | | |
| Charlotte/Gastonia/Rock Hill NC/SC | 20 | | | | 0 | | 20 |
| Erie PA | 5 | | | | 5 | | |
| Fort Myers/Cape Coral FL | 5 | | | | 5 | | |
| Greensboro/Winston Salem/High Poi | 20 | | | | 0 | | 20 |
| Greenville/Spartanburg/Anderson S | 15 | | | | 10 | | 5 |
| Harrisburg/Lebanon/Carisle PA | 10 | | | | 10 | | |
| Hartford CT | 20 | | | | 20 | | |
| Jacksonville FL | 15 | | | | 15 | | |
| Lakeland/Winter Haven FL | 5 | | | | 5 | | |
| Lancaster PA | 10 | | | | 10 | | |
| Miami/Fort Lauderdale | 50 | | 30 | | 0 | | 20 |
| New London/Norwich CT | 10 | | | | 10 | | |
| New York/Long Island/et.al. NY/N | 300 | 200 | | | 50 | | 50 |
| Norfolk/Virginia Beach/Newport Ne | 30 | | | | 30 | | |
| Orlando FL | 20 | | | | 20 | | |
| Pensacola FL | 5 | | | | 5 | | |
| Philadelphia/Wilmington/Atlantic C | 90 | 25 | | | 0 | | 65 |
| Pittsburgh PA | 50 | | | | 50 | | |
| Providence/Fall River/Warwick RI | 15 | | | | 15 | | |
| Raleigh-Durham/Chapel Hill NC | 15 | | | | 0 | | 15 |
| Reading PA | 10 | | | | 10 | | |

## Table 4-84A PADD I continued

| | Ethanol total Volume (mmgy) | Ship | Ocean Barge | River Barge | Rail | Truck | Intra-PADD |
|---|---|---|---|---|---|---|---|
| Richmond/Petersburg VA | 15 | | | | 15 | | |
| Rochester NY | 20 | | | | 20 | | |
| Sarasota/Bradenton FL | 5 | | | | 5 | | |
| Scranton/Wilkes-Barre/Hazelton P. | 10 | | | | 10 | | |
| Springfield MA | 10 | | | | 10 | | |
| Syracuse NY | 15 | | | | 15 | | |
| Tampa/St. Petersburg/Clearwater | 30 | | 20 | | 5 | | 5 |
| Utica/Rome NY | 10 | | | | 10 | | |
| Washington/Baltimore DC/MD/VA/ | 160 | 110 | | | 50 | | |
| West Palm Beach/Boca Raton FL | 15 | | | | 15 | | |
| York PA | 10 | | | | 10 | | |
| E-85 | 100 | 85 | | | 15 | | |
| **TOTALS** | **1300** | **490** | **50** | **0** | **560** | **0** | **200** |

| | | | | |
|---|---|---|---|---|
| Note: E-85 | 85 million gallons ship | 40.0 New York | 35.0 DC | 10.0 Boston |
| | 15 million gallons rail | 5.0 Pittsburgh | 5.0 New York | 5.0 Boston |

**Transportation Recap**

| **Mode** | **Volume** | **Shipments Annual** | **Shipments Monthly** |
|---|---|---|---|
| **Ocean Barge (@ 840,000 gallons)** | **50 million gallons** | **59.52** | **4.96** |
| **River Barge (@ 420,000 gallons)** | **0 million gallons** | **0** | **0** |
| **Rail Cars (@ 30,000 gallons)** | **560 million gallons** | **18,666** | **1,555** |
| **Ship (@ 10.5 million gallons)** | **430 million gallons** | **40.95** | **3.41** |
| **Ship compartment (@ 5.25 million gallons)** | **60 million gallons** | **11.43** | **.95** |

**PADD II does not import any product.**

## Table 4-84B Study Case B1 PADD III Ethanol Import Movements

| Cities over 250,000 | Ethanol total Volume (mmgy) | Ship | Ocean Barge | River Barge | Rail | Truck | Intra-·PADD |
|---|---|---|---|---|---|---|---|
| Albuquerque NM | 30 | | | | | | 30 |
| Austin/San Marcos TX | 30 | | | | 30 | | |
| Baton Rouge LA | 15 | | | | | | 15 |
| Beaumont/Port Arthur TX | 10 | | | | | | 10 |
| Biloxi/Gulfport/Pascagoula MS | 10 | | | | | | 10 |
| Birmingham Al | 25 | | | | 25 | | |
| Brownsville/Harlingen/San Benito TX | 10 | | 10 | | | | |
| Corpus Cristi TX | 10 | | 10 | | | | |
| Dallas/Fort Worth TX | 140 | | | | 140 | | |
| El Paso TX | 20 | | | | 20 | | |
| Fayetteville/Springdale/Rogers AR | 8 | | | | 8 | | |
| Houston/Galveston/Brazoria TX | 110 | | | 50 | | | 60 |
| Huntsville AL | 7 | | | | 7 | | |
| Jackson MS | 10 | | | | | | 10 |
| Killeen/Temple TX | 7 | | | | 7 | | |
| Lafayette LA | 10 | | | | | | 10 |
| Little Rock/North Little Rock AR | 15 | | | | 15 | | |
| McAllen/Edinburg/Mission TX | 15 | | | | 15 | | |
| Mobile AL | 15 | | 15 | | | | |
| Montgomery AL | 10 | | | | 10 | | |
| New Orleans LA | 45 | | | | | | 45 |
| San Antonio TX | 40 | | | | 40 | | |
| Shreveport/Bossier City LA | 10 | | | | 10 | | |
| Abilene TX | 4 | | | | 4 | | |
| Alexandria LA | 4 | | | | 4 | | |
| Amarillo TX | 6 | | | | 6 | | |
| Anniston AL | 3 | | | | 3 | | |
| Auburn/Opelika AL | 2 | | | | 2 | | |
| Bryan/College Station | 3 | | | | 3 | | |
| Decatur AL | 3 | | | | 3 | | |
| Dothan AL | 3 | | | | 3 | | |
| Florence AL | 3 | | | | 3 | | |
| Fort Smith AR | 4 | | | | 4 | | |
| Gadsdden AL | 3 | | | | 3 | | |
| Hattiesburg MS | 3 | | | | | | 3 |
| Houma LA | 4 | | | | | | 4 |
| Lake Charles LA | 4 | | | | 4 | | |
| **Laredo TX** | **4** | | | | **4** | | |
| Las Cruces NM | 4 | | | | 4 | | |
| Longview/Marshall TX | 5 | | | | 5 | | |
| Lubbock TX | 5 | | | | 5 | | |
| Monroe LA | 3 | | | | | | 3 |
| Odessa/Midland TX | 5 | | | | 5 | | |
| Santa Fe NM | 3 | | | | 3 | | |
| Sherman/Denison TX | 2 | | | | 2 | | |
| Texarkana TX/AR | 3 | | | | 3 | | |
| Tuscaloosa AL | 4 | | | | 4 | | |
| Tyler TX | 4 | | | | 4 | | |
| Waco TX | 4 | | | | 4 | | |
| Wichita Falls TX | 3 | | | | 3 | | |
| TOTALS | 700 | 0 | 35 | 50 | 415 | 0 | 200 |

**Transportation Recap**

| **Mode** | **Volume** | **Shipments** Annual | Monthly |
|---|---|---|---|
| **Ocean Barge (@ 840,000 gallons)** | **35 million gallons** | **41** | **3.5** |
| **River Barge (@ 420,000 gallons)** | **50 million gallons** | **119** | **10** |
| **Rail Cars (@ 30,000 gallons)** | **415 million gallons** | **13,833** | **1,153** |

## Table 4-84C Study Case B1 PADD IV Ethanol Import Movements

| Cities over 250,000 | Ethanol total Volume (mmgy) | Ship | Ocean Barge | River Barge | Rail | Truck | Intra-PADD |
|---|---|---|---|---|---|---|---|
| Boise City ID | 10 | | | | 10 | | |
| Colorado Springs CO | 15 | | | | 15 | | |
| Denver/Boulder/Greeley CO | 55 | | | | 55 | | |
| Provo/Orem UT | 5 | | | | 5 | | |
| Salt Lake City/Ogden | 15 | | | | 15 | | |
| TOTALS | 100 | 0 | 0 | 0 | 100 | 0 | 0 |

**Transportation Recap**

| Mode | Volume | Shipments Annual | Shipments Monthly |
|---|---|---|---|
| Rail Cars (@ 30,000 gallons) | 100 million | 3,333 | 277 |

## Table 4-84D Study Case B1 PADD V Ethanol Import Movements

| Cities | Ethanol total Volume (mmgy) | Ship | Ocean Barge | River Barge | Rail | Truck | Intra-PADD |
|---|---|---|---|---|---|---|---|
| Anchorage AK | 5 | 5 | | | | | |
| Bakersfield CA | 15 | | | | 15 | | |
| Fresno CA | 20 | | | | 20 | | |
| Los Angeles/Riverside/Orange Cty, ( | 400 | 250 | | | 82.7 | | 67.3 |
| Modesto CA | 10 | | | | 10 | | |
| Sacramento/Yolo CA | 45 | | | | | | 45 |
| San Diego CA | 70 | 30 | | | 40 | | |
| San Francisco/Iakland/San Jose CA | 160 | 80 | | | 30 | | 50 |
| Seattle/Tacoma/Bremerton WA | 50 | | | | 12.3 | | 37.7 |
| Stockton-Lodi CA | 15 | | | | 15 | | |
| Visalia/Tulare/Pottersville CA | 10 | | | | 10 | | |
| TOTAL | 800 | 365 | 0 | 0 | 235 | 0 | 200 |

**Transportation Recap**

| Mode | Volume | Shipments Annual | Shipments Monthly |
|---|---|---|---|
| **Ship (@ 10.5 million gallons)** | **300 million gallons** | **28.5** | **2.38** |
| **Ship compartment (@ 5.25 million gallons)** | **65 million gallons** | **12.38** | **1.03** |
| **Rail Cars (@ 30,000 gallons)** | **235 million gallons** | **7,833** | **652** |

**PADD I:** In PADD I, movements by ship of 0.430 bgy would require 41 shipments annually (of 10.5mm gallons/250 mbbl) or an average 3.4 per month. Additionally 0.060 bgy would move by ship compartments requiring 11.4 shipments (of 5.25 mm gallons/125,000 bbl) annually or roughly one per month. It is also estimated that 0.050 bgy annually would move by small ocean barge (20,000 barrel capacity) requiring 60 annual shipments† or 5 per month. Finally, 0.560 bgy would move by rail requiring 18,666 rail car movements†† annually or 1555 monthly. This transportation split varies somewhat from our original estimate in the Terminal Analysis section in that a smaller amount is moved by ocean barge and a greater amount is moved by ship. This is primarily a result of placement of PADD I production and the ability and economics of placing full ships and ship compartments into the high volume New York, Philadelphia, Baltimore/Washington, and Boston markets.

**Table 4-85 Study Case B1 - PADD I Ship Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Shipments (of 10.5mm gallons/250M bbl) | 41 | 3.4 |
| Ship compartments (of 5.25 mm gallons/125,000 bbl) | 11.4 | 1 |

Since shipping demands are unique to PADDs I and V, the impact on shipping is discussed collectively at the end of this report section. However, rail cars and ocean barges are discussed here.

- Ocean Barge: As noted, the movements by ocean barge are only 5 per month, a very small amount expected to have no impact on the demand for these units.

**Table 4-86 Study Case B1 - PADD I Ocean Barge Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Ocean barge (20M bbl) | 60 | 5 |

*† Many clean product vessels are compartmentalized enabling them to segregate multiple products on the same shipment. For instance, gasoline might comprise 3 or 4 compartments while ethanol would be hauled in the 4th or 5th compartment.*

*†† For purposes of this report, a rail car movement represents delivery of 30,000 gallons of product in one rail car. Thus a unit train of 100 rail cars is 100 rail car movements.*

- Rail Cars: While unit trains would be the preferred mode for rail shipments, not many terminals can handle this many cars. Other terminals may not have sufficient volumes to handle such large inventory. Unit trains would likely be limited to a few key markets with hub terminal operations. It is therefore assumed that only 2 unit trains per month are shipped (100 cars @ 30,000 gallons = 3,000,000 gallons) with the remainder being smaller shipments of 1 to 20 cars. Based on industry contacts, unit trains might be expected to achieve a turn around time (from the Midwest) of 14-15 days while smaller shipments would likely require 21-22 days. This would indicate a need for 100 rail cars for unit train (100 cars x 2 trips = 2 unit trains) use and 1018 rail cars for the other rail car shipments. This is recapped in the following table.

**Table 4-87 Case B1 PADD I Imports from PADD II- Rail Car Demand**

| | **Rail cars needed** |
|---|---|
| 200 rail cars in unit trains @ 2 turns per month = | 100 |
| 1355 rail cars monthly in smaller quantities @ 1.33 turns per month = | 1018 |
| Total rail car demand | 1118 |

The impact on total rail car demand is dependent on the total demand for all PADDs as well as the rail cars required for intra-PADD movements and is therefore discussed later in this section of the report. We would also note that our terminal analysis section for Case B1 included the addition of 20 rail handling facilities in PADD I bringing the total number of terminals capable of handling rail receipt of ethanol to 42, a sufficient number to deal with the projected shipments.

**PADD II:** Ethanol movements within PADD II are covered in the section on Intra-PADD Movements. Rail shipments to other PADDs are covered as imports into those PADDs. Here we are only concerned with the requirements to move ethanol to the Gulf Coast for shipment to PADDs I, III, and V, the only areas requiring such shipments. PADD I requires 0.540 bgy to move by ship, ship compartment, or ocean barge. PADD III requires 0.035 bgy to move by ocean barge and PADD V requires 0.365 bgy to move by ship or ship compartment. Collectively this indicates a need for staging 0.940 bgy of product as listed in the following table.

**Table 4-88 Case B1 PADD II -River Barge Movements for Staging Waterborne Cargoes in New Orleans**

| | Barges needed |
|---|---|
| 186 River barges (2 turns per month) | 93 |

The total river barge movements required are 2238 annually or approximately 186 monthly. River barges can easily make two round trips from Illinois to New Orleans per month. At two turns per month, the actual river barge requirement for staging product is then approximately 93 barges.

As discussed later in this report, this also helps identify the needed volume for staging tankage (tankage to store product pending shipment from the Gulf Coast to east and west coasts). The estimate indicates that monthly movements would be about 75 to 80 million gallons. While industry could easily operate on a 10 day supply or 25 to 27 million gallons, they will likely want some capacity to store additional product to take care of production swings, problems with river traffic, and market conditions. Consequently, we think enough storage to handle 20 days of supply or 50 to 54 million gallons is more likely. This equates to about 1.2 million barrels of storage requirement for the Gulf Coast staging area.

**PADD III:** In PADD III there are no movements by ship. Ocean barges ship only 0.035 bgy equating to 41 annual shipments or 3.5 monthly. Again, capacity is available to handle these small volumes.

**Table 4-89 Study Case B1 - PADD III Ocean Barge Cargo Profile**

| | Total Annual Shipment | Total Monthly Shipments |
|---|---|---|
| Ocean Barge shipments (20M bbl) | 45 | 3.5 |

As mentioned earlier, waterborne cargoes are discussed in their entirety at the end of this section. An additional 0.050 bgy moves by river barge equating to 119 movements annually or 10 monthly. Rail cars are discussed here because of the different turn around times between PADD II and the various PADDs.

**Table 4-90 Case B1 PADD III -River Barge Movements Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| River Barge | 119 | 10 |

- Rail cars: Rail shipments are projected to total 0.415 bgy equating to 13,833 rail car shipments annually or an average of 1153 monthly. Again, unit trains, though the preferred mode for rail, cannot be handled by many terminals. We therefore assume only one unit train per month with the remaining rail shipments being smaller quantities. Based on industry estimates, turn around time for most destinations in PADD III are similar to PADD I, providing 2 turns per month for unit train movements and 1.33 turns per month for smaller shipments. This would indicate a need for 842 rail cars as covered in the following table.

**Table 4-91 Case B1 PADD III Imports from PADD II - Rail Car Demand**

| | **Rail cars needed** |
|---|---|
| 100 rail cars in unit train @ 2 turn per month = | 50† |
| 1053 rail cars monthly in smaller quantities @ 1.33 turns per month = | 792 |
| Total rail car demand ........................................................................... | 842 |

*† Fifty cars cannot comprise a unit train. Need is listed as 50 cars because that is the increase required in the total pool of rail cars whereby 50 cars @ 2 turns are equivalent to 1 unit train.*

Again, we would note that the terminal analysis section included the addition of 10 rail facilities at terminals, bringing the total number of terminals with rail capability in PADD III to 27, a sufficient number to handle projected rail traffic. It should be noted that due to displacement by In-PADD production the transportation mode split is revised somewhat here by increasing the number of rail movements by 165 million gallons and lowering waterborne cargoes by a like amount.

**PADD IV:** All of the 0.1 bgy of ethanol imported into PADD IV from PADD II will be by rail.

- Rail cars: Due to the lower volumes in PADD IV, we do not project any use of unit trains. Rail shipments would presumably come from the four western-most states in PADD II, i.e., North Dakota, South Dakota, Nebraska, and Kansas, all of which are large exporters of ethanol. Consequently, turn around times are estimated to be only on the order of 20-22 days. Annual ethanol shipments equate to 3333 rail cars or 277 monthly. As listed in the table below this would require 208 additional rail cars.

**Table 4-92 Case B1 PADD IV Imports from PADD II - Rail Car Demand**

| | **Rail cars needed** |
|---|---|
| 277 rail cars monthly in smaller quantities @ 1.33 turns per month = | 208 |
| Total rail car demand ........................................................................... | 208 |

As with the other PADDs we increased the number of rail accessible terminals in the terminal analysis section. In the case of PADD IV, we added rail facilities at three terminals bringing the total of rail receipt capable terminals in Case B1 to 7. The transportation mode split estimate here is identical to that used in the terminal analysis section.

**PADD V:** In PADD V movements by ship of 0.30 bgy would require 28.5 shipments of 250 mbbl (10.5mm gallons) annually or an average of 2.4 monthly. Additionally, 0.065 bgy are estimated to move on ships in compartments averaging 125 mbbl (5.25mm gallons) per shipment or approximately 12 shipments annually for an average of 1 per month as covered in the following table.

**Table 4-93 Study Case B1 - PADD V Ship Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Shipments (of 10.5mm gallons/250M bbl) | 28.5 | 2.4 |
| Ship compartments (of 5.25 mm gallons/125,000 bbl) | 12 | 1 |

A total of 0.235 bgy would be shipped by rail. This equates to 7,833 rail cars deliveries annually or 653 monthly. This differs slightly from the original transportation mode split estimate in the terminal analysis section. Waterborne cargoes are increased by 0.065 bgy and rail shipments reduced by a similar amount. The implications for shipping demand on waterborne cargoes are discussed at the end of this section. Rail cars are discussed here.

- Rail cars: In the case of the West Coast, high volumes and long shipping distances do favor unit train movements. However, these will be limited to some degree by congestion in rail yards and the receiving capability of the terminals which do not routinely receive large volumes of product by rail. We are therefore estimating movement of only two unit trains per month with the balance of 453 rail cars as smaller shipments. Unit train turn around time is estimated at 15-16 days (2 turns per month) while smaller movements are estimated at 26-27 days per month (1.1 turns per month). The increased rail car demand would then equate to 100 for unit train movements (100 cars x 2 trips per month = 2 unit trains) and 411 for smaller movements. This yields a total need for 511 rail cars for PADD V imports as covered in the following table.

**Table 4-94 Case B1 PADD V Imports from PADD II - Rail Car Demand**

| | Rail cars needed |
|---|---|
| 200 rail cars in unit train @ 2 turn per month = | 100 |
| 453 rail cars monthly in smaller quantities @ 1.1 urns per month = | 411 |
| Total rail car demand | 511 |

In the terminal analysis section, there were 13 terminals with rail and the addition of one terminal brought the total to 14 which should prove sufficient for the rail deliveries projected.

## 4.12 Study Case B1 Transportation Equipment Demand for Imports to Other PADDs from PADD II - Waterborne Cargo

The following table recaps the waterborne cargo movements previously discussed.

**Table 4-95 Case B1 Recap of Waterborne Cargo Movements**

| PADD | Ship Annual/Monthly | Ship Compartment Annual/Monthly | Ocean Barge Annual/Monthly | River Barge Annual/Monthly |
|---|---|---|---|---|
| I | 41/3.4 | 11.4/1 | 60/5 | - |
| II | - | - | - | 2238/186 |
| III | - | - | 41/3.5 | 119/10 |
| IV | - | - | - | - |
| V | 28.5/2.4 | 12/1 | - | - |
| Totals | 69.5/5.8 | 23.4/2 | 101/8.5 | 2357/196 |

Ships: A total of 69.5 ship cargoes ( at 250,000 barrels/~ 10.5 million gallons) would be delivered each year or an average of just under 6 per month. From a transportation time standpoint, 2.4 shipments per month would go to PADD V (primarily California) and 3.4 ships per month would go to PADD I. We would envision that at least 2 ships per month (one each to PADDs I and V) would move as undenatured product and would therefore not require OPA90 double hulled vessels. The 24 ship compartments would equate to about one shipment per month each to PADDs I and V. Since these shipments would have space on a vessel with petroleum products, the vessel would be an OPA90 double hulled vessel.

**Table 4-96 Case B1 PADD I and V Combined Ship Cargo Profile Shipments Annual/Monthly**

| | Non OPA90 Vessels | OPA90 Vessels | Ship Totals | OPA90 Ship Compartments |
|---|---|---|---|---|
| PADD I | 12/1 | 29/2.4 | 41/3.4 | 11/4.1 |
| PADD V | 12/1 | 17/1.4 | 29/2.4 | 12/1 |
| Total | 24/2 | 46/3.8 | 70/5.8 | 23/4.2 |

Turn around times from the Gulf Coast to PADDs I and V will, of course, be a factor. The distance from New Orleans to, for instance, San Diego (the closest PADD V port) via the Panama Canal is ~ 4,222 miles. At a speed of 10 knots time usage would be 17 days, 14 hours. However there could also be delays at the Panama Canal or for weather conditions. The time to the New York harbor would be less than half that of shipments to southern California (6 to 7 days). So the 1.5 average monthly shipments of denatured product to California would tie up two small vessels. The 2.5 average monthly shipments of denatured product to the upper East Coast could probably be handled by one vessel plus supplemental shipments from a second vessel.

With regards to available equipment, the following is noted. The two ships per month of undenatured product would move in vessels that are currently idle or underutilized due to retirement from petroleum product service.

The shipments listed as Non OPA90 vessels in Table 4-96 are undenatured product (pure spirits) and could move in single hulled ships that have been retired from petroleum product service. Consequently no investment would be required for these shipments.

The availability of OPA90 compliant Jones Act vessels is the subject of some debate. As noted earlier, some recent studies have projected a shortage of OPA90 vessels. (9)

The American Waterways Operators (AWO), however, indicate there are 50 coastal, U.S. flagged double hulled ships capable of transporting ethanol from the Gulf Coast to the East and West Coasts. Other industry members of the AWO, when questioned about shipping as much as 0.6 bgy to California stated, "There is ample U.S. flag tonnage available to satisfy the required shipment of ethanol to California." We would note, however, that after considering recent ship retirements, the fleet of smaller ships, i.e. under 50,000 Dead Weight Tons (DWT), in clean product service include 10 ships. Of these 3 will be retired in the 2005 to 2007 time frame and 4 in the 2011 to 2014 time frame. At this point there would only remain 3 vessels, of this smaller size, in clean product service. It should also be noted that to date, new construction of double hulled U.S. flag tank ships has consistently proven cost prohibitive.

The last tank ships built were at a cost of over $80 million each. (21) As smaller ships are retired from service, potential spikes in freight costs are a possibility. In such an event it may become necessary to ship more ethanol as a compartment on a larger ship, or to build one or more ships to be placed in ethanol service. Alternatively, this could create more demand for rail shipments and a necessity for more rail capable terminals, requiring more investment in rail spurs.

However, in Case B1 the ethanol shipments would largely be displacing current MTBE shipments to California. The California Energy Commission (23) estimates that California currently imports 40,200 barrels per day of MTBE from the Gulf Coast. This equates to approximately 0.62 bgy. The total ethanol movement to the West Coast via ship is only 0.365 bgy and of that 0.126 bgy would move in non OPA90 vessels leaving only 0.239 bgy to move in OPA90 compliant vessels. This is less than 40% of the volume of MTBE being shipped from the Gulf Coast. Consequently there should be no need for additional Jones Act tonnage for California deliveries.

Similarly, on the East Coast the volume of ethanol delivered by ship would be 0.490 bgy. However 0.126 of this volume would be undenatured and move in Non OPA90 vessels. This leaves only 0.364 bgy to move in OPA90 compliant vessels. Reasonably large volumes of gasoline are moved from the Gulf Coast to the northeast by ship and ethanol would be largely displacing gasoline volume on these shipments. So again we see no need for additional Jones Act tonnage to service PADD I in Case B1.

Combining the small volumes moved to PADD I and V by ship in Case B1 (0.855 bgy) would not require additional Jones Act tonnage if, in fact, the estimated 0.252 bgy of undenatured ethanol can move in non OPA90 vessels (handling undenatured product).

Ocean Barge: Ocean barge movements for Case B1 total only 101 annual or 8.5 monthly. These are for ethanol shipped from the Gulf Coast staging area to relatively close destinations in PADD I and III. Turn around times for these distances range from 5 to 12 days. So an average of three turns per month or more could be expected. This, then would require only three ocean barges monthly. This small volume will create no unusual demand, or any requirement for new ocean barges, and is not analyzed further here.

River Barge: As noted in table 4-88, the exports of ethanol from PADD II to PADD I and V would require196 barge movements monthly (2,238 annual) to move ethanol to the Gulf Coast for staging. As noted in the transportation discussion for PADD II, barges from Illinois to New Orleans can be expected to achieve 2 round trips (two turns) per month. So 196 barge movements monthly would require 93 barges. Barge shipments in 1999 (the base year in the terminal analysis) were estimated by industry to be 0.42 bgy, approximately 1000 barge movements annually or approximately 83 monthly. Using the same average of two turns per barge would indicate that approximately 42 barges were in ethanol service in 1999. This is consistent with industry estimates. While these barges were, in some cases, used for deliveries within PADD II, we are reassigning their service here to Gulf Coast service. The additional barge demand for intra-PADD movements (over and above the Gulf Coast requirement) will be added in the intra-PADD assessment section. This then will yield an accurate picture for total barge demand. If there is a demand for 93 barges and 42 are currently in service, the new demand would equate to 51 barges.

Industry estimates (21) indicate that there are about 2900 inland barges of which approximately 1800 would be suitable to transport ethanol. However, some marine transport companies indicate that the supply and demand for such barges is nearly in balance.

The AWO has indicated a higher number of 2300 double hulled tank barges operating on the inland waterways and further that any of these could be placed in ethanol service after a quick cleaning. The higher AWO number includes barges which are currently in other service, that could be redirected to ethanol transport if demand dictated.

Although it is quite likely that some existing barges would be reassigned to ethanol service, we are assuming here that any new demand will be met with newly constructed barges. This then should be considered an upper bound estimate

Rather than build 10,000 barrel barges for service from the Midwest to the Gulf Coast, it is far more likely that 30,000 barrel barges would be built for this service. These barges would run in 6 barge tows equating to the same capacity as an 18 barge tow of current sized barges. Utilizing this approach it is estimated that the inland tow boat fleet is of sufficient size. The number of new vessels placed in service would be reduced from 51 monthly to 17 per month. The current construction cost on a new barge of this size is approximately 1.6 million dollars. (21) Total estimated cost is listed in the following table.

| **Table 4-97  Study Case B1 Cost for New Inland Waterway Barges** | |
|---|---|
| 17 barges† @ $1.6 million each = | $27,200,000 |
| † 30 mbbl capacity equivalent to 3 current river barges | |

Based on table 4-97 the estimated cost of increasing the inland waterway barge fleet for PADD II exports is $27,200,000. The current projected lead time on 30,000 barrel barge construction is nine months to one year for the first barges in a series, with delivery capability of about one per month thereafter. A discussion of the demand on the nation's inland waterway system is provided after the intra-PADD movements are calculated and totaled.

## 4.13 Study Case B1 Transportation Equipment Demand for Exports from PADD II to Other PADDs - Rail Shipments

The preceding tables in this section listed annual and monthly rail car shipments, turn around times, and projected rail car demand. The following table recaps the estimate of the total number of rail cars needed to handle PADD II exports to the other PADDs.

**Table 4-98 Study Case B1 Increased Demand for Rail cars**

| PADD | # of Cars Required |
|---|---|
| I | 1118 |
| II | - |
| III | 842 |
| IV | 208 |
| V | 511 |
| Total | 2679 |

Ethanol would be moved in DOT-111A100W1 tank cars, which could carry about 30,000 gallons each (T108 cars with a gross weight on rail of 263K pounds) or in some cases 33,000 gallons (T109 cars with a gross weight on rail of 286K pounds). Use of the larger cars would require an exemption granted by the U.S. Department of Transportation (DOT). Use of the T109 cars may also require additional investments on the lines (including bridges) of regional or short line railroads involved in handling the traffic. This can only be determined by analyzing the specifics of each movement and the routes they traverse. Consequently, we are assuming here that the T108 cars would be used. The Association of American Railways (AAR) indicates that the 30,000 gallon tank cars (263K pounds) could cost up to $60,000 each based upon discussion with the manufacturers and a review of cars installed in recent years. T108 cars installed and registered from January 1 through December 15, 2000, have cost an average of $62,000 (with a minimum cost of $52,000). A 286K tank car might cost

5-10% more, but would haul as much as 9% more product. Other rail industry estimates put the cost for a T108 car in the area of $57,000 per car (17). Here we are using $60,000 as an average cost

In assessing demand for new rail cars it is important to note that there are already some rail cars in ethanol service. The Class I railroads originated 70,125 carloads of alcohols in 1999. Based on 1998 hazardous materials data, 5% of that traffic was ethanol. This equates to approximately 3,500 rail car shipments annually or 0.105 bgy. Industry estimates put rail deliveries of ethanol for that time frame at 0.2 bgy to 0.25 bgy ethanol. Some of the difference may be from ethanol movements on rail lines other than those in the Class I category. Here we are assuming that 0.15 bgy was moved in 1999 at an average of 1.5 turns per month per car. This is reasonable given that most ethanol shipments by rail in that time frame were to northern PADD I, various PADD II locations, and also to PADD IV (primarily Colorado). Based on this, 0.15 bgy would require 5,000 rail car shipments annually or 416 monthly. If the rail cars achieve 1.5 turns monthly, this would indicate that 278 rail cars were in ethanol service. For purposes of adding new rail car demand, we are subtracting these rail cars from the calculated need of 2,679 rail cars which leaves a demand for new rail cars of 2,401 units. Again, this should be considered an upper bound estimate because industry sources indicate that more ethanol is already moved by rail than the volume we have calculated. As indicated in the next table, the demand for 2,401 new rail cars equates to an investment of $144,060,000

| **Table 4-99 Study Case B1 Increased Demand for Rail cars - Imports from PADD II** | |
|---|---|
| 2,401 T108 rail cars at $60,000 each = | $144, 060,000 |

The AAR indicates that up to 7,000 additional tank cars of this type could be constructed annually without significant disruptions. Freight car builders produced about 7,500 tank cars (and a total of 43,850 cars of all types) in the first three quarters of 2000, down slightly from the peak activity levels of the past couple of years. "We believe that they have sufficient capacity to begin building additional cars almost immediately" says AAR. It appears that lead time for rail cars would not be a major issue.

Some industry sources also noted that there are a number of older 26,000 gallon cars setting idle that could be used for any transitional period. [22] However, given the freight car builders capacity, it is not likely that such use would be required since ethanol volumes will increase in small increments as plants are built.

The demand on the railway system itself is discussed in more detail later in this section.

## 4.14 Study Case B1 Recap of Transportation Equipment Costs for Exports from PADD II to Other PADDs - Rail and River Barge

As the tables in the previous section indicate, the total investment for Study Case B1 imports into PADDs I, III, IV, and V would then include $144,060,000 for rail cars and $27,200,000 for river barges.

**Table 4-100 Study Case B1 Transportation Investments for PADD II Exports**

**Capital Investments**

Equipment life cycle 15 years

| | |
|---|---|
| Rail cars | $144,060,000 |
| River barges | $27,200,000 |
| Total | $171,260,000 |
| Total New ethanol volume | 3.887 bgy |
| **Amortized cost per new ethanol gallon** | **$0.0075** |

The total capital investment for new transportation equipment to transport exports from PADD II to the other PADDs is $171,260,000. If calculated over new ethanol volume of 3.887 bgy and a fifteen year equipment life period, this equates to $0.075 per gallon of new ethanol volume in Case B1.

No calculations were made for operating expenses since they would be the same as for any petroleum product shipped by these modes. While these modes of transportation are higher than pipeline expenses, such incremental costs are reflected in the freight expenses.

## 4.15 Transportation Costs for Exports from PADD II to Other PADDs

The price of ethanol to the refiner or blender is based on its value as a blend component (including octane value and oxygenate compliance value when applicable). Consequently, formulas used to price ethanol are keyed off of gasoline prices in the destination market. While transportation costs do not have a significant impact on ethanol's market price, they do impact the economic viability for certain plants to supply certain markets and, of course, affect the net revenue/profitability of plants. They also have economic impact in other sectors, especially for the transportation industry. This section covers composite transportation cost estimates (see page 4-90 for a discussion of composite freight rates) for shipping ethanol from PADD II to the importing PADDs.

In the case of PADDs I and V, large volumes of ethanol are sent via river barge to New Orleans where it is staged (stored) in tanks in sufficient quantity to facilitate loading ships and ocean barges . The total cost of shipping to these markets on the water, then, includes river barge freight, any demurrage incurred, terminaling fees at staging areas, and in some cases terminaling fees at destination markets, in the case of hub terminal operations.

Large tanks for staging product, and tanks of sufficient capacity to receive ship quantities, are already available.

Such facilities are generally operated as common carrier terminals and routinely do not maintain their own inventory of product, but rather provide a warehousing service. Such tankage was not built specifically for ethanol use but rather to provide receipt, storage, and distribution of petroleum products, petrochemicals, and in some cases, a variety of other liquid products. These tanks can be placed in, or removed from, service for various products as circumstances dictate, typically without any modification. Since these warehouse tank facilities were not built especially for ethanol, their costs were not included in the terminal analysis. However ethanol producers will need to either lease these tanks or arrange for a throughput agreement of some type.

There are generally two ways to do this, a "shell capacity lease" or "throughput agreement" with guaranteed minimums. A shell capacity lease is much like leasing any other space. The company utilizing the tank would essentially lease the tank at a flat charge based on its total capacity. As an example the lessor might lease a 500,000 barrel (21 million gallon) tank for $1.00 per barrel of capacity per year ($500,000). The actual cost per gallon would then depend on the number of inventory turns. If the inventory turns are twelve per year (one per month) the cost equates to $0.083 per barrel or $0.002 per gallon. However, if the lessor achieves thirty-six inventory turns per year (three inventory turns per month), the cost drops to one third of that on a per barrel or per gallon basis or $0.028 per barrel ($0.0007 per gallon). The terminal operator will usually add some type of unloading and loading fee on a per barrel basis.

In the case of throughput agreements, the terminal operator provides tankage to one or more ethanol producers and charges a throughput fee usually in the $0.25-$0.40 per barrel range ($0.006 to $0.01 per gallon) and requests a minimum guarantee from the company utilizing the agreement to assure adequate revenues for the use of their assets. In this case, unloading and loading fees are not usually charged since the cost is incorporated into the throughput charge. In many cases, these fees may approach or even exceed $0.01 per gallon of ethanol at the current time. This is largely in instances where throughput volumes are relatively low. However, with the larger volumes envisioned in the study cases, it is more likely that the ethanol industry would enjoy rates similar to those cited above for the petroleum or petrochemical industries. These are at the lower end of the $0.25 to $0.40 per barrel range (cited above).[†]

Likewise, large tanks capable of receiving ship quantities (250,000 barrels or 10.5 million gallons) will be required at the destination markets. A similar system and fee would be expected at these larger destination terminals as well, if they are hub terminal operations that would redistribute product.

Shell capacity leases and throughput charges in this section are presented as illustrative examples and are not necessarily meant to be representative of petroleum industry storage costs. Actual costs associated with shell capacity leases and throughput charges are included in the composite freight costs used in this study. For example, the composite freight cost of shipping from the Midwest to northern PADD I includes the freight charge for river barge movement to New Orleans, terminal fees for staging products there, freight for the ship to deliver product to, for example, New York, and terminaling fees there.

Composite estimated freight cost for waterborne cargoes would be as listed in Table 4-101. Note that we have used freight rates applicable for calendar year 2000 for denatured ethanol. If, in fact, large volumes are moved as denatured product, total transportation costs would be lower.

**Table 4-101 Study Case B1 Composite Freight Rates for Waterborne Cargoes Imported from PADD II**

| PADD | Ship or compartment | Ocean barge (southern PADD I & III) |
|---|---|---|
| I | $0.11 per gal/$4.62 per barrel | $0.07 per gal/$2.94 per barrel |
| II | NA | NA |
| III | NA | $0.03 per gal/$1.26 per barrel |
| IV | NA | NA |
| V | $.14 per gal/$5.88 per barrel | NA |

Applying the above composite freight rates to the volume exported to each PADD is covered in the following table.

**Table 4-102 Study Case B1 Annual Transportation Volumes and Costs for Waterborne Cargo by PADD - Imported from PADD II**

| PADD | Ship or Compartment | Ocean barge | Total |
|---|---|---|---|
| I | 490 million gal @ $0.1111 per = $53,900,000 | 50 million gal @ $0.07 = $3,500,000 | $57,400,000 |
| II | NA | NA | -- |
| III | NA | 85 million gal @ $0.03 per = $2,555,000(1) | $2,555,000 |
| IV | NA | NA | -- |
| V | 365 million gal @ $0.14 per = $51,100,000 | NA | $51,100,000 |
| Totals | 855 million gal | 135 million gal | $111,055,000 |

(1) Includes some river barge

Similarly a composite rail freight rate for each PADD has been developed. It is assumed that PADD I rail shipments will be sourced primarily from Illinois at a composite rate of $0.125 per gallon. For PADD III, it is assumed that product is sourced from Illinois, Iowa, Kansas, and Nebraska at a composite freight rate of $0.085. For PADD IV, it is assumed that product is sourced from the western-most plants in PADD II (i.e., the Dakotas, Nebraska, and Kansas) at a composite freight rate of $0.045. Finally for PADD V it is assumed that product is sourced from a composite of all plants in PADD II, except Illinois which will presumably ship the majority of its production via waterborne cargo. The composite freight rate for PADD V is $0.14. These composite freight rates are calculated against their respective volumes by PADD in the following table.

**Table 4-103 Study Case B1 Total Annual Cost of Rail Shipments Imported from PADD II by PADD**

| PADD | Rail volume | Composite Freight Rate | Total |
|---|---|---|---|
| I | 560 million gal. | $0.125 | $70,000,000 |
| II | NA | NA | -- |
| III | 415 million gal. | $0.085 | $35,275,000 |
| IV | 100 million gal. | $0.045 | $4,500,000 |
| V | 235 million gal. | $0.14 | $32,900,000 |
| Totals | 1,310 million gal. | - | $142,675,000 |

The following table lists the combined costs of water and rail transportation by PADD.

**Table 4-104  Study Case B1 Total Transportation Cost for Imports from PADD II by PADD**

| PADD | Total Water | Total Rail | Total |
|---|---|---|---|
| I | $57,400,000 | $70,000,000 | $127,400,000 |
| II | -- | -- | -- |
| III | $2,555,000 | $35,275,000 | $37,830,000 |
| IV | -- | $4,500,000 | $4,500,000 |
| V | $51,100,000 | $32,900,000 | $84,000,000 |
| Totals | $111,055,000 | $142,675,000 | $253,730,000 |

As can be seen in the above table, transportation costs for all ethanol imported into other PADDs from PADD II totals $253,730,000 equating to approximately $0.110 per gallon when averaged across the total ethanol volume of 2.3 bgy exported from PADD II to the other PADDs.

### 4.16 Study Case B1 Transportation Analysis - Mode of Transportation for Intra-PADD Movements

After analyzing the product movements from PADD II to the other PADDs, it is then necessary to assess transportation requirements and costs for product movements with each PADD, i.e., intra-PADD ethanol movements. The ethanol produced within each state of each PADD is analyzed assuming that this production would be used in the state produced, if demand warrants, or the next closest state (within the PADD) where such demand exists. The following table covers this exercise by PADD/ State.

**Table 4-105 Study Case B1 Ethanol Supply Demand Balance by State**

| PADD I | Ethanol Produced | Ethanol Demand | Production Shortfall | Intra-PADD Transfer |
|---|---|---|---|---|
| CT | 0.0 | 30.0 | 30.0 | |
| DE | 0.0 | 0.0 | 0.0 | |
| DC | 0.0 | 160.0 | 160.0 | |
| FL | 25.0 | 150.0 | 125.0 | |
| GA | 0.0 | 30.0 | 30.0 | |
| ME | 0.0 | 0.0 | 0.0 | |
| MD | 0.0 | 0.0 | 0.0 | |
| MA | 0.0 | 110.0 | 110.0 | |
| NH | 0.0 | 0.0 | 0.0 | |
| NJ | 0.0 | 0.0 | 0.0 | |
| NY | 50.0 | 375.0 | 325.0 | |
| NC | 60.0 | 35.0 | 0.0 | 25.0 |
| PA | 65.0 | 205.0 | 140.0 | |
| RI | 0.0 | 15.0 | 15.0 | |
| SC | 0.0 | 45.0 | 45.0 | |
| VT | 0.0 | 0.0 | 0.0 | |
| VA | 0.0 | 45.0 | 45.0 | |
| WV | 0.0 | 0.0 | | |
| E-85 | | 100.0 | 100.0 | |
| **Total** | **200.0** | **1300.0** | **1125.0** | **(25.0)** |
| **Less Intra-PADD Transfer** | | | **(25.0)** | |
| **Total Imported from PADD II** | | | **1100.0** | |

| PADD II | Ethanol Produced | Ethanol Demand | Production Shortfall | Intra-PADD Transfer |
|---|---|---|---|---|
| IL | 1525.4 | 450.0 | | 1075.4 |
| IN | 210.5 | 125.0 | | 85.5 |
| IA | 325.5 | 42.0 | | 283.5 |
| KS | 176.1 | 20.0 | | 156.1 |
| KY | 153.0 | 65.0 | | 88.0 |
| MI | 135.0 | 295.0 | 160.0 | |
| MN | 365.6 | 155.0 | | 210.6 |
| MO | 250.0 | 170.0 | | 80.0 |
| NE | 725.6 | 35.0 | | 690.6 |
| ND | 93.9 | 5.0 | | 88.9 |
| OH | 142.2 | 327.0 | 184.8 | |
| OK | 45.0 | 58.0 | 13.0 | |
| SD | 179.0 | 0.0 | | 179.0 |
| TN | 108.5 | 141.0 | 32.5 | |
| WI | 64.7 | 112.0 | 47.3 | |
| Outlying Areas | | | | |
| E-85 | | 200.0 | 200.0 | (2937.6) |
| **Total** | **4500.0** | **2200.0** | **637.6** | **(2937.6)** † |
| **Less Intra-PADD Transfer** | | | | **637.6** |
| **Total Exported from PADD II** | | | | **2300.0** |

***† (includes exports)***

| PADD III | Ethanol Produced | Ethanol Demand | Product Shortfall | Intra-PADD Transfer |
|---|---|---|---|---|
| AL | 0.0 | 78.0 | 78.0 | |
| AR | 0.0 | 27.0 | 27.0 | |
| LA | 120.0 | 100.0 | | 20.0 |
| MS | 0.0 | 23.0 | 23.0 | |
| NM | 30.0 | 37.0 | 7.0 | |
| TX | 50.0 | 435.0 | 385.0 | |
| Outlying Areas | | | | |
| **Total** | **200.0** | **700.0** | **520.0** | **(20.0)** |
| **Less Intra-PADD Transfer** | | | **(20.0)** | |
| **Total Imported from PADD II** | | | **500.0** | |

| PADD IV | Ethanol Produced | Ethanol Demand | Product Shortfall | Intra-PADD Transfer |
|---|---|---|---|---|
| CO | 0.0 | 70.0 | 70.0 | |
| ID | 0.0 | 10.0 | 10.0 | |
| MT | 0.0 | 0.0 | 0.0 | |
| UT | 0.0 | 20.0 | 20.0 | |
| WY | 0.0 | 0.0 | 0.0 | |
| Outlying Areas | | | | |
| **Total** | **0.0** | **100.0** | **100.0** | |
| **Less Intra-PADD Transfer** | | | **0.0** | |
| **Total Imported from PADD II** | | | **100.0** | |

| PADD V | Ethanol Produced | Ethanol Demand | Product Shortfall | Intra-PADD Transfer |
|---|---|---|---|---|
| AK | 0.0 | 5.0 | 5.0 | |
| AZ | 0.0 | 0.0 | 0.0 | |
| CA | 162.3 | 745.0 | 582.7 | |
| HI | 0.0 | 0.0 | 0.0 | |
| NV | 0.0 | 0.0 | 0.0 | |
| OR | 30.0 | 0.0 | | 30.0 |
| WA | 7.7 | 50.0 | 42.3 | |
| Outlying Areas | | | | |
| **Total** | **200.0** | **800.0** | **630.0** | **(30.0)** |
| **Less Intra-PADD Transfer** | | | **(30.0)** | |
| **Total Imported from PADD II** | | | **600.0** | |

It is assumed that each state directs its own in-state production to supply in-state demand. While there may be some carry-over in bordering states this will generally balance out.

The amount of product exported from states within PADDs, the destination market, and likely transportation mode are listed in the following table.

**Table 4-106 Case B1 Intra-PADD Exports from States within PADD**

| | Originating State | Million Gallons | Destination State(s) | Primary Delivery Mode |
|---|---|---|---|---|
| **PADD I** | North Carolina | 25.0 | South Carolina | truck |
| **PADD II** | Indiana | 85.5 | Michigan | truck/rail |
| | Illinois | 74.5 | Michigan | rail |
| | Illinois | 32.5 | Tennessee | barge/rail |
| | Illinois | 22.3 | Wisconsin | truck |
| | Illinois | 96.8 | Ohio | barge/rail |
| | Kentucky | 88.0 | Ohio | barge/truck |
| | Kansas | 13.0 | Oklahoma | rail/truck |
| | Minnesota | 25.0 | Wisconsin | rail/truck |
| | E-85 Multiple Areas | 200.0 | Multiple | truck |
| **PADD III** | Louisiana | 20.0 | Mississippi | barge |
| **PADD IV** | | | | |
| **PADD V** | Oregon | 30.0 | Washington | truck |

From the above table, estimates of transportation demands and costs can begin to be made. For purposes of intra-PADD shipments, product movements have been broken down into three categories as follows.

1. Intra-PADD Transfers - represents states with excess production shipping to another state within the PADD

2. In-State Shipment - represents shipments from a producing plant to destinations within the same state.

NOTE: The total of the two above categories equals the ethanol production within the PADD except in PADD II where exports would also need to be added to equal total production.

3. Intra-PADD Redistribution - represents imported product that is redistributed from a hub terminal operation to another terminal in the PADD.

The above categories for each PADD are discussed below. Both the equipment demand and freight costs are discussed and recapped at the end of this section. For an expanded discussion on the construction of composite freight rates, refer to page 4-90.

**PADD I**

**Intra-PADD Transfers** - In PADD I the 25 million gallons of excess production in Greene County NC would go to Greenville and Park Hill SC. The average distance is 150-160 miles so product would move by truck at an estimated cost of $0.04 per gallon and require 3125 annual truck shipments. Total freight cost would be $1,000,000.

**In-state Shipments** - The remaining production of 175 million gallons is all located close to the markets where it would be used and would be in-state shipments. We would anticipate that these plants would ship via truck to smaller terminals allowing importers to come into larger terminals by ship. This would also minimize the necessity of redistribution of product from hub terminals. Given the close proximity of the plants to their markets, a representative composite freight rate of $0.035 is used. This volume would require 21,875 annual truck shipments. Total freight cost would be $6,125,000.

**Intra-PADD Redistribution** -In addition to the above, product shipped into the PADD via ship, ocean barge, and rail would, in some cases, need to be redistributed to other smaller terminals via truck. After tankage additions in PADD I there are at least 96 terminals handling ethanol. At least 42 of these have rail capabilities and the majority of the remainder have water access. However, because of the large volumes shipped into New York, Baltimore/DC, Philadelphia, and Boston, it is estimated that at least 0.4 bgy would need to be redistributed. It is estimated that 0.2 bgy would move by barge to smaller water accessible terminals at a composite freight rate of $0.02 per gallon and require 476 barge shipments annually at a total freight cost of $4,000,000. The remaining 0.2 bgy would move by truck at an estimated composite freight rate of $0.03 per gallon and require 25,000 truck shipments annually at an estimated total freight cost of $6,000,000.

**PADD II**

**Intra-PADD Transfer** - In PADD II, states with excess production would supply those with a production shortfall. Indiana and Illinois would supply Michigan. Illinois would supply Tennessee, Wisconsin, and Ohio. Kentucky would also ship to Ohio. Kansas would ship to Oklahoma. Finally, Minnesota would supply some volume to Wisconsin. For purposes of this study we have included E-85 as a category area of 0.2 bgy. Most states would utilize multiple transportation modes so a combination of truck and rail would be used. There would also be some movements by barge from Illinois to Tennessee and Ohio, and some barge movements from Kentucky to Ohio. A total of 0.6376 bgy would be moved by these combined modes. Of this volume, an estimated 0.090 bgy would move by barge at a composite freight rate of $0.035 per gallon and require 214 barge shipments annually at a total cost of $3,150,000. An estimated 0.16 bgy would move by rail at a composite freight rate of $0.08 per gallon and require 5333 annual rail car movements at a total freight cost of $12,800,000. The remaining volume of 0.3876 bgy would move by truck at an estimated composite freight rate of $0.06 per gallon and require 48,450 truck shipments at a total estimated freight cost of $23,256,000. All other excess production in PADD II would be exported to other PADDs. Intra PADD transfers could be easily handled by the estimated 228 terminals handling ethanol, of which 40 have water access and 37 would have rail capabilities. The remaining excess production in each state is exported out of the PADD either directly or via exchange. The above costs are just for transfer to states within the PADD that have insufficient production to cover demand.

**In-state Shipments** - In addition, 1.5624 bgy would be distributed in-state among the states in PADD II. With the wide geographic dispersal of plants in these states, product would seldom have to be moved more than 100 miles to reach the target markets. In many cases the distance would be much less. This, combined with the fact that we have utilized smaller tanks at terminals due to widespread availability of ethanol, would dictate that these volumes would move almost exclusively by truck at an estimated composite truck rate of $0.035 per gallon. This volume would require 195,300 truck shipments at a total freight cost of $54,684,000.

**Intra-PADD Redistribution** - Due to the geographic dispersion of plants there should be no need for Intra-PADD redistribution.

**PADD III**

**Intra-PADD Transfers** - In PADD III the only product exported from one state to another would be the 20 million gallon excess production in Louisiana. This would most likely be sent to Biloxi, MS, by truck and barge and Mobile, AL, by barge. The composite freight for barge shipment is $0.02 per gallon with 15 million gallons estimated to move by barge requiring approximately 36 barge shipments and a total freight cost of $300,000. The composite freight rate for the 5 million gallons moved by truck is $0.025 and this would require 625 truck shipments with a total freight cost of $125,000.

**In-State Shipment**s - The remaining 0.18 bgy produced in PADD III would be used within the state where it was produced, i.e. New Mexico, Louisiana, and Texas. The New Orleans and Baton Rouge plants would supply local markets by truck, as would the Houston plant, at very low truck freight rates, generally under $.02 per gallon. The Portales, NM, plant would likely ship to Albuquerque via truck. This is a distance in excess of 160 miles but probably better hauled by truck. Due to the anticipation that Portales would ship by truck, the composite freight rate is estimated to be $0.03 overall, compensating for the 20 million gallons in New Mexico at a freight rate substantially above the 160 million gallons that would be shipped in Texas and Louisiana at much lower rates. The 180 million gallons shipped via truck would require 22,500 truck shipments annually at a total freight cost of $5,400,000.

**Intra-PADD Redistribution** - In PADD III, 87 of the 159 terminals are estimated to have ethanol. Of these, 32 have water receipt capability and 27 have rail capability. Consequently we would estimate that no more than 0.1 bgy would need to be redistributed from product shipped into the PADD. These movements would all be by truck requiring 12,500 annual truck shipments. At a composite freight rate estimate of $0.025 per gallon, this equates to $2,500,000 total freight cost.

**PADD IV**

**Intra-PADD Transfers** - PADD IV imports all 0.1 bgy used from PADD II. Technically there is 12.5 million gallons of existing ethanol production in PADD IV. However we increased PADD IV demand to 0.1125 bgy. Here we assume that the 12.5 million gallons of existing production continues to be dispersed in its existing manner and deal with the 0.1 bgy exported from PADD II.

**In-State Shipments** - There are no in-state shipments

**Intra-State Redistribution** - These rail shipments were picked up in the product movements from PADD II to PADD IV. However only 7 of the eleven servicing terminals have rail so we would expect at least 0.01 bgy to be redistributed by truck requiring 1250 annual truck shipments at an estimated composite freight rate of $0.02 per gallon. The total freight cost would then be $200,000.

**PADD V**

**Intra-PADD Transfers** - In PADD V the 0.03 bgy of ethanol produced in Oregon, due to the plant location, would be trucked to Washington in case B1. The distance is extensive (estimated at 270 miles) at an estimated freight rate of $0.075 per gallon. This would require 3750 annual truck shipments and total freight cost would be $2,250,000.

**In-State Shipments** - The remaining 0.17 bgy produced in PADD V is located close enough to its markets that we would expect product to move by truck at an estimated composite truck rate of $0.04 per gallon. This would require 21,250 annual truck shipments with total freight costs of $6,800,000.

**In-State Redistribution** - Redistribution within PADD V is a little more complicated. Of the 73 servicing terminals with ethanol an estimated 10 would, or could, take waterborne cargoes. There are also 14 terminals with rail capacity. Consequently we envision large quantities of ethanol being redistributed from hub terminal operations after initial import from PADD II. Total imports are 0.6 bgy. Estimates based on permit filings (17, 18) are that perhaps 0.05 bgy would be transferred by pipeline. Many rail shipments could be used at the terminals to which they were sent. Still an estimated 0.08 bgy sent via rail would require redistribution via truck. Of the 0.365 bgy received via water, it is estimated that at least 0.27 bgy would be redistributed by truck because these imports would come in large cargoes to coastal hub terminals. Consequently the total of intra-PADD redistribution should approach (other than the small amount by pipeline) 0.35 bgy. Since shipments into California would be delivered directly into key markets they would be redistributed by truck, over very short distances, at an estimated composite freight rate of $0.025 per gallon. This would require 43,750 annual truck shipments with a total estimated freight cost of $8,750,000.

Table 4-107 recaps the estimated freight charges for each category by PADD. As can be seen, the combined totals of all PADDs indicate that estimated annual freight costs would total $117,090,000 for truck shipments, $12,800,000 for rail shipments, and $7,450,000 for barge shipments for a total estimated freight cost of $137,340,000 for intra-PADD ethanol shipments.

**Table 4-107 Study Case B1 Recap of Estimated Freight Costs for Intra-PADD Movements**

| PADD | Category | Truck | Rail | Barge |
|---|---|---|---|---|
| I | Intra-PADD Transfers | $1,000,000 | | |
| | In-state shipments | $6,125,000 | | |
| | Intra-PADD redistribution | $6,000,000 | - | $4,000,000 |
| | PADD Totals | $13,125,000 | -- | $4,000,000 |
| II | Intra-PADD Transfers | $23,256,000 | $12,800,000 | $3,150,000 |
| | In-state shipments | $54,684,000 | -- | -- |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Totals | $77,940,000 | $12,800,000 | $3,150,000 |
| III | Intra-PADD Transfers | $125,000 | -- | $300,000 |
| | In-state shipments | $5, 400,000 | -- | -- |
| | Intra-PADD redistribution | $2,500,000 | - | -- |
| | PADD Totals | $8,025,000 | -- | $300,000 |
| IV | Intra-PADD Transfers | -- | -- | -- |
| | In-state shipments | -- | -- | -- |
| | Intra-PADD redistribution | $200,000 | - | -- |
| | PADD Totals | $200,000 | -- | -- |
| V | Intra-PADD Transfers | $2,250,000 | -- | -- |
| | In-state shipments | $6,800,000 | -- | -- |
| | Intra-PADD redistribution | $8,750,000 | -- | -- |
| | PADD Totals | $17,800,000 | -- | -- |
| National Total | | $117,090,000 | $12,800,000 | $7,450,000 |
| **Total Cost All Freight Categories** | | **$137,340,000** | | |

Table 4-108 lists annual truck, rail, and barge shipments for moving product within each PADD.

**Table 4-108 Study Case B1 Recap of Transportation Demands for Intra-PADD Movements Annual Shipments by Mode**

| PADD | Category | Truck | Rail | Barge |
|---|---|---|---|---|
| I | Intra-PADD Transfers | 3125 | -- | -- |
| | In-state shipments | 21,875 | -- | -- |
| | Intra-PADD redistribution | 25,000 | -- | 476 |
| | PADD Total | 50,000 | -- | 476 |
| II | Intra-PADD Transfers | 48,450 | 5,333 | 214 |
| | In-state shipments | 195,300 | -- | -- |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Total | 243,750 | 5,333 | 214 |
| III | Intra-PADD Transfers | 625 | -- | 36 |
| | In-state shipments | 22,500 | -- | -- |
| | Intra-PADD redistribution | 12,500 | - | -- |
| | PADD Total | 35,625 | -- | 36 |
| IV | Intra-PADD Transfers | -- | -- | -- |
| | In-state shipments | -- | -- | -- |
| | Intra-PADD redistribution | 1,250 | - | -- |
| | PADD Total | 1,250 | -- | -- |
| V | Intra-PADD Transfers | 3,750 | -- | -- |
| | In-state shipments | 21,250 | -- | -- |
| | Intra-PADD redistribution | 43,750 | -- | -- |
| | PADD Total | 68,750 | -- | -- |
| Grand Total | | 399,375 | 5,333 | 726 |

Here we can see that annual truck shipments for intra-PADD movements are 399,375 deliveries while rail movements equal 5,333 deliveries and barge 726 deliveries. Table 4-109 breaks annual requirements into monthly requirements. It also estimates turn around times given the anticipated shipment destinations.

**Table 4-109 Study Case B1 Transportation Requirements for Intra-PADD Movements**

| | Transport Truck Demand | Rail Car Demand | Barge Demand |
|---|---|---|---|
| Annual | 399,375 | 5,333 | 726 |
| Monthly | 33,281 | 444 | 60 |
| Turn arounds per month | 78(†) | 3 | 5 |
| Unit requirements | 427 | 148 | 12÷3=4 (††) |
| Less existing equipment | (173) | 0 | 0 |
| Balance needed | 254 | 148 | 4 |

*(†) 3.5 loads per day 26 days per month = 78 turns monthly*

*(††) Assumes new larger 30,000 barrel barges replace 3-10,000 barrel barges*

Table 4-109 above lists total annual and monthly demand by transportation category. Equipment turn arounds per month are estimated. Since large volumes by truck are over short distances, a typical truck could haul 3 deliveries in a 10-12 hour day. At 26 days per month, this equates 78 loads per truck monthly, resulting in a need for 427 trucks. However, all PADDs, especially PADD II, already have a number of trucks in such service. Based on 1999 ethanol volume, truck deliveries for direct shipment and redistribution of ethanol would have reached 162,500 loads annually or 13,541 monthly. Using the same factors in determining demand (i.e., 78 turns per month), this would indicate that the equivalent of 173 trucks are already in ethanol service. These are subtracted from the requirements yielding a need for 254 new tractor trailer rigs. No credits are given for in-use rail cars or barges because the existing units were assumed to be used for new PADD II exports. Here it can be seen that movements within PADD would require 254 tractor/transport rigs, 148 rail cars, and 4 barges (assuming 4-30,000 barrel barges replace 12-10,000 barrel barges). Cost estimates for these units are covered in the following table. (See Appendix E for cost estimates and amortization information.)

**Table 4-110 Study Case B1 Transportation Equipment Investment for Intra-PADD Product Movements**

| | | | | |
|---|---|---|---|---|
| 254 tractor/trailer | @ | $115,000 | = | $29,210,000 |
| 148 rail cars (T108) | @ | $60,000 | = | $8,880,000 |
| 4 barges - 30M barrel | @ | $1,600,000 | = | $6,400,000 |
| Total | | | | $44,490,000 |

Consequently the analysis indicates that while total freight costs would be $137,340,000 it would also be necessary to expend $44,490,000 for capital investments in transportation equipment for intra-PADD movements for Case B1.

To calculate amortized costs we total new Case B1 ethanol volume of 3.287 bgy and add in the 0.6 bgy of volume for California in 2003 since we did not credit off any transportation equipment as “in use” for that area. Consequently, the new volume for the transportation equipment demand is 3.887 bgy. As noted in Appendix E the life cycle of barges and rail cars is assumed to be 15 years while transport truck and trailer life cycle is assumed to be 10 years. Amortized costs are listed in the following table.

**Table 4-111 Study Case B1 Amortized Transportation Equipment Costs for New Equipment for Intra-PADD Movements**

| | Cost | Amortized cpg |
|---|---|---|
| 254 Transport tractor/trailer | $29,210,000 | $0.0015 |
| 148 T108 Rail cars | $8,880,000 | $0.0004 |
| 4 Barges (30 mbbl) | $6,400,000 | $0.0003 |

Operating Costs: As noted in the previous section, the assumption is made that the operating costs are similar to those for any other petroleum product or petrochemical. Any incremental costs related to these modes of transportation are, of course, reflected in the freight price.

## 4.17 Study Case B1 Combined Transportation Demand & Freight Costs

### Transportation Equipment Costs

To get a total picture of the transportation costs and demand, it is necessary to combine the transportation requirements of the ethanol that is exported from PADD II to the other PADDs, as well as the requirements covered for intra-PADD movements. Table 4-112 below indicates total investment in river barges for Case B1 would total $33.6 million at an amortized cost of $0.0015 per gallon of new ethanol volume. Rail car investments total $152.94 million at an amortized cost of $0.0067 per gallon of new ethanol volume. Truck/transport rig investment totals $29.21 million at an amortized cost of $0.0015 per gallon. Investments in transportation equipment would of course be recaptured through revenues for freight charges. Therefore, freight charges are the more important element of program costs. Obviously, equipment costs should not be considered additive to freight costs. The equipment demand and cost information is provided primarily to identify requirements that might be placed on the transportation industry.

**Table 4-112 Study Case B1 Total and Amortized Transportation Equipment Costs**

| Category | River barge | Rail | Truck transport |
|---|---|---|---|
| Import/export between PADDs | $27,200,000 | $144,060,000 | -- |
| Intra-PADD movements | $6,400,000 | $8,880,000 | $29,210,000 |
| Totals | $33,600,000 | $152,940,000 | $29,210,000 |
| Amortized Costs Per Gallon | $0.0015 | $0.0067 | $0.0015 |

### Total Freight Costs

Table 4-113 recaps total annual freight cost of all movements to transport (and where applicable to redistribute) 5.1 bgy of ethanol.

**Table 4-113 Study Case B1 Total Freight Costs for All Ethanol Movements**

| Category | Ship† | Ocean Barge† | River Barge | Rail | Truck Transport | Totals |
|---|---|---|---|---|---|---|
| Imports/exports between PADDS | $105,000,000 | $6,055,000 | -- | $142,675,000 | -- | $253,730,000 |
| Intra-PADD Movements | -- | -- | $7,450,000 | $12,800,000 | $117,090,000 | $137,340,000 |
| Total | $105,000,000 | $6,055,000 | $7,450,000 | $155,475,000 | $117,090,000 | $391,070,000 |

† *Includes freight for river barge to Gulf Coast and transfer to/from staging.*

Average per gallon $0.0767

The total freight costs by all modes is $391,070,000 which equates to an average freight cost of $0.0767 per gallon of ethanol shipped (and where applicable, redistributed). Table 4-114 provides a breakdown of import/export shipment volumes by mode of transportation. Note that the total volume shipped exceeds the actual totals imported by the other PADDs. Imports from PADD II total 2.3 bgy while actual shipments total 3.24 bgy. This is a reflection of the intermodal scenario of barging to the Gulf Coast, staging product, and then shipping it to other destinations. Consequently, the volume shipped exceeds the volume imported by 0.94 bgy which is the volume of ethanol shipped by barge for staging at the Gulf Coast.

**Table 4-114 Study Case B1 - Imports/Exports - Ethanol Volumes by Transportation Mode (bgy)**

| PADD | Ocean Barge | River Barge | Rail Car | Ship | Totals |
|---|---|---|---|---|---|
| I | 0.050 | - | 0.560 | 0.490 | 1.100 |
| II | - | 0.940† | - | - | 0.940 |
| III | 0.035 | 0.050 | 0.415 | - | 0.500 |
| IV | - | - | 0.100 | - | 0.100 |
| V | - | - | 0.235 | 0.365 | 0.600 |
| Totals | 0.085 | 0.990 | 1.310 | 0.855 | 3.240 |

† The 0.940 bgy of barge movements in PADD II are to stage product for loading onto ships and ocean barges for subsequent delivery to PADDs I, III, and V

Table 4-115 provides a breakdown of intra-PADD ethanol shipment volumes by transportation mode. These volumes represent the shipment of ethanol produced within each PADD as well as any volumes redistributed from any hub terminal operations.

**Table 4-115 Study Case B1 - Intra-PADD Ethanol Shipment Volumes by Transportation Mode (bgy)**

| PADD | | Intra-PADD | In-State Shipment | Intra-PADD Redistribution | Totals |
|---|---|---|---|---|---|
| I | Truck | 0.0250 | 0.1750 | 0.2000 | 0.4000 |
| | Rail | - | - | - | - |
| | Barge | - | - | 0.2000 | 0.2000 |
| II | Truck | 0.3876 | 1.5624 | - | 1.9500 |
| | Rail | 0.1600 | - | - | 0.1600 |
| | Barge | 0.0900 | - | - | 0.0900 |
| III | Truck | 0.0500 | 0.1800 | 0.1000 | 0.3300 |
| | Rail | - | - | - | - |
| | Barge | 0.0150 | - | - | 0.0150 |
| IV | Truck | - | - | 0.0100 | 0.0100 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| V | Truck | 0.0300 | 0.1700 | 0.3500 | 0.5500 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| Totals | Truck | 0.4926 | 2.0874 | 0.6600 | 3.2400 |
| | Rail | 0.1600 | - | - | 0.1600 |
| | Barge | 0.1050 | - | 0.2000 | 0.3050 |
| Grand Total | | 0.7576 | 2.0874 | 0.8600 | 3.7050 |

†Note that 0.05 bgy per year in PADD V (California) is assumed to be transferred by pipeline as an intra-PADD redistribution

Table 4-116 provides a breakdown of costs by mode, as well as an average freight cost per gallon of ethanol for each PADD.

Average freight costs for PADD V are the highest at $0.1273 per gallon reflecting the greater shipping distances as well as staging costs for ocean going cargoes. PADD I is second highest at $0.1112 per gallon. PADD I has many of the same attendant staging costs as PADD V but shipping distances are shorter.

The average freight cost for PADD III is $0.0659 per gallon. For PADD IV the average freight cost is $0.470 per gallon. While this may seem low for PADD IV geography, this is largely because most product is moved to the PADD by rail, from the western-most plants in PADD II.

Finally, the average freight cost for PADD II is $0.0427 per gallon. The lower average freight cost for PADD II is, of course, due to the majority of plants being located within the PADD precluding the need to ship ethanol over long distances.

**Table 4-116 Study Case B1 Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II | | Intra-PADD Ethanol Shipments | | | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | Ship/ barge | Rail | Truck | Rail | Barge | | |
| I | 1.3 | $57,400,000 | $70,000,000 | $13,125,000 | - | $4,000,000 | $144,525,000 | $0.1112 |
| II | 2.2 | - | - | $77,940,000 | $12,800,000 | $3,150,000 | $93,890,000 | $0.0427 |
| III | 0.7 | $2,555,000 | $35,275,000 | $8,025,000 | - | $300,000 | $46,155,000 | $0.0659 |
| IV | 0.1 | | $4,500,000 | $200,000 | - | - | $4,700,000 | $0.0470 |
| V | 0.8 | $51,100,000 | $32,900,000 | $17,800,000 | - | - | $101,800,000 | $0.1273 |
| TOTAL | 5.1 | $111,055,000 | $142,675,000 | $117,090,000 | $12,800,000 | $7,450,000 | $391,070,000 | $0.0767 |

## 4.18 Study Case B1 Demands on the U.S. Railroad System

In addition to the demand for railroad tank cars to move new ethanol production, it is also important to assess the impact on the railroad system itself.

In 1999 the Class I railroads† owned 99,430 road miles and 168,979 track miles††. They operated 20,256 locomotives and had a total of 579,140 freight cars in service. Regional railroads owned another 126,762 freight cars while car companies and shippers owned 662,934 freight cars. Among the 1,368,836 total freight cars, approximately 18% of the cars are defined as tank cars, although not all of these would necessarily be suitable for hauling ethanol. A total of 77,538 freight cars were added to the system in 1999.

In 1999 the Class I railroads originated 27,096,202 freight carloads generating 1.433 trillion revenue ton miles. For 1999 the Class I railroads averaged 69 cars per freight train and the average length of a haul was 835 miles.

**Rail Infrastructure Demands:** As discussed in the preceding section, the total number of rail car shipments is estimated to be 48,998 as broken down in the following table.

*† The Surface Transportation Board (STB), the federal agency responisble for economic regulation of the rail industry, classifies railroads by their level of operating revenue, adjusted annually for inflation. For 1999, the Class I railroads had operating revenue of $258.5 million or more, Class II had revenue of $20.0 million to $258.5 million, and Class III railroads had revenues of less than $20.7 million.*

*†† Miles of road owned is the aggregate length of roadway, excluding yard tracks and sidings and does not reflect the fact that a mile of road may include two, three, or more parallel tracks. Miles of track owned includes multiple main tracks, yard tracks, and sidings.*

**Table 4-117 Study Case B1 Total Rail Car Movements**

| PADD | Annual Rail Car Car Movements Per Year |
|---|---|
| I | 18,666 |
| II (Intra-PADD) | 5,333 |
| III | 13,833 |
| IV | 3,333 |
| V | 7,833 |
| Total | 48,998 |

To put the above into perspective, we incorporate some information from the AAR . Tank car loadings (all types) by Class I railroads accounted for 1.54 million of the total 21.9 million cars originated in 1999. The 48,998 rail car shipments of ethanol represents approximately 3.2% of the total of all tank car loadings by the Class I railroads and only 0.2% of all cars originated.

The Class I railroads originated 70,125 cars of all alcohols in 1999, producing total revenue of $153 million. Based upon analyses of 1998 hazardous materials data only about 5% of this traffic was ethanol, somewhat over 10% was MTBE. Industry contacts do not believe that the small volumes involved for Case B1 would result in any increased need for "power", (i.e., locomotives) or strain on rail systems.

Although the rail industry does have to consider capacity requirements and investment needs as it increases the traffic it handles, the AAR indicates the potential increase is not of such magnitude that it would anticipate any significant issues, and the industry is certainly capable of making the investments to handle increased traffic if it will provide a satisfactory return. In 1999, Class I railroads spent $7.6 billion on capital expenditures and maintenance work related to way and structures (an additional $8.5 billion was spent by industry on equipment, such as tank cars).

Maps for the majority of the Class I railroads are included in Appendix J. Industry sources indicate that the great majority of ethanol shipments on the railway system will be on the Class I railroads.

### 4.19 Study Case B1 Demands on the Inland and Intercoastal Waterway System

A discussion of the logistics of ethanol movements would not be complete without discussing the demand placed on the nation's inland and intercoastal waterway system. This system is depicted in Appendix J and includes over 11,000 miles of waterway with 226 lock sites and 268 chambers.

Movements along intercoastal waterways as a result of increased ethanol production are minimal and not expected to have any major impact. However increased barge movements on the inland waterways does need to be assessed.

Inland waterway traffic grew from less than 500 million tons annually in the early 1980s to almost 625 million tons in 1998. Traffic is projected to increase 1.3% yearly or nearly 34% by 2020, to roughly 830 million tons. The utilization of key waterways is expected to increase at higher rates depending on their commodity mix. One of the key concerns with increased inland waterway traffic is delays at locks. Delays due to undersized locks nearing capacity continue to increase on key waterways. Of the top 23 locks in terms of delay, 13 are on the Upper Mississippi and Illinois rivers where much of the ethanol shipments would originate. It should also be noted that the upper Mississippi and Missouri rivers are typically closed from December through February due to frozen waters.

A key problem on the Upper Mississippi and Illinois rivers, as well as the Tennessee river, is that locks are generally 600 ft. long requiring tows to be cut in half, which more than doubles lock passing time. This is also discussed in the report "Ethanol Logistics Colloquies Overview and Observations" in Appendix F.

Appendix J depicts key areas of lock delays, most of which would impact ethanol shipments given that they are located predominantly at the origination and staging areas for ethanol movement.

These delays can be more pronounced during peak traffic months, during which time they can increase several orders of magnitude as depicted in Appendix J.

Some locks are not only undersized but the increasing average age of these facilities means more maintenance and unexpected closures.

The Army Corps of Engineers does have major lock improvement programs underway. Six new larger locks are under construction while four are undergoing major rehabilitation. These are also depicted in Appendix J.

The Corps has a requirement needs assessment study in progress analyzing the needs at some 80 locks including 37 on the Upper Mississippi and Illinois rivers.

However, implementing any identified needs for improvement will take several years of construction and, of course, will be subject to budget considerations.

The real question is how much traffic will ethanol add to an already strained system.

Based on the transportation estimates 0.94 bgy would be moved to New Orleans via barge for staging and subsequent shipment to the East and West coasts. An additional 0.155 bgy in annual barge shipments would be required for direct shipments to PADD III and intra-PADD product movements (exclusive of coastal movements in PADD I). Total river movements would then be 1.095 bgy. At an average weight of 6.58 pounds per gallon, this equals 3.6 million short tons. This equates to only 0.58% of current tonnage moved.

Obviously ethanol movements are a very small percentage of total tonnage moved on the inland waterway system. However, much of the ethanol shipments will originate and terminate in the vicinity of some locks which have traditionally experienced delays. Therefore, any future major ethanol expansion should include a more detailed assessment (i.e., private industry study or assessment by the Army Corp of Engineers) to insure adequate capabilities.

## 4.20 Ethanol Plant Coproducts

Although not a formal part of this study, it should be noted that increased grain based ethanol production will result in increased coproducts such as Distillers Dried Grain and Solubles (DDGS) in the case of dry mills. Since the size of the plants will probably dictate largely dry mill operations, some rough estimates can be made.

For Study Case B1, 4.0 bgy of ethanol production is grain based. At a yield of 2.65 gallons per bushel (for denatured basis) this equates to 1.51 billion bushels of corn. Of this amount, about half is already being used in ethanol production at existing plants. Therefore, increased corn grind is 0.75 billion bushels. Each bushel of corn processed in a dry mill yields 18.5 pounds of DDGS equating to 13.875 billion pounds or 6,937,500 short tons. Some portion of these volumes would need to be shipped to various markets and coastal export centers, presumably by rail and river barge. This is a difficult area to assess because with increased production of DDGS, it is likely that large Midwestern cattle feed lots would use a larger volume of DDGS. This in turn would eliminate the need for long distance shipments to other markets (both domestic and foreign). Furthermore, any DDGS shipped would, at least to some degree, replace corn shipments that would otherwise be shipped to other areas for export. This, too, would offset some of the impact of increased DDGS shipments. Although not included in this analysis, the coproducts are mentioned here because they would place a simultaneous increased demand on rail and river traffic capabilities to the extent that they represent a net increase in tonnage shipped.

## 4.21 Study Case B1 Recommendations Resulting from Transportation Analysis

There are areas that appear to be in need of additional assessment to determine the need for any future action. Both the inland waterway system, including its lock sites and chambers, and the availability of Jones Act/OPA90 compliant vessels (or alternatives) need to be studied further.

Specifically, it is recommended that any major ethanol expansion include a study to assess the impact of increased traffic on the inland waterway system as a result of increased ethanol production and distribution. Such an assessment should include not only the impact of ethanol movements, but also of any increased movements of both coproducts and feedstocks, on the inland waterway system. The assessment should closely examine the location of any projected new plants, shipping by inland waterways, and the relationship to locks currently experiencing the greatest delays, or those approaching maximum capacity.

With regards to Jones Act/OPA90 compliant vessels, the assessment is a little more difficult because of the number of products that require shipment in such vessels. Obviously the availability of these ships has been, and will continue to be, assessed by the petroleum and petrochemical industries. The volumes of ethanol being shipped are relatively small compared to other products. However, it is recommended that current studies on Jones Act/OPA90 vessels be reviewed in greater detail to determine more precisely how increased ethanol volumes would fit into the total shipment picture.

Another alternative is to maximize ethanol shipments that do not require OPA90 compliant vessels. There are at least two possibilities here. The first is simply to establish more hub terminal operations, in coastal areas, that have DSPs. Ethanol could be shipped undenatured (as pure spirits) to these terminals precluding the need for OPA90 vessels. Another option would be to explore the existing BATF approved denaturants (or alternatives) to identify those that, while acceptable for automotive fuel use, may not be subject to OPA90 regulations. This would enable denatured ethanol to be shipped in non OPA90 vessels. It is recommended that these issues be examined in more detail.

**Section 4: Study Case B1**

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# Section 5

## Study Case C

## 5.0 Study Case C

Information developed for Study Case C is included in this section.

## 5.1 Ethanol Production

Study Case C is based on a total ethanol production scenario of 10.0 billion gallons of annual ethanol production. The production of ethanol by PADD and feedstock type as well as the amount exported/imported and used in each PADD are recapped in the following table.

**Table 5-1 Ethanol Production, Use, Import and Export by PADD (Study Case C - 10.0 BGY)**

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 1.4 | 1.4 | | 1.3 | 2.7 |
| 2 | 4.5 | 2.1 | 6.6 | 2.9 | | 3.7 |
| 3 | | 1.1 | 1.1 | | 0.7 | 1.8 |
| 4 | | 0.4 | 0.4 | | | 0.4 |
| 5 | | 0.5 | 0.5 | | 0.9 | 1.4 |
| Totals | 4.5 | 5.5 | 10.0 | 2.9 | 2.9 | 10.0 |

In Study Case C, the majority of increased ethanol production (increase over Study Case B1) is based on cellulosic feedstocks and is spread across all five PADDs with fairly significant production increases in all PADDs. As with Study Case B1, in order to develop transportation cost information and assess transportation demands, it is necessary to hypothesize where increased production may be located. Here we start with all plants (existing, under construction, proposed, and theoretical) that were included in Study Case B1 representing a total of 5.1125 BGY of ethanol production. From this starting point we developed a second group of theoretical plant locations. The same assumptions for feedstock availability and yields for Study Case B1 are used in Case C and include the following:

**For Corn Stover Based Plants** - We assume 1.7 Bone Dry Tons (BDT) of feedstock per acre. Yield 80 gallons per bone dry ton.

**For Forest Residue/Thinnings Based Plants** - We assume a 40 mile radius wooded area would equate to 520,000 BDT yielding 60 gallons per BDT.

**For Agricultural Residue Based Plants** - We assume a 40 mile radius would provide 640,000 BDT. Yield of 71 gallons per BDT.

**For Urban Waste Based Plants** - We use a yield of 70 gallons per BDT and assume that an area could not generate more than 285,000 BDT per year for each 400,000 residents.

As noted in Study Case B1, no feasibility studies for these plants were undertaken. They were placed in what was deemed to be appropriate locations based on feedstock availability. The primary intent here was to represent a likely geographic placement of plants to facilitate assessment of ethanol transportation demands.

It is also plausible that corn, and eventually corn stover and additional agricultural residues, would represent a much larger share of the feedstock base relative to the hypothetical MSW and forest residues use postulated in this section. However, the scenarios chosen were meant to provide a framework for the logistics analysis and are not forecasts of the use of particular feedstocks. Given the assumption of production and consumption by PADD, the choice of different feedstocks may result in different plant sitings and could make a difference at the detailed level, but would not have a material impact on the overall logistics-related conclusions

Theoretical plants added in Study Case C are listed by PADD in Table 5-2A

**Table 5-2A: Theoretic Plants/Locations Added for Study Case C**

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD I | Hartford | CT | MSW | 30.0 | |
| | Washington /Baltimore | DC/MD | MSW | 100.0 | |
| | Jacksonville | FL | MSW | 50.0 | |
| | Miami | FL | MSW | 30.0 | |
| | Tampa/St. Petersburg | FL | MSW | 50.0 | |
| | Atlanta | GA | MSW | 50.0 | |
| | Rockville | MD | MSW | 50.0 | |
| | Boston | MA | MSW | 100.0 | |
| | Charlotte | NC | MSW | 30.0 | |
| | High Point | NC | wood waste | 50.0 | |
| | Raleigh/Durham | NC | MSW | 40.0 | |
| | Trenton | NJ | MSW | 40.0 | |
| | Buffalo | NY | MSW | 40.0 | |
| | Albany | NY | MSW | 40.0 | |
| | New York City | NY | MSW | 50.0 | |
| | New York City | NY | MSW | 100.0 | |
| | Rome | NY | Forest | 40.0 | |
| | Syracuse | NY | MSW | 30.0 | |
| | Allentown | PA | MSW | 40.0 | |
| | Philadelphia | PA | MSW | 50.0 | |
| | Pittsburgh | PA | MSW | 30.0 | |
| | Williamsport | PA | forest | 40.0 | |
| | Providence | RI | MSW | 40.0 | |
| | Norfolk | VA | MSW | 50.0 | |
| | Beckley | WV | forest | 30.0 | |
| | TOTAL Cellulosic | | | 1200.0 | (78.3 mbcd) |
| | TOTAL Grain | | | 0.0 | |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) |
|---|---|---|---|---|
| PADD II | Quincy | IL | grain | 50.0 |
| | Lafayette | IN | grain | 50.0 |
| | Caruthersville | MO | grain | 40.0 |
| | St. Louis | MO | grain | 150.0 |
| | Grand Forks | ND | grain | 30.0 |
| | Columbus | OH | grain | 50.0 |
| | Toledo | OH | grain | 40.0 |
| | Nashville | TN | grain | 40.0 |
| | Madison | WI | grain | 50.0 |
| | Chicago | IL | MSW | 100.0 |
| | Chicago | IL | MSW | 50.0 |
| | Mt. Carmel | IL | stover | 50.0 |
| | Springfield | IL | stover | 50.0 |
| | Springfield | IL | stover | 50.0 |
| | Bloomington | IN | stover | 50.0 |
| | Gary | IN | MSW | 50.0 |
| | Indianapolis | IN | stover | 50.0 |
| | Indianapolis | IN | MSW | 40.0 |
| | Clinton | IA | stover | 30.0 |
| | Des Moines | IA | stover | 50.0 |

| | | | | | |
|---|---|---|---|---|---|
| | Spencer | IA | stover | 50.0 | |
| | Manhattan | KS | stover | 50.0 | |
| | McPherson | KS | stover | 50.0 | |
| | Detroit | MI | MSW | 100.0 | |
| | Grayling | MI | forest | 40.0 | |
| | Union City | MI | stover | 50.0 | |
| | Mankato | MN | stover | 50.0 | |
| | Chester | MO | stover | 50.0 | |
| | Columbia | MO | stover | 40.0 | |
| | Norfolk | MO | stover | 50.0 | |
| | St. Louis | MO | MSW | 50.0 | |
| | Grand Island | NE | stover | 50.0 | |
| | Grand Fork | ND | stover | 40.0 | |
| | Columbus | OH | stover | 50.0 | |
| | Cleveland | OH | MSW | 50.0 | |
| | Sioux Falls | SD | stover | 50.0 | |
| | Knoxville | TN | stover | 40.0 | |
| | Memphis | TN | stover | 50.0 | |
| | Memphis | TN | MSW | 40.0 | |
| | Milwaukee | WI | MSW | 40.0 | |
| | Milwaukee | WI | stover | 40.0 | |
| | TOTAL | | Cellulosic | 1600.0 | (104.4 mbcd) |
| | TOTAL | | Grain | 500 | (32.6 mbcd) |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD III | Clanton | AL | MSW | 40.0 | |
| | Mobile | AL | MSW | 30.0 | |
| | Hot Springs | AR | forest | 40.0 | |
| | Little Rock | AR | MSW | 20.0 | |
| | Russellville | AR | forest | 40.0 | |
| | Fayetteville | AR | forest | 40.0 | |
| | Alexandria | LA | forest | 40.0 | |
| | Lafayette | LA | rice waste/sugar cane | 30.0 | |
| | Winfield | LA | forest | 50.0 | |
| | Hattiesburg | MS | forest | 30.0 | |
| | Jackson | MS | MSW | 20.0 | |
| | Meridian | MS | forest | 30.0 | |
| | Natchez | MS | forest | 50.0 | |
| | Tupelo | MS | forest | 50.0 | |
| | Albuquerque | NM | MSW | 30.0 | |
| | Las Vegas | NM | forest | 40.0 | |
| | Magdalena | NM | forest | 50.0 | |
| | Austin | TX | MSW | 30.0 | |
| | El Paso | TX | MSW | 20.0 | |
| | Dallas/Ft. Worth | TX | MSW | 90.0 | |
| | Houston | TX | MSW | 40.0 | |
| | Lufkin | TX | forest | 40.0 | |
| | San Antonio | TX | MSW | 50.0 | |
| | TOTAL | | Cellulosic | 900.0 | (58.7 mbcd) |
| | TOTAL | | Grain | 0.0 | |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) |
|---|---|---|---|---|
| PADD IV | Colorado Springs | CO | MSW | 20.0 |
| | Denver | CO | MSW | 40.0 |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| | Gunnison | CO | forest | 40.0 | |
| | Idaho City | ID | forest | 40.0 | |
| | Jerome | ID | potatos | 20.0 | |
| | Kooskia | ID | forest | 20.0 | |
| | New Meadows | ID | forest | 20.0 | |
| | Bozeman | MT | forest | 30.0 | |
| | Superior | MT | forest | 40.0 | |
| | Provo | UT | MSW | 20.0 | |
| | Salt Lake City | UT | MSW | 30.0 | |
| | Jackson | WY | forest | 40.0 | |
| | Riverside | WY | forest | 27.5 | |
| | TOTAL | | Cellulosic | 387.5 | (25.3 mbcd) |
| | TOTAL | | Grain | 0.0 | |

| | Geographic Location | State | Feedstock | Annual Capacity (mmgy) | |
|---|---|---|---|---|---|
| PADD V | Phoenix | AZ | MSW | 50.0 | |
| | Fresno | CA | ag residue | 30.0 | |
| | Gridley #2 | CA | ag residue | 20.0 | |
| | San Diego | CA | MSW | 10.0 | |
| | Hawaiian Islands | HI | sugar cane/MSW | 30.0 | |
| | Las Vegas | NV | MSW | 20.0 | |
| | Portland | OR | MSW | 30.0 | |
| | LaGrande | OR | forest | 30.0 | |
| | Seattle | WA | MSW | 50.0 | |
| | Elma | WA | forest | 30 | |
| | TOTAL | | Cellulosic | 300.0 | (19.6 mbcd) |
| | TOTAL | | Grain | 0.0 | |
| TOTAL ALL | | | Cellulosic | 4387.5 | (286.2 mbcd) |
| TOTAL ALL | | | Grain | 500.0 | (32.6 mbcd) |
| **GRAND TOTAL ALL PADDS** | | | | **4887.5** | **(318.8 mbcd)** |

Table5-2B lists the total production breakdown by PADD which meets the TMS scenarios for Study Case C.

**Table 5-2B: US Ethanol Production Capacity by PADD -mmgy (with Theoretical Plant Locations)**

| | PADD I | PADD II | PADD III | PADD IV | PADD V | TOTALS |
|---|---|---|---|---|---|---|
| Grain | 0.0 | 500.0 | 0.0 | 0.0 | 0.0 | 500.0 |
| Cellulose | 1200.0 | 1600.0 | 900.0 | 387.5 | 300.0 | 4387.5 |
| TOTAL | 1200.0 | 2100.0 | 900.0 | 387.5 | 300.0 | 4887.5 |
| **Cumulative Grain** | 0.0 | 4500.0 | 30.0 | 5.0 | 0.0 | 4535.0 |
| **Cumulative Cellulose** | 1400.0 | 2100.0 | 1070.0 | 395.0 | 500.0 | 5465.0 |
| **Cumulative Total** | **1400.0** | **6600.0** | **1100.0** | **400.0** | **500.0** | **10000.0** |
| **mbcd** | **91.3** | **430.5** | **71.8** | **26.1** | **32.6** | **652.3** |

After adding the theoretical plant locations for Study Case C to the total plants listed in Study Case B1, the break down of total plant locations by PADD would be as listed in Table 5-3. Note that a company listing in bold indicates total production for more than one plant.

**Table 5-3: Final Plant Count By PADD - Study Case C - mmgy**

**PADD I**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Hartford | CT | 30.0 | MSW |
| Washington /Baltimore | DC/MD | 100.0 | MSW |
| Parallel Products | FL | 5.0 | waste |
| Miami | FL | 20.0 | MSW |
| Jacksonville | FL | 50.0 | MSW |
| Miami | FL | 30.0 | MSW |
| Tampa/St. Petersburg | FL | 50.0 | MSW |
| Atlanta | GA | 50.0 | MSW |
| Rockville | MD | 50.0 | MSW |
| Boston | MA | 100.0 | MSW |
| Greene County | NC | 60.0 | sweet potatoes |
| Charlotte | NC | 30.0 | MSW |
| High Point | NC | 50.0 | wood waste |
| Raleigh/Durham | NC | 40.0 | MSW |
| Trenton | NJ | 40.0 | MSW |
| Buffalo | NY | 40.0 | MSW |
| Albany | NY | 40.0 | MSW |
| New York City | NY | 50.0 | MSW |
| New York City | NY | 100.0 | MSW |
| Rome | NY | 40.0 | forest |
| Syracuse | NY | 30.0 | MSW |
| New York City | NY | 50.0 | MSW |
| Philadelphia | PA | 15.0 | MSW |
| Philadelphia | PA | 50.0 | MSW |
| Allentown | PA | 40.0 | MSW |
| Philadelphia | PA | 50.0 | MSW |
| Pittsburgh | PA | 30.0 | MSW |
| Williamsport | PA | 40.0 | forest |
| Providence | RI | 40.0 | MSW |
| Norfolk | VA | 50.0 | MSW |
| Beckley | WV | 30.0 | forest |
| Total Grain | | 0.0 | |
| Total Cellulosic | | 1400.0 | (91.3 mbcd) |
| Grand Total - 31 production facilities | | 1400.0 | (91.3 mbcd) |

**PADD II**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| **ADM, Decatur** | **IL** | **975.0** | **grain** |
| ADM, Peoria | IL | | grain |
| **Midwest Grain, Pekin** | **IL** | **140.4** | **grain** |
| Williams Energy Services, Pekin | IL | 130.0 | grain |
| Adkins Energy, Lena | IL | 30.0 | grain |
| Cascade | IL | 100.0 | grain |
| Mt. Carmel | IL | 50.0 | grain |
| Quincy | IL | 50.0 | grain |
| New Energy Corp., S. Bend | IN | 110.5 | grain |
| Indianapolis | IN | 50.0 | grain |
| Lafayette | IN | 50.0 | grain |
| ADM, Cedar Rapids | IA | | grain |
| Cargill, Eddyville | IA | | grain |
| GPC. , Muscatine | IA | 10.0 | grain |
| Manildra Ethanol , Hamburg | IA | 7.0 | grain |
| Sunrise Energy, Blairstown | IA | 7.0 | grain |
| Des Moines | IA | 15.0 | grain |
| Spencer | IA | 40.0 | grain |
| Burlington | IA | 35.0 | grain |
| Davenport | IA | 30.0 | grain |
| Des Moines | IA | 50.0 | grain |
| Waterloo | IA | 30.0 | grain |
| ESE Alcohol , Leoti | KS | 1.1 | grain |
| High Plains Corporation, Colwich | KS | | grain |
| Midwest Grain, Atchison | KS | | grain |
| Reeve Agri-Energy, Garden City | KS | 10.0 | grain |
| Pratte | KS | 15.0 | grain |
| Salinas | KS | 50.0 | grain |
| Topeka | KS | 50.0 | grain |
| Witchita | KS | 50.0 | grain |
| Louisville | KY | 50.0 | grain |
| Bowling Green | KY | 50.0 | grain |
| Lansing | MI | 40.0 | grain |
| Jackson | MI | 45.0 | grain |
| Kalamazoo | MI | 50.0 | grain |
| Al-Corn, Claremont, | MN | 17.0 | grain |
| Central MN , Little Falls | MN | 18.0 | grain |
| Chip. Valley Ethanol , Benson | MN | 19.0 | grain |
| Corn Plus , Winnebago | MN | 20.0 | grain |
| DENCO, LLC. , Morris | MN | 15.0 | grain |
| Ethanol2000 , Bingham Lake | MN | 28.0 | grain |
| Exol, Inc. , Albert Lea | MN | 17.0 | grain |
| Gopher State Eth, St. Paul | MN | 15.0 | grain |
| Heartland Corn Pdts ,Winthrop | MN | 17.0 | grain |

**PADD II con't.**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Agri-Energy , Luverne | MN | 17.0 | grain |
| MPC, Marshall | MN | | grain |
| MN Energy, Buffalo Lake | MN | 12.0 | grain |
| Pro-Corn, Preston | MN | 18.0 | grain |
| St. Paul | MN | 30.0 | grain |
| Mankato | MN | 30.0 | grain |
| St. Paul | MN | 40.0 | grain |
| NE MO Grain Processors, Macon, MO | MO | 15.0 | grain |
| Golden Triangle, St. Joseph | MO | 15.0 | grain |
| Caruthersville | MO | 40.0 | grain |
| Cape Girado | MO | 30.0 | grain |
| Jefferson City | MO | 50.0 | grain |
| St. Louis | MO | 50.0 | grain |
| St. Louis | MO | 150.0 | grain |
| Springfield | MO | 40.0 | grain |
| AGP , Hastings | NE | 67.6 | grain |
| **Cargill (total capacity), Blair** | **NE** | **130.0** | **grain** |
| **MPC, Columbus** | **NE** | **143.0** | **grain** |
| **High Plains Corporation, York** | **NE** | **61.0** | **grain** |
| Chief Ethanol, Hastings | NE | 80.6 | grain |
| Sutherland Associates, Sutherland | NE | 15.0 | grain |
| Williams Energy, Aurora | NE | 30.0 | grain |
| Sioux City | NE | 33.4 | grain |
| Lincoln | NE | 50.0 | grain |
| Omaha | NE | 50.0 | grain |
| Neely | NE | 15.0 | grain |
| ADM, Walhalla | ND | 36.4 | grain |
| Alchem , Grafton | ND | 10.5 | grain |
| Bismarck | ND | 30.0 | grain |
| Fargo | ND | 17.0 | grain |
| Grand Forks | ND | 30.0 | grain |
| Cincinnati | OH | 50.0 | grain |
| Columbus | OH | 50.0 | grain |
| Toledo | OH | 40.0 | grain |
| Mansfield | OH | 50.0 | grain |
| Oklahoma City | OK | 25.0 | grain |
| Tulsa | OK | 20.0 | grain |
| Heartland Grain Fuel , Aberdeen | SD | 8.0 | grain |
| Heartland Grain, Huron | SD | 14.0 | grain |
| Lake Area Corn Processors, Wentworth | SD | 15.0 | grain |
| Tri County Corn Processors, Rosholt | SD | 15.0 | grain |
| Broin Enterprises, Scotland | SD | 7.0 | grain |
| Milbank | SD | 40.0 | grain |
| Platte | SD | 15.0 | grain |
| Rosholt | SD | 15.0 | grain |

**PADD II con't.**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Rapid City | SD | 20.0 | grain |
| Sioux Falls | SD | 30.0 | grain |
| A.E. Staley, Loudon | TN | 58.5 | grain |
| Nashville | TN | 50.0 | grain |
| Nashville | TN | 40.0 | grain |
| Milwaukee | WI | 40.0 | grain |
| Plover Ethanol, Plover | WI | 4.0 | grain |
| Lacrosse | WI | 20.0 | grain |
| Madison | WI | 50.0 | grain |
| Chicago | IL | 100.0 | MSW |
| Chicago | IL | 50.0 | MSW |
| Decatur | IL | 50.0 | stover |
| Mt. Carmel | IL | 50.0 | stover |
| Peoria | IL | 50.0 | stover |
| Springfield | IL | 50.0 | stover |
| Springfield | IL | 50.0 | stover |
| Bloomington | IN | 50.0 | stover |
| Gary | IN | 50.0 | MSW |
| Indianapolis | IN | 50.0 | stover |
| Indianapolis | IN | 40.0 | MSW |
| South Bend | IN | 50.0 | stover |
| Permeate Refining, Hopkinton | IA | 1.5 | waste |
| Cedar Rapids | IA | 50.0 | stover |
| Clinton | IA | 30.0 | stover |
| Des Moines | IA | 50.0 | stover |
| Eddyville | IA | 50.0 | stover |
| Spencer | IA | 50.0 | stover |
| Manhattan | KS | 50.0 | stover |
| McPherson | KS | 50.0 | stover |
| Parallel Products, Louisville | KY | 3.0 | waste |
| Louisville | KY | 50.0 | stover |
| Detroit | MI | 100.0 | MSW |
| Grayling | MI | 40.0 | forest |
| Union City | MI | 50.0 | stover |
| Kraft, Inc., Melrose | MN | 2.6 | waste |
| Mankato | MN | 50.0 | stover |
| Twin Cities | MN | 50.0 | stover |
| Chester | MO | 50.0 | stover |
| Columbia | MO | 40.0 | stover |
| Norfolk | MO | 50.0 | stover |
| St. Louis | MO | 50.0 | MSW |
| St. Louis | MO | 50.0 | stover |
| Grand Island | NE | 50.0 | stover |
| Omaha | NE | 50.0 | stover |
| Grand Fork | ND | 40.0 | stover |

**PADD II con't.**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Cincinnati | OH | 42.2 | stover |
| Cleveland | OH | 50.0 | MSW |
| Columbus | OH | 50.0 | stover |
| Sioux Falls | SD | 50.0 | stover |
| Knoxville | TN | 40.0 | stover |
| Memphis | TN | 50.0 | stover |
| Memphis | TN | 40.0 | MSW |
| Milwaukee | WI | 40.0 | MSW |
| Milwaukee | WI | 40.0 | stover |
| Spring Green Ethanol, Spring Green, | WI | 0.7 | waste |
| Total Grain | | 4500.0 | (293.5 mbcd) |
| Total Cellulosic | | 2100.0 | (137.0 mbcd) |
| Grand Total - 144 production facilities | | 6600.0 | (430.5 (mbcd) |

**PADD III**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| High Plains | NM | 30.0 | grain |
| Clanton | AL | 40.0 | MSW |
| Mobile | AL | 30.0 | MSW |
| Hot Springs | AR | 40.0 | forest |
| Little Rock | AR | 20.0 | MSW |
| Russellville | AR | 40.0 | forest |
| Fayetteville | AR | 40.0 | forest |
| BC International | LA | 20.0 | rice waste |
| Alexandria | LA | 40.0 | forest |
| Baton Rouge | LA | 50.0 | MSW |
| Lafayette | LA | 30.0 | rice waste/sugar cane |
| New Orleans | LA | 50.0 | MSW |
| Winfield | LA | 50.0 | forest |
| Hattiesburg | MS | 30.0 | forest |
| Jackson | MS | 20.0 | MSW |
| Meridian | MS | 30.0 | forest |
| Natchez | MS | 50.0 | forest |
| Tupelo | MS | 50.0 | forest |
| Albuquerque | NM | 30.0 | MSW |
| Las Vegas | NM | 40.0 | forest |
| Magdalena | NM | 50.0 | forest |
| Austin | TX | 30.0 | MSW |
| El Paso | TX | 20.0 | MSW |
| Dallas/Ft. Worth | TX | 90.0 | MSW |
| Houston | TX | 40.0 | MSW |
| Houston | TX | 50.0 | MSW |
| Lufkin | TX | 40.0 | forest |
| San Antonio | TX | 50.0 | MSW |
| Total Grain | | 30.0 | (2.0 mbcd) |
| Total Cellulosic | | 1070.0 | (69.8 mbcd) |
| Grand Total - 28 production facilities | | 1100.0 | (71.8 mbcd) |

**PADD IV**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Wyoming Ethanol | WY | 5.0 | grain |
| Merrick/Coors | CO | 1.5 | waste |
| Colorado Springs | CO | 20.0 | MSW |
| Denver | CO | 40.0 | MSW |
| Gunnison | CO | 40.0 | forest |
| JR Simplot (total) | ID | 6.0 | waste |
| JR Simplot | ID | | waste |
| Idaho City | ID | 40.0 | forest |
| Jerome | ID | 20.0 | potatos |
| Kooskia | ID | 20.0 | forest |
| New Meadows | ID | 20.0 | forest |
| Bozeman | MT | 30.0 | forest |
| Superior | MT | 40.0 | forest |
| Provo | UT | 20.0 | MSW |
| Salt Lake City | UT | 30.0 | MSW |
| Jackson | WY | 40.0 | forest |
| Riverside | WY | 27.5 | forest |
| | | | |
| Total Grain | | 5.0 | (0.3 mbcd) |
| Total Cellulosic | | 395.0 | (25.8 (mbcd) |
| Grand Total - 17 production facilities | | 400.0 | (26.1 mbcd) |

**PADD V**

| Plant location | State | Capacity (mmgy) | Feedstock |
|---|---|---|---|
| Phoenix | AZ | 50.0 | MSW |
| Parallel Products | CA | 4.0 | waste |
| Golden Cheese | CA | 2.8 | waste |
| Chester | CA | 20.0 | waste |
| Fresno | CA | 30.0 | ag residue |
| Gridley | CA | 20.0 | waste |
| Gridley #2 | CA | 20.0 | ag residue |
| San Diego | CA | 10.0 | MSW |
| Los Angeles | CA | 52.5 | waste |
| Mission Viejo | CA | 8.0 | waste |
| San Francisco | CA | 40.0 | waste |
| Susanville | CA | 15.0 | waste |
| Hawaian Islands | HI | 30.0 | sugar cane/MSW |
| Las Vegas | NV | 20.0 | MSW |
| Bend | OR | 30.0 | waste |
| LaGrande | OR | 30.0 | forest |
| Portland | OR | 30.0 | MSW |
| Pabst Brewing | WA | 0.7 | waste |
| Georgia Pacific | WA | 7.0 | waste |
| Seattle | WA | 50.0 | MSW |
| Elma | WA | 30.0 | forest |
| Total Grain | | 0.0 | |
| Total Cellulosic | | 500.0 | (32.6 mbcd) |
| Grand Total - 21 production facilities | | 500.0 | (32.6 mbcd) |
| | | | |
| **TOTAL ALL PADDS GRAIN** | | **4535.0** | **(295.8 mbcd)** |
| **TOTAL ALL PADDS CELLULOSIC** | | **5465.0** | **(356.5 mbcd)** |
| **TOTAL ALL PADDS - 241 production facilities** | | **10000.0** | **(652.3 mbcd)** |

## 5.2 Ethanol Markets - Study Case C

As with Study Case B1, the ethanol use volume, by PADD for Case C has been provided in the base scenarios. In order to determine the number of terminals and retail locations involved, it is necessary to make some additional assumptions about the most likely ethanol markets. These assumptions are also necessary to assess transportation modes and costs, as well as identifying any shortfalls in current transportation capabilities.

Most ethanol is currently sold in PADD II. Case B1 reflects significant increased use in PADD II as well as increased use in other PADDs. However, Case C reflects significant increases in ethanol production and use in all PADDs. To determine potential ethanol market scenarios, we followed the same initial steps as in Case B1. We started by determining the cities in each PADD that were in two population categories, those over 250,000 and those between 100,000 and 250,000 (see Appendix A). We then developed the population for each PADD (see Appendix B). Based on the targeted projected ethanol use, we developed a factor that would create the demand necessary (in each PADD) for each of the two cases studied (see Appendix C). A spreadsheet was developed to calculate gasoline demand within each city/MSA to and apply the necessary factor to determine ethanol demand in each area. These various calculations are included as Appendix D. In a supply driven scenario, with large ethanol volumes available, petroleum marketers will seek to move the product through as few terminals as possible to minimize expenses (as discussed in Study Case B1).

Consequently, as with Study Case B1, the next step was to try and direct higher portions (above the factor used) of ethanol into the largest population centers since this would result in fewer terminal conversions. In addition, these areas usually have several servicing terminals (usually with a greater number of tanks) making it easier to have only a portion of the terminals offer ethanol to achieve desired throughput. Moreover, the greater number of terminals would provide more flexibility in adjusting for exchange agreements of blended product for non-blended product among companies.

In many instances, gasoline ethanol blend percentages exceed 100% market share. However the base gasoline volumes are from 1998. The Case C annual ethanol production volume of 10 billion gallons annually will take a significant amount of time to reach, likely well in excess of ten years.

Since gasoline demand is increasing at 1.5 to 2.0% annually the gasoline ethanol blends percentage of market share would not exceed 100% at that point in time. Also, as discussed in Study Case B1, 10v% ethanol blends result in a 2-3% fuel economy penalty which will have the affect of increasing demand. It is also important to reiterate that these numbers were developed as a cap to make sure the volumes of ethanol directed to various markets did not exceed the volumes needed to blend to the gasoline volume in the applicable market.

In Study case C it was also necessary to direct more ethanol to less populated outlying areas to achieve the desired volumes in each PADD.

For Study Case C we have also increased the volumes for E-85 since many more flexible fuel vehicles, that are E85 capable will, or could, be available by that time.

Based on the aforementioned considerations and assumptions, ethanol demand by area within each PADD is broken down in the following tables.

**Table 5-4A PADD I Ethanol Use Study Case C**

PADD I Target Use: 2.7 billion gallon ethanol annually
.3 billion gallons ethanol in E-85 (.375 billion gallons E85)
2.4 billion gallons ethanol in E10 (124 billion gallons gasoline ethanol blend)

| Cities over 250,000 | Gasoline Demand | Case C (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Albany/Schenectady/Troy NY | 394,668,044 | 30 | 76.01 |
| Allentown/Bethlehem/Easton PA | 280,678,876 | 15 | 53.44 |
| Atlanta GA | 1,750,797,527 | 100 | 57.12 |
| Augusta/Aiken GA | 209,176,233 | 10 | 47.81 |
| Boston/Worcester/Lawrence MA | 2,572,443,347 | 165 | 64.14 |
| Buffalo/Niagra Falls NY | 518,426,843 | 40 | 77.16 |
| Charleston/North Charleston SC | 250,926,053 | 15 | 59.78 |
| Charleston WV | 114,023,212 | 5 | 43.85 |
| Charlotte/Gastonia/Rock Hill NC/SC | 643,297,283 | 40 | 62.18 |
| Columbia SC | 234,334,520 | 15 | 64.01 |
| Columbus GA | 123,200,483 | 5 | 40.58 |
| Daytona Beach FL | 215,478,855 | 15 | 69.61 |
| Erie PA | 125,731,518 | 10 | 79.53 |
| Fayetteville NC | 128,753,236 | 5 | 38.83 |
| Fort Myers/Cape Coral FL | 181,812,369 | 10 | 55.00 |
| Fort Pierce/Port St. Lucie FL | 136,159,781 | 10 | 73.44 |
| Greensboro/Winston Salem/High Point NC | 535,341,110 | 30 | 56.04 |
| Greenville/Spartanburg/Anderson SC | 421,944,302 | 25 | 59.25 |
| Harrisburg/Lebanon/Carisle PA | 280,690,224 | 20 | 71.25 |
| Hartford CT | 520,870,272 | 35 | 67.20 |
| Hickory/Morganton/Lenoir NC | 147,895,322 | 10 | 67.62 |
| Jacksonville FL | 479,485,855 | 30 | 62.57 |
| Lakeland/Winter Haven FL | 207,597,060 | 10 | 48.17 |
| Lancaster PA | 208,817,186 | 15 | 71.83 |
| Macon GA | 145,972,988 | 5 | 34.25 |
| Melbourne/Titusville/Palm Bay FL | 213,506,137 | 10 | 46.83 |
| Miami/Fort Lauderdale | 1,684,528,080 | 100 | 59.36 |
| New London/Norwich CT | 1,289,515,967 | 10 | 77.55 |
| New York/Long Island/et.al. NY/NJ/CT/PA | 9,167,579,432 | 700 | 76.36 |
| Norfolk/Virginia Beach/Newport News VA/NC | 709,304,820 | 45 | 63.44 |
| Orlando FL | 696,762,671 | 40 | 57.41 |
| Pensacola FL | 183,102,398 | 10 | 54.61 |
| Philadelphia/Wilmington/Atl. City PA/NJ/DE/MD | 2,723,056,716 | 180 | 66.10 |
| Pittsburgh PA | 1,058,230,401 | 70 | 66.15 |
| Providence/Fall River/Warwick RI/MA | 510,945,402 | 35 | 68.50 |
| Raleigh-Durham/Chapel Hill NC | 501,819,877 | 30 | 59.78 |
| Reading PA | 162,597,656 | 10 | 61.50 |
| Richmond/Petersburg VA | 436,401,977 | 25 | 57.29 |
| Rochester NY | 489,808,356 | 35 | 71.46 |
| Sarasota/Bradenton FL | 249,688,678 | 15 | 60.07 |

| | | | |
|---|---|---|---|
| Savannah GA | 130,921,138 | 5 | 38.19 |
| Scranton/Wilkes-Barre/Hazelton PA | 277,565,921 | 20 | 72.05 |
| Springfield MA | 260,520,472 | 20 | 76.77 |
| Syracuse NY | 332,684,017 | 25 | 75.15 |
| Tallahassee FL | 118,019,487 | 5 | 42.37 |
| Tampa/St. Petersburg/Clearwater F | 1,034,097,056 | 60 | 58.02 |
| Utica/Rome NY | 133,028,215 | 10 | 75.17 |
| Washington/Baltimore DC/MD/VA/WV | 3,340,386,834 | 230 | 68.85 |
| West Palm Beach/Boca Raton FL | 476,348,389 | 30 | 62.98 |
| York PA | 170,938,361 | 10 | 58.50 |
| Total | 37,179,880,957 | 2400 | 66.63 |

| | | | |
|---|---|---|---|
| PADD I TOTALS (used in E-10) (1) | 37,179,880,957 | 2.4 bgy | 66.63% |
| PADD I TOTALS (including E-85) (1) | | 2.7 bgy (176.1 mbcd) | 67.90% |

(1) NOTE: calculations are based on 2.4 bgy blended in E-10 yielding 24 billion gallons of E-10 blend or 66.63% of total 1998 gasoline sales. For E-85 the 0.3 bgy yields 0.375 bgy of E-85 which when added to E-10 sales represents 67.9% of total gasoline sales for 1998 in PADD I.

## Table 5-4B PADD II Ethanol Use Study Case C

| | |
|---|---|
| PADD II Target Use | 3.7 billion gallon ethanol annually<br>.4 billion gallons ethanol in E-85 (.5 billion gallons E85)<br>3.3 billion gallons ethanol in E10 (12 billion gallons gasoline ethanol blend) |

| Cities over 250,000 | Gasoline Demand | Case C (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Appleton/Oshkosh/Neehah WI | 172,925,305 | 18 | 104.09 |
| Canton/Massillon OH | 1,999,296,701 | 20 | 100.04 |
| Chattanooga TN | 224,556,500 | 23 | 102.42 |
| Chicago/Gary/Kenosha IL/IN/WI | 4,414,249,517 | 450 | 101.94 |
| Cincinnati-Hamilton OH/KY/IN | 974,161,618 | 97 | 99.57 |
| Cleveland/Akron OH | 1,445,903,938 | 150 | 103.74 |
| Columbus OH | 739,931,038 | 74 | 100.01 |
| Davenport/Moline/Rock Island IA/I | 178,261,599 | 18 | 100.98 |
| Dayton/Springfield OH | 476,251,492 | 48 | 100.79 |
| Des Moines IA | 220,315,085 | 23 | 104.40 |
| Detroit/Ann Arbor/Flint MI | 2,716,984,913 | 270 | 99.37 |
| Evansville/Henderson IN/KY | 144,649,708 | 15 | 103.70 |
| Fort Wayne IN | 240,595,185 | 25 | 103.91 |
| Grand Rapids/Muskegon/Holland MI | 522,646,741 | 53 | 101.41 |
| Huntington/Ashland KY | 155,213,999 | 16 | 103.08 |
| Indianapolis IN | 763,367,608 | 80 | 104.80 |
| Johnson City/Kingsport/Bristol TN/VA | 229,889,315 | 23 | 100.05 |
| Kalamazoo/Battle Creek MI | 222,137,234 | 23 | 103.54 |
| Kansas City MO/KS | 872,276,274 | 88 | 100.89 |
| Knoxville TN | 333,872,319 | 33 | 98.84 |
| Lansing/East Lansing MI | 223,938,022 | 23 | 102.71 |
| Lexington KY | 226,336,423 | 23 | 101.62 |
| Louisville KY | 499,674,650 | 50 | 100.07 |
| Madison WI | 212,896,833 | 22 | 103.34 |
| Memphis TN/AR/MS | 548,958,610 | 55 | 100.19 |
| Milwaukee/Racine | 818,774,247 | 82 | 100.15 |
| Minneapolis/St. Paul MN | 1,426,774,852 | 143 | 100.23 |
| Nashville TN | 582,091,615 | 60 | 103.08 |
| Oklahoma City OK | 519,761,009 | 52 | 100.81 |
| Omaha NE/IA | 347,179,468 | 35 | 108.12 |
| Peoria/Pekin IL | 172,120,540 | 18 | 104.58 |
| Rockford IL | 178,161,251 | 18 | 101.03 |
| Saginaw/Bay City/Midland | 199,081,686 | 20 | 100.46 |
| St. Louis MO/IL | 1,276,214,089 | 128 | 100.30 |
| South Bend IN | 128,433,179 | 13 | 101.22 |
| Springfield MO | 153,169,794 | 15 | 97.93 |
| Toledo OH | 302,520,427 | 31 | 102.47 |
| Tulsa OK | 390,518,593 | 40 | 102.43 |
| Wichita KS | 272,584,131 | 28 | 102.72 |
| Youngstown/Warren OH | 292,714,206 | 30 | 102.49 |
| TOTAL | 25,819,389,714 | 2433 | |

| | | | |
|---|---|---|---|
| **Cities over 100,000/under 250,000** | | | |
| Benton Harbor MI | 79,338,488 | 8 | 100.83 |
| Bloomington IN | 58,083,727 | 6 | 103.30 |
| Bloomington/Normal IL | 72,268,471 | 8 | 110.70 |
| Cedar Rapids IA | 91,848,126 | 10 | 108.88 |
| Champaign/Urbana IL | 84,585,859 | 9 | 106.40 |
| Clarksville/Hopkinsville TN/KY | 100,025,441 | 11 | 109.97 |
| Columbia MO | 64,668,898 | 7 | 108.24 |
| Decatur IL | 56,243,695 | 6 | 106.68 |
| Duluth/Superior MN/WI | 117,436,203 | 12 | 102.18 |
| Eau Claire WI | 71,764,747 | 8 | 111.48 |
| Elkhart/Goschen IN | 86,775,617 | 9 | 103.72 |
| Fargo/Moorehead ND/MN | 84,511,344 | 9 | 106.49 |
| Green Bay WI | 107,576,331 | 11 | 102.25 |
| Iowa City IA | 51,571,085 | 6 | 116.34 |
| Jackson MI | 78,127,365 | 8 | 102.40 |
| Jackson TN | 504,77,200 | 6 | 118.87 |
| Janesville/Beloit WI | 75,072,235 | 8 | 106.56 |
| Joplin MO | 74,505,919 | 8 | 107.37 |
| Kokomo IN | 49,864,187 | 5 | 100.27 |
| LaCrosse WI | 60,569,560 | 7 | 115.57 |
| Lafayette IN | 87,152,665 | 9 | 103.27 |
| Lawton OK | 52,966,013 | 6 | 113.28 |
| Lima OH | 76,534,723 | 8 | 104.53 |
| Lincoln NE | 118,060,642 | 12 | 101.64 |
| Mansfield OH | 87,737,859 | 9 | 102.58 |
| Muncie IN | 57,362,915 | 6 | 104.60 |
| Rochester MN | 59,153,768 | 6 | 101.43 |
| St. Cloud MN | 81,923674 | 9 | 109.86 |
| Sheboygan WI | 54,712,156 | 6 | 100.17 |
| Sioux City IA/NE | 59,898,921 | 6 | 109.66 |
| Sioux Falls SD | 81,709,070 | 9 | 110.15 |
| Springfield IL | 101,355,789 | 11 | 108.53 |
| Stuebenville/Weirton OH/WV | 66,215,340 | 7 | 105.72 |
| Terre Haute IN | 73,624,153 | 8 | 108.66 |
| Topeka KS | 84,834,741 | 9 | 106.09 |
| Waterloo/Cedar Falls IA | 59,591,918 | 6 | 100.68 |
| Wausau WI | 61,392,706 | 7 | 114.02 |
| TOTALS | 2,779,541,551 | 296 | |
| | | | |
| Misc. outlying rural areas (see terminal analysis) | 5,710,000,000 | 571 | |
| | | | |
| PADD II TOTAL (used in E-10) (1) | 34,308,931,265 | 3300 | 104.00% |
| PADD II TOTALS (including E-85) (1) | | 3700 | 110.76% |
| | | (241.4 mbcd) | |

(1) NOTE: calculations are based on 3.3 bgy blended in E-10 yielding 33.0 billion gallons of E-10 blend or 101.51% of total 1998 gasoline sales. For E-85 the 0.4 billion gallons of ethanol yields 0.5 bgy of E-85 which when added to E-10 sales represents 116.89% of total gasoline sales for 1998.

**Table 5-4C PADD III Ethanol Use Study Case C**

| | |
|---|---|
| PADD III Target Use | 1.8 billion gallon ethanol annually<br>0.0 billion gallons ethanol in E-85 (.125 billion gallons E85)<br>1.8 billion gallons ethanol in E10 (12 billion gallons gasoline ethanol blend) |

| Cities over 250,000 | Gasoline Demand | Case C (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Albuquerque NM | 466,688,057 | 45 | 94.42 |
| Austin/San Marcos TX | 608,597,720 | 60 | 98.59 |
| Baton Rouge LA | 307,443,144 | 30 | 97.58 |
| Beaumont/Port Arthur TX | 199,806,765 | 20 | 100.10 |
| Biloxi/Gulfport/Pascagoula MS | 187,565,776 | 20 | 106.63 |
| Birmingham Al | 485,941,953 | 50 | 102.89 |
| Brownsville/Harlingen/San Benito TX | 174,781,533 | 15 | 85.82 |
| Corpus Cristi TX | 205,568,012 | 20 | 97.29 |
| Dallas/Fort Worth TX | 2,607,150,213 | 250 | 95.89 |
| El Paso TX | 372,740,812 | 35 | 93.90 |
| Fayetteville/Springdale/Rogers AR | 151,355,260 | 15 | 99.10 |
| Houston/Galveston/Brazoria TX | 2,386,353,584 | 235 | 98.48 |
| Huntsville AL | 182,368,493 | 15 | 82.25 |
| Jackson MS | 229,752,609 | 20 | 87.05 |
| Killeen/Temple TX | 157,355,475 | 15 | 95.33 |
| Lafayette LA | 200,328,246 | 20 | 99.84 |
| Little Rock/North Little Rock AR | 296,890,329 | 30 | 101.05 |
| McAllen/Edinburg/Mission TX | 284,056,699 | 30 | 105.61 |
| Mobile AL | 284,356,737 | 30 | 105.50 |
| Montgomery AL | 171,228,879 | 15 | 87.60 |
| New Orleans LA | 693,260,802 | 70 | 100.97 |
| San Antonio TX | 831,049,599 | 85 | 96.26 |
| Shreveport/Bossier City LA | 200,559,248 | 20 | 99.72 |
| TOTAL | 11,685,199,945 | 1145 | |

| Cities over 100,000/under 250,000 | | | |
|---|---|---|---|
| Abilene TX | 65,040,645 | 6 | 92.25 |
| Alexandria LA | 67,322,522 | 7 | 103.98 |
| Amarillo TX | 110,823,146 | 11 | 99.26 |
| Anniston AL | 61,887,864 | 6 | 96.95 |
| Auburn/Opelika AL | 54,253,111 | 5 | 92.16 |
| Bryan/College Station TX | 71,272,393 | 7 | 98.21 |
| Decatur AL | 76,187,694 | 7 | 91.88 |
| Dothan AL | 71,819,363 | 7 | 97.47 |

| | | | |
|---|---|---|---|
| Florence AL | 72,688,144 | 7 | 96.30 |
| Fort Smith AR | 103,843,164 | 10 | 96.30 |
| Gadsdden AL | 54,947,710 | 5 | 91.00 |
| Hattiesburg MS | 60,036,130 | 6 | 99.94 |
| Houma LA | 103,335,490 | 10 | 96.77 |
| Lake Charles LA | 95,646,040 | 9 | 94.10 |
| Laredo TX | 102,586,194 | 10 | 97.48 |
| Las Cruces NM | 90,468,405 | 9 | 99.48 |
| Longview/Marshall TX | 111,249,040 | 11 | 98.88 |
| Lubbock TX | 121,018,572 | 12 | 99.16 |
| Monroe LA | 77,888,613 | 8 | 102.71 |
| Odessa/Midland TX | 128,637,925 | 13 | 101.06 |
| San Angelo TX | 54,325,332 | 5 | 92.04 |
| Santa Fe NM | 75,677,896 | 7 | 92.50 |
| Sherman/Denison TX | 55,083,656 | 5 | 90.77 |
| Texarkana TX/AR | 65,257,309 | 6 | 91.94 |
| Tuscaloosa AL | 85,728,348 | 8 | 93.32 |
| Tyler TX | 90,113,671 | 9 | 99.87 |
| Waco TX | 108,461,614 | 11 | 101.57 |
| Wichita Falls TX | 72,483,163 | 7 | 96.57 |
| TOTAL | 2,308,083,154 | 224 | |
| | | | |
| Misc. outlying rural areas (see terminal analysis) | 4,310,000,000 | 431 | |
| | | | |
| PADD III TOTALS | 18,303,283,099 | 1800<br>(117.4 mbcd) | 98.34% |

**Table 5-4D PADD IV Ethanol Use Study Case C**

PADD IV Target Use — 0.4 billion gallon ethanol annually
0.0 billion gallons ethanol in E-85 (.125 billion gallons E85)
0.4 billion gallons ethanol in E10 (12 billion gallons gasoline ethanol blend)

| **Cities over 250,000** | **Gasoline Demand** | **Case C (mmgy)** | **Market Share for Blended Fuel** |
|---|---|---|---|
| Boise City ID | 204,660,663 | 21 | 102.61 |
| Colorado Springs CO | 250,902,560 | 26 | 103.63 |
| Denver/Boulder/Greeley CO | 1213,333,175 | 122 | 100.55 |
| Provo/Orem UT | 174,126,961 | 16 | 103.37 |
| Salt Lake City/Ogden | 639,847,344 | 64 | 100.02 |
| TOTALS | 2,482,870,703 | 249 | |
| **Cities over 100,000/under 250,000** | | | |
| Billings MT | 63,859,482 | 7 | 109.62 |
| Fort Collins/Loveland CO | 118,853,467 | 12 | 100.96 |
| Grand Junction CO | 57,782,048 | 6 | 103.84 |
| Pueblo CO | 6,8741,603 | 7 | 101.83 |
| TOTALS | 309,236,600 | 32 | |
| Misc. outlying rural areas (see terminal analysis) | 1,190,000,000 | 119 | |
| TOTALS PADD IV | 3,982,107,303 | 400 (26.1 mbcd) | 99.55% |

## Table 5-4E PADD V Ethanol Use Study Case C

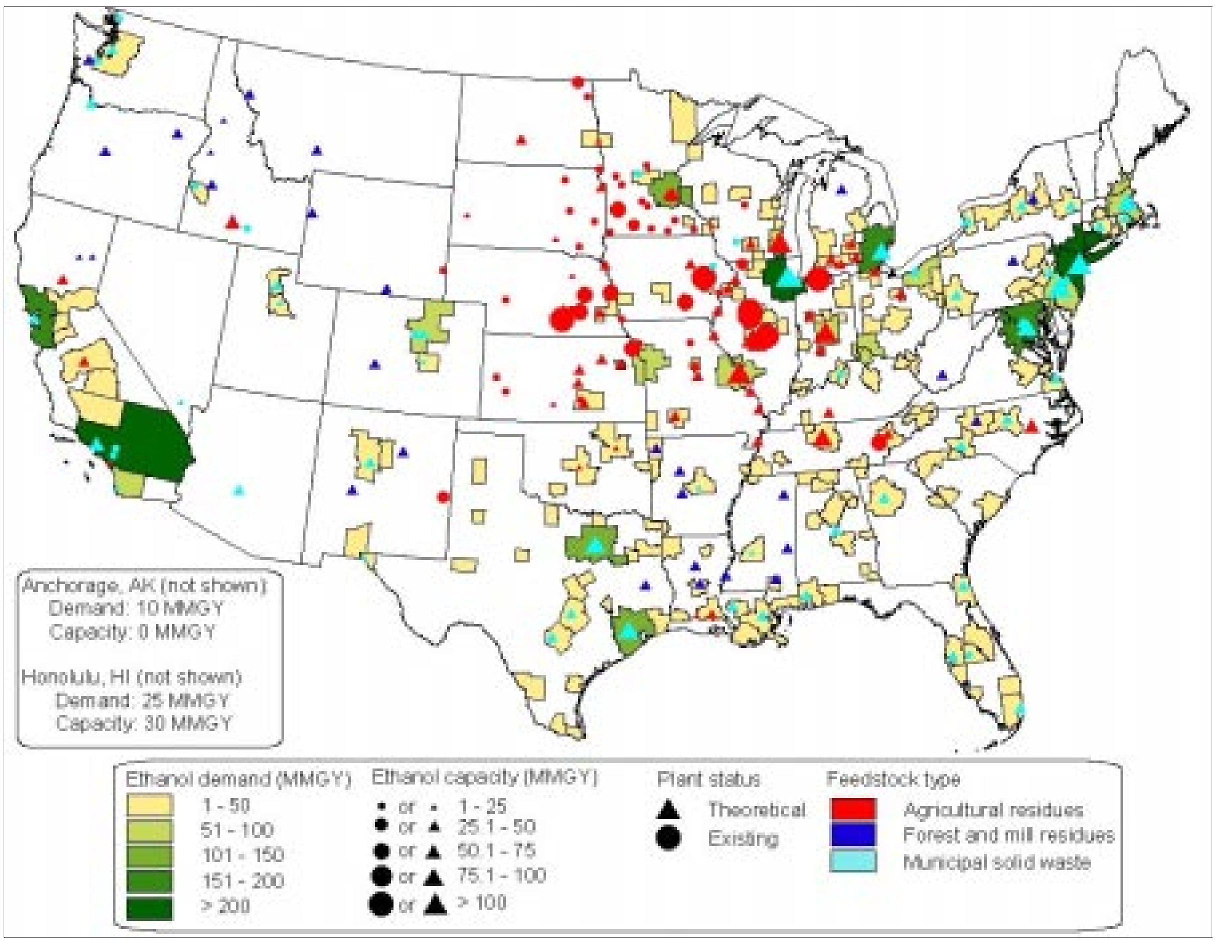
PADD IV Target Use — 1.4 billion gallon ethanol annually
0.0 billion gallons ethanol in E-85 (.125 billion gallons E85)
1.4 billion gallons ethanol in E10 and E-5.7 (2.026 bgy gasoline ethanol blend)

| Cities over 250,000 | Gasoline Demand | Case C (mmgy) | Market Share for Blended Fuel |
|---|---|---|---|
| Anchorage AK | 112,683,836 | 10 | 88.74 |
| Bakersfield CA | 280,824,493 | 16 | 99.96 |
| Eugene OR | 137,638,291 | 13 | 94.45 |
| Fresno CA | 384,559,464 | 22 | 100.37 |
| Honolulu HI | 377,890,432 | 25 | 66.16 |
| Las Vegas NV/AZ | 603,651,042 | 60 | 99.40 |
| Los Angeles/Riverside/Orange Cty, CA | 7,009,340,798 | 420 | 105.12 |
| Modesto CA | 190,914,062 | 11 | 101.08 |
| Phoenix/Mesa AZ | 1,317,239,281 | 90 | 68.32 |
| Portland/Salem OR/WA | 953,279,164 | 95 | 99.66 |
| Reno NV | 139,786,560 | 14 | 100.15 |
| Sacramento/Yolo CA | 760,964,683 | 46 | 106.05 |
| Salinas CA | 162,488,720 | 10 | 107.97 |
| San Diego CA | 1,232,946,695 | 75 | 106.72 |
| San Francisco/Lakeland/San Jose CA | 3,004,362,483 | 175 | 102.19 |
| Santa Barbara/Santa Maria/Lompoc CA | 170,931,004 | 10 | 102.64 |
| Seattle/Tacoma/Bremerton WA | 1,514,829,369 | 120 | 79.22 |
| Spokane WA | 179,089,183 | 15 | 83.76 |
| Stockton-Lodi CA | 246,158,461 | 15 | 106.91 |
| Tucson AZ | 351,248,831 | 25 | 71.17 |
| Visalia/Tulare/Pottersville CA | 156,681,618 | 10 | 111.97 |
| TOTAL | 19,287,508,470 | 1277 | |
| **Cities over 100,000/under 250,000** | | | |
| Chico/Paradise CA | 85,327,602 | 5 | 102.80 |
| Flagstaff AZ | 52,735,098 | 5 | 94.81 |
| Medford/Ashland OR | 76,849,040 | 7 | 91.09 |
| Merced CA | 87,742,930 | 5 | 99.97 |
| Redding CA | 71,913,484 | 4 | 97.58 |
| Richland/Kennewick/Pasco WA | 80,697,131 | 7 | 86.74 |
| San Luis Obispo/Atascadero/Paso Robles CA | 103,568,442 | 6 | 101.64 |
| Yakima WA | 96,501,663 | 8 | 82.90 |
| Yuba City CA | 60,330,749 | 4 | 116.32 |
| Yuma AZ | 59,274,754 | 5 | 84.35 |
| TOTALS | 774,940,893 | 56 | |
| Misc. outlying rural areas (see terminal analysis) | 670,000,000 | 67 | |
| PADD V TOTALS E-5.7 (1) | 0.834 | 14.6 | 70.42% |
| PADD V TOTALS E-10 (1) | 0.566 | 5.66 | 27.30% |
| PADD V Total All | 20,732,449,363 | 1400 (91.3 mbcd) | 97.72% |

(1) Calculations are based on 0.834 bgy used in California in E-5.7 blends yielding 14.6 bgy of E-5.7 and 0.566 bgy as E-10 yielding 5.66 bgy of E-10 blend for a total of 2.026 bgy of total blend sales in PADD V.

Figure 5-1, prepared by McNeil Technologies Inc. of Lakeland, Colorado, provides the reader with a graphic depiction of the location of ethanol production facilities and key ethanol markets developed for Study Case C.

**Figure 5-1 Ethanol Production and Key Markets Map**




**Ethanol plant location and size (existing and theoretical) and ethanol demand by metropolitan area in million gallons per year (mmgy) – Scenario C**

With plants assigned actual or theoretical locations and the ethanol production assigned to designated market areas, it is possible to proceed to the terminal analysis which in turn will allow development of projected transportation demands.

## 5.3 Terminal Analysis

Once the market areas for ethanol use were determined, the next step was to identify petroleum products terminals that service each market area. This was done by researching maps and terminal listings. The primary reference used was the *Petroleum Terminal Encyclopedia (10th edition, 1999-OPIS Directories)*. Procedures used for Study Case C were the same as described for Study Case B1 (Section 4.3).

As discussed in the Transportation Analysis section, it is assumed that none of the ethanol moved between PADDs was done so via pipeline.

There were also some special considerations for transshipment points or special receiving tankage which, when applicable, are discussed in that PADDs report section or the Transportation Analysis section.

The analysis results are discussed in the next section. The actual tables summarizing the analysis are included in Appendix H, Tables 2A through 2E. As in Study Case B1, various estimates for terminal and retail equipment and retail unit conversion costs are based on estimates from recently completed work and all costs should therefore be considered as Year 2000 dollars (2000 $). Procedures used for amortization are discussed in Appendix E.

There are a few additional issues to cover for Study Case C. In this Study Case it was necessary to expand into rural areas (populations below 100,000) in all PADDs except PADD I. Consequently, a number of terminals in outlying locations were added as servicing terminals for those PADDs. Note that in Appendix H the terminal analysis sheets have not provided specific terminals in these outlying areas where the tankage would be installed but the total tanks needed for the combined area have been included in the PADD totals for “Estimated Tankage Additions”.

Also in Study Case C, there are areas where all, or nearly all, terminals would need to add tankage to handle ethanol if the ethanol volume scenarios are to be achieved. While we have listed the necessary required tankage in the tables and included them in capital investment requirements, no assessment was made of land availability for the tankage requirement or any permitting problems that might be experienced (e.g., terminals in residential areas). This could be more important in Case C where it may not be possible to install new tanks in every case where they are needed. If tanks could not be installed, the only other option would likely be for that terminal to work out an exchange agreement, or joint operations agreement, with a nearby terminal. As an example, one terminal could handle distillates and non-blended gasoline and the other terminal could distribute ethanol blends. Both companies could cross utilize the terminals thereby maintaining total volume on all products.

Note that in the following section, tanks, other terminal equipment, and retail requirements listed for Study Case C are in addition to those already added for Study Case B1. There are also a greater number of servicing terminals in Study Case C reflecting the need to utilize more terminals as ethanol market share is increased and also to expand into a greater number of market areas (more servicing terminals).

## 5.4 Discussion of Projected Terminal Tankage and Equipment Requirements by PADD - Study Case C

This section examines the estimated terminal tankage and equipment requirements for Study Case C. Again, we use the *"Petroleum Terminal Encyclopedia"* which does not always disclose all terminal capabilities, and some inaccuracies were noted. Since requirements were already examined to increase existing ethanol production/distribution and sales by 3.287 bgy, to 5.1 billion gallons annually in Case B1, that becomes our starting point for Study Case C. Here we examine only the additional requirements necessary to raise production/distribution and sales from the Study Case B1 volume to Study Case C volume of 10 billion gallons of annual ethanol production, an increase of 4.9 bgy of ethanol production and use. In Study Case C, it is necessary to expand into more markets necessitating use of more terminals than just those used in Study Case B1. The tankage needs listed for Study Case C are in addition to those listed for Study Case B1. Note that the estimates in the following sections should be considered as likely upper bound estimates for the same reasons discussed in Section 4.3 (Page 4-27).

**Study Case C - PADD I:** In Study Case C the amount of ethanol used in PADD I increases from the 1.3 bgy in Study Case B1 to 2.7 bgy. This, of course, dictates a much higher percentage of ethanol in each major market area as well as ethanol distribution in cities/MSAs that were not included in Study Case B1. Consequently, the number of servicing terminals increases. Analysis of PADD I Study Case C indicates there are 288 terminals servicing the designated market areas, an increase of 17 terminals over Study Case B1. Of these, 126 are indicated to have water capabilities (10 more than Study Case B1) and 23 are indicated to have rail capability (1 more than Study Case B1). Of the terminals disclosing their storage capabilities, 12 are under 100m bbl, 104 are capable of storing 100m-250m bbl, and 123 indicate storage capabilities in excess of 250m bbl. Terminals listing ethanol storage availability remain at 11, the same as in Study Case B1. Initial additional tankage required for Study Case C based solely on information in the *"Petroleum Terminal Encyclopedia"* would indicate a need for the following:

**Table 5-5 Study Case C - PADD I Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 9 | 2 |
| 2 | 3 |
| 37 | 5 |
| 26 | 10 |
| 10 | 20 |
| 18 | 25 |
| 3 | 50 |

While some tankage in PADD I is underutilized, we have already taken this into account in Study Case B1. Consequently, we are very conservative in our estimate of using existing tankage in terminals that were already included in Study Case B1. Using the above listing of tankage requirements, estimates were made for terminals that already have ethanol or could use existing tankage, with or without modification. The remaining revised storage needs are assumed to require installation of new tanks. This is covered in the following table.

**Table 5-6 Study Case C - PADD I Revised Tank Requirement Estimate**

| Tanks Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 2 | 9 | 2 | 0 | 0 | 7 |
| 3 | 2 | 1 | 0 | 0 | 1 |
| 5 | 37 | 1 | 3 | 4 | 29 |
| 10 | 26 | 0 | 4 | 2 | 20 |
| 20 | 10 | 0 | 0 | 0 | 10 |
| 25 | 18 | 0 | 0 | 1 | 17 |
| 50 | 3 | 0 | 0 | 0 | 3 |
| Total | 105 | 4 | 7 | 7 | 87 |

Based on the above estimates for Study Case C, PADD I would require modifications to 7 existing tanks ranging in size from 5m bbl to 25m bbl and installation of 87 new tanks ranging in size from 2m bbl to 50m bbl. Additionally, 7 tanks would be converted without modification.

A discussion of estimates for building new tanks, converting existing tanks, and other terminal equipment is included in Appendix E. The following Table provides a breakdown of costs for new tankage.

**Table 5-7 Study Case C- PADD I Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 7 | 2 | $20 per steel barrel = | $280,000 |
| 1 | 3 | $20 per steel barrel = | $60,000 |
| 29 | 5 | $15 per steel barrel = | $2,175,000 |
| 20 | 10 | $15 per steel barrel = | $3,000,000 |
| 10 | 20 | $15 per steel barrel = | $3,000,000 |
| 17 | 25 | $12 per steel barrel = | $5,100,000 |
| 3 | 50 | $10 per steel barrel = | $1,500,000 |
| 87 | Total | | $15,115,000 |

Costs for converting currently existing tankage was estimated to cost 20% of the cost of installing new tanks (see Appendix E). This number would include floating internal covers, piping changes, etc. These are covered in the following table.

| Table 5-8 Study Case C - PADD I Cost Estimate for Converting Existing Tanks | | |
|---|---|---|
| Total # of Conversions | Tank Size (mbbl) | Total Cost |
| 4 | 5 | $60,000 |
| 2 | 10 | $60,000 |
| 1 | 25 | $60,000 |
| 7 | Total | $180,000 |

It is also estimated that the installation of computer controlled in-line injection blending equipment will be required at all new ethanol terminals (other than those estimated to already have ethanol). This equates to 101 terminals. Here we have assumed an average of two truck racks per terminal to arrive at the following estimate (development of cost estimates for blending system installation is discussed in Appendix E).

| Table 5-9 Study Case C - PADD I Cost Estimate for Blending Systems | |
|---|---|
| Number of terminals requiring blending systems | 101 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $30,300,000 |

In Study Case B1 almost all ethanol used in PADD I would be imported from PADD II. In Study Case C a great deal of ethanol production exists in PADD I and ethanol imported from PADD II only increases by 0.2 bgy.

Because a number of terminals in Study Case C are water accessible (at least 126), a large portion of the ethanol will be shipped by water to larger "hub terminals" for redistribution to smaller terminals via transport trucks and in some instances by barge. Significant volumes of ethanol will also be shipped by rail. The impact on transportation demand is discussed in more detail in the appropriate section of this report, as is ethanol movements within each PADD. Here we assume a 50/50 split between rail and water delivery or 0.650 bgy (15.5 mmbbl) by each mode for product imported into PADD I from PADD II.

**Table 5-10 Study Case C - PADD I Ethanol Import Transportation Modes Estimate**

| bgy (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Ocean barges annual/monthly | Ships annual/monthly |
|---|---|---|---|---|
| 0.65 (15.5 mmbbl) | 21,666 | 1805 | | |
| 0.65 (15.5 mmbbl) | | | 386.9/32.2 | 61.9/5.2 |

The method of waterborne cargos will vary depending on destination. In all cases, ethanol from PADD II would be shipped to New Orleans via river barge (and in some cases by rail) where it would be staged for delivery to PADD I. Shipments to the southern ports on the East Coast would be by ocean-going barge. Industry sources indicate that from the Carolinas north, using ships (or more specifically compartments of ships) is more feasible. We have therefore assumed that waterborne cargoes will be split equally between 5.25 million gallon (125 mbbl) cargoes on ships and 840m gallon (20 mbbl) cargoes on ocean-going barges. Note that major hub terminals are not included in cost estimates for capital expenditures. In the case of large ship cargoes, the ethanol will be shipped to existing tankage in areas such as the New York Harbor where it would be reshipped to other terminals via barge, truck, and in rare instances rail. Such terminals and tankage already exist and are available for a fee based on product throughput, or on a shell capacity basis. These costs are included in the transportation cost analysis since they are largely to accommodate transfer of product in intermodal shipment scenarios.

Based on the terminal assessment, a sufficient number of terminals with water receipt capabilities is available. However to handle an average of 1805 rail cars per month (278 more than Study Case B1), across the geography of PADD I, would likely require at least 2 of the 17 new terminals added in Study Case C, to add rail capabilities. This would require the installation of rail spurs and piping/headers to accommodate rail delivery. Installation of track spurs is estimated to cost between $75 and $95 per track foot (see Appendix E). Here we assume each of the 2 terminals would need to install a 3/4 mile rail spur at a total cost of $340,000 plus an additional $15,000 for attendant headers and piping (for off-loading) bringing the total cost to $355,000 per terminal as covered in the following table.

**Table 5-11 Study Case C - PADD I Estimated Cost of Rail Spur Installation**

| No. of terminals requiring rail | Average cost per terminal | Total Cost |
|---|---|---|
| 2 | $355,000 | $710,000 |

We have also included a contingency amount for other terminal expenses for terminals requiring new tanks or tank conversions. See table below.

**Table 5-12 Study Case C - PADD I Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 94 | $20,000 | $1,880,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Included in the ethanol market volume for PADD I in Study Case C are sales of 0.3 bgy of ethanol for use in E-85 blending, a tripling of the volume from Study Case B1. As noted in Study Case B1, for purposes of our calculations, we have assumed an annual average of 80v% ethanol in E-85. Again, there are no terminal requirements for E-85 since it would presumably be blended and distributed from a terminal that is already blending E-10.

If 0.3 bgy of ethanol are used in E-85 in PADD I, this would equate to 0.375 bgy of E-85. Assuming vehicles travel 12,000 miles per year and average 20 mpg, the average vehicle would purchase 600 gallons per year (50 gallons per month). Based on these averages it would take 625,000 vehicles to support these volume projections. However before estimating infrastructure costs, it is important to recognize that these vehicles may not operate exclusively on E-85. Here we are making the assumption that vehicles using E-85 will include a large number of fleet vehicles that operate on E-85 the majority of the time, as well as consumers who operate 50% of the time on E-85. This would raise the number of vehicles required to support these volumes to, at most, 1.25 million. This is still within projected sales figures for such vehicles under current production scenarios.

We also assume that E-85 fueling facilities will be selectively placed to accommodate a high level of fleet use and in locations with very high traffic counts (e.g. airport corridors). The average gasoline sales volume for a retail outlet in PADD I is 743,523 gallons (49 bcd) annually. Inner-city location sales volumes are generally higher, as are superpumpers and hypermarts. Some E-85 facilities may be located in such outlets while others will be based in fleet locations.

Of course, E-85 sales cannot be expected to be in line with gasoline sales. Instead it is more likely to be similar to the sales of midgrade unleaded, around 10%-15% of total facility volume. In Study Case B1 we assumed that the average outlet would dispense 11,000 gallons monthly or 132,000 annually. With greater vehicle density in future years, we now assume an increase in per unit volume. An average facility with one dual nozzle E-85 dispenser could be assumed to easily average 6 fueling events per hour, 10 hours per day at 10 gallons per fill, or 600 gallons per day. Due to the lower volumes on weekends when many fleets are not operating, we are using an average of 500 gallons daily or 15,000 gallons monthly/180,000 gallons annually. As covered in the following table, this would equate to a total need for 2083 outlets (before considering mobile fleet fueling).

**Table 5-13 Study Case C - PADD I E-85 Infrastructure Requirements (Initial)**

| | |
|---|---|
| Total targeted sales | 0.375 bgy |
| Total annual sales per facility | 180,000 gallons |
| Total number of facilities required | 2083 |
| (serving approximately 1,250,000 vehicles) | 10 gallons per fueling event -<br>1500 fueling events per unit month or<br>50 per unit day |

Whether at retail or commercial fleet fueling facilities, the dispensing of E-85 requires a dedicated tank and certain special equipment (1, 2). In some cases E-85 could displace a low sales volume grade such as diesel or heating oil. However, this would still require retrofitting the tank. Depending on the type of tank, retrofitting could cost $19,000 to $30,000 based on estimates for M-85 which has near identical requirements (3). It is unlikely that many facility operators would chose to displace a grade providing a known revenue stream for a product that would provide low volume sales in its initial years. We are therefore assuming that only 10% of additional E-85 fueling facilities, for Study Case C, will be retrofits at an average cost of $25,000 each.

If the decision is made to install new tankage, it may be possible to install above ground tanks in a few cases, but in most cases underground tanks will be required. Estimated costs for a new underground tank system is $62,407 (3) and some estimates are higher. (4) We have used a cost of $62,000 per unit in this study.

As discussed in Study Case B1, "Mobile Fueling" (5) is another option for dispensing E-85. Here we assume that mobile fueling will displace approximately 10% of the facility requirement or 208 facilities. The revised breakdown would then be as follows.

**Table 5-14 Study Case C - PADD I E-85 Infrastructure Requirements (Revised)**

| | |
|---|---|
| Initial fueling facility requirement | 2083 |
| Less Mobile Fueling (facility equivalent) | 208 |
| Revised fueling facility requirements | 1875 |
| Less existing facilities from Study Case B1 | 852 |
| Subtotal - remaining fueling facilities needed | 1023 |
| Retrofits at existing facilities | 102 |
| New installations at existing facilities | 921 |

Based on Table 5-14, the infrastructure costs for retail E-85 facilities are estimated in Table 5-15 and would total $59,652,000.

**Table 5-15 Study Case B1 - PADD I E-85 Infrastructure Cost Estimate**

| | | | | |
|---|---|---|---|---|
| 102 retrofits | @ | $25,000 per | = | $2,550,000 |
| 921 new facilities | @ | $62,000 per | = | $57,102,000 |
| Total | | | | $59,652,000 |

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However, when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are discussed in Appendix E.

In Study Case B1, we used 1,000,000 gallons per year as an average station volume based on the premise that ethanol blend sales would be directed at the higher volume retail outlets typically found in metropolitan areas. Although the ethanol production volumes in Study Case C will take at least 5 to 10 years to reach, we are not increasing the per unit volume above the 1,000,000 gallons average for Study Case B. This is based on the fact that volumes were already increased significantly above the 743,523 gallon station average for Study Case B1 and also because the expanded market will result in inclusion of lower volume outlets. The total number of retail units required to convert to ethanol blends to achieve 24 bgy of E-10 sales for PADD I is 24,000 units. However, there were enough units converted in Study Case B1, which when combined with existing facilities totaled 12,000 units. So for Study Case C, a total of 12,000 more facilities will need to be converted bringing the total to 24,000 units representing 39% of the 61,581 total station population. These figures are recapped in the following table.

**Table 5-16 Study Case C - PADD I Station Retail Conversion Requirements (bgy)**

| | Blend sales | Ethanol required |
|---|---|---|
| Targeted ethanol volume | 24.0 | 2.40 |
| Number of facilities required for blend sales<br>@ average volume 1.0 mmgy per unit<br>(39.0% of station population) | | 24,000 |
| Less existing & Study Case B1 conversions | | 12,000 |
| Number of new conversions for Study Case C | | 12,000 |

Using the cost estimates, from Appendix E of $590 per facility, retail conversion costs for the additional retail conversions in PADD I, for Study Case C, equate to $7,080,000 as shown in the following table.

**Table 5-17 Study Case C - PADD I Retail Unit Conversion Cost Estimate**

| | |
|---|---|
| Number of facilities converted | 12,000 |
| Estimated cost per facility | $590 |
| Total cost | $7,080,000 |

Table 5-18 recaps all of the estimated terminal and retail expenses associated with distributing 2.7 bgy of ethanol in PADD I based on 2.4 bgy being sold in E-10 blends and 0.3 bgy sold in E-85 blends. Capital investments at the terminal level are estimated to be $48,200,000 while the capital cost for the retail infrastructure for E-85 is $59,652,000. One time costs for converting retail units to E-10 blends are estimated to be $7,080,000 bringing the total for all categories to $114,932,000.

**Table 5-18 Study Case C - PADD I Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| Terminaling Costs | |
| Cost for additional new tankage | $15,115,000 |
| Cost for conversion of existing tankage | $180,000 |
| Cost for blending systems | $30,300,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $710,000 |
| Contingency-Piping/site work etc. | $1,880,000 |
| Total capital expenditure at terminal level for E-10 blending | $48,185,000 |
| E-10 conversion costs (one-time cost at retail level) | $7,080,000 |
| E-85 infrastructure (capital expenditure at the retail level) | $59,652,000 |
| Total Costs | $114,917,000 |

Table 5-19 calculates costs on an amortized dollars per gallon of new ethanol volume basis for Case C, using a 20 year equipment life cycle. (See Appendix E for discussion of amortization). The total amortized cost for E-10 and E-85 combined is $0.0128 per gallon. However if E-10 cost is split out from E-85, the amortized cost for E-10 equates to only $0.0072 per gallon of ethanol. This compares to $0.0465 per gallon for the ethanol used in E-85, reflecting the higher cost of the retail infrastructure for this fuel.

**Table 5-19 Study Case C - PADD I Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 1.2 bgy | $55,280,000 | $0.0072 |
| Total cost for E-85 infrastructure | 0.2 bgy | $59,652,000 | $0.0465 |
| Total all | 1.4 bgy | $114,932,000 | $0.0128 |

The costs are amortized over the gallons of ethanol that represent new sales volume compared to the volume levels of Study Case B1. Also, although 0.2 bgy of new ethanol volume terminaled is actually for use in E-85, all terminal equipment charges are assigned to the E-10 category. New ethanol volume use in E-85 equates to 14.29% of total PADD I ethanol volume in Study Case C.

Note that there are additional expenses associated with tankage to stage product for shipment to coastal areas. These expenses are discussed as part of transportation expenses and are covered in the Transportation Analysis section. Likewise, tanks in coastal areas used solely for storing and staging product to be sent to other areas are discussed in the Transportation Analysis section.

**Study Case C - PADD II:** In Study Case C annual ethanol use in PADD II increases from the 2.2 bgy in Study Case B1 to 3.7 bgy. All ethanol used in PADD II is produced in PADD II. Since current gasoline sales in PADD II are in the range of 37 billion gallons this indicates the need for near 100% market penetration. Consequently, we are assuming that nearly all terminals not handling ethanol in Study Case B1 will now need to do so. Additionally, a few terminals already in ethanol service will need to add additional tanks.

Analysis in Study Case B1 indicated there were 311 servicing terminals. However in Case C there are 401 servicing terminals as ethanol distribution expands into more remote, rural areas. Of the 401 terminals, 68 have water receipt capability and 38 have rail capability. While 80 terminals list ethanol storage as available, the number is known to be much higher due to near exclusive ethanol blend use in Chicago, Milwaukee, and the entire state of Minnesota. Of the terminals disclosing size, 14 are listed as being under 100m bbl of storage while 161 are in the 100m to 250m bbl storage range. A total of 127 terminals indicate a storage capacity in excess of 250m bbl.

Initial tankage requirements are based solely on information in the *"Petroleum Terminal Encyclopedia"* and would indicate a need for the following:

**Table 5-20 Study Case C - PADD II Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 25 | 2 |
| 36 | 3 |
| 42 | 5 |
| 22 | 10 |
| 9 | 20 |
| 5 | 25 |
| 1 | 50 |

As mentioned in Study Case B1, the close proximity of many terminals to ethanol production facilities enables them to operate on much lower inventory levels. This has been considered when selecting tank size. Also, some terminals in the Midwest do have idle tankage and with ethanol displacing 10% of gasoline sales on a near marketwide basis a few additional tanks would likely become available. Based on these factors, we have revised tankage requirements in the following table.

**Table 5-21 Study Case C - PADD II Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 2 | 25 | 5 | 2 | 3 | 15 |
| 3 | 36 | 6 | 2 | 3 | 25 |
| 5 | 42 | 10 | 5 | 7 | 20 |
| 10 | 22 | - | 2 | 5 | 15 |
| 20 | 9 | - | 1 | 1 | 7 |
| 25 | 5 | - | - | - | 5 |
| 50 | 1 | - | - | - | 1 |
| Total | 140 | 21 | 12 | 19 | 88 |

Based on the above estimates, PADD II would require modifications to 19 tanks ranging in size from 2m bbl to 20m bbl and the installation of 88 tanks ranging in size from 2m bbl to 50m bbl.

A discussion of cost estimates for building new tanks, converting existing tanks, and blending system equipment is included in Appendix E. Estimates for new tank costs are projected in the following table.

**Table 5-22 Study Case C - PADD II Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 15 | 2 | $20 per steel barrel = | $600,000 |
| 25 | 3 | $20 per steel barrel = | $1,500,000 |
| 20 | 5 | $15 per steel barrel = | $1,500,000 |
| 15 | 10 | $15 per steel barrel = | $2,250,000 |
| 7 | 20 | $15 per steel barrel = | $2,100,000 |
| 5 | 25 | $12 per steel barrel = | $1,500,000 |
| 1 | 50 | $10 per steel barrel = | $500,000 |
| 88 | Total | | $9,950,000 |

Estimates for converting existing tankage are included in the following table.

**Table 5-23 Study Case C - PADD II Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 3 | 2 | $24,000 |
| 3 | 3 | $36,000 |
| 7 | 5 | $105,000 |
| 5 | 10 | $150,000 |
| 1 | 20 | $60,000 |
| 19 | Total | $375,000 |

As in Study Case B1, we assume that all terminals not already in ethanol service would need to install a blending system. Here it is assumed that there are two blending systems per terminal. The total of terminals requiring new blending systems in PADD II for Study Case C is 119 units. The projections in Appendix E are used to estimate blending system costs in the following table.

| **Table 5-24 Study Case C - PADD II Cost Estimate for Blending Systems** | |
|---|---|
| Number of terminals requiring blending systems | 119 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $35,700,000 |

In the case of PADD II all ethanol is supplied from within the PADD, mostly by truck, except in areas farther from the production facilities. Barge terminaling capability is already sufficient. For Study Case C we assume that 25% of intra-PADD movements are by rail car and ~ 15% by river barge. This estimate is for determining terminal requirements only. A more detailed estimate of the transportation requirement is covered in the transportation analysis. Estimated demand for total rail and barge shipments are covered in the following table.

**Table 5-25 Study Case C - PADD II Transportation Modes Estimate (within PADD)**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of river barges | Monthly # of river barges |
|---|---|---|---|---|
| 0.925 bgy (22.0 mmbbl) | 30,833 | 2569 | | |
| 0.555 bgy (13.2 mmbbl) | | | 1321 | 110 |

In Study Case B1, existing rail facilities plus new installations brought terminals with rail capability to 37. Of the terminals added in outlying areas, 14 already have rail capability bringing the total to 51. However with the increased volume and number of servicing terminals in Study Case C, we believe it will still be necessary to add rail capability at 10 more terminals. These costs are estimated in the following table.

| Table 5-26 Study Case C - PADD II Estimated Cost of Rail Spur Installation | | |
|---|---|---|
| No. of terminals requiring rail | Average cost per terminal | Total Cost |
| 10 | $355,000 | $3,550,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for terminals requiring conversion of tanks or new tanks. This is recapped in the following table.

| Table 5-27 Study Case C - PADD II Miscellaneous Contingency Cost | | |
|---|---|---|
| No. of terminals | Average cost per terminal | Total Cost |
| 107 | $20,000 | $2,140,000 |

In Study Case C you will note that total costs for additional tankage are more than double those of Study Case B1. This is in large part due to the fact that a great many existing terminals could be used to achieve targeted volume for Study Case B1 due to currently existing blending programs. However, the volumes necessitated for Study Case C dictate expansion of blending programs into nearly all remaining terminals, most of which are not currently blending ethanol. This results in greater expense, not only for tanks, but also for tank conversions, blending systems, and miscellaneous contingency costs.

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Included in the market volume for PADD II are annual sales of 0.4 bgy of ethanol for use in E-85 blending, a 0.2 bgy per year increase over Study Case B1. For purposes of our calculations and for the reasons discussed in Study Case B1, we have assumed an annual average of 80v% ethanol in E-85. There are no terminal requirements for E-85 since it would presumably be blended and distributed from a terminal that is already blending E-10.

If 0.4 bgy of ethanol per year are used in E-85 in PADD II, this would equate to 0.5 bgy annually of E-85. Assuming vehicles travel 12,000 miles per year and average 20 mpg, the average vehicle would purchase 600 gallons per year (50 gallons per month). Based on these averages it would take 833,000 vehicles to support these E-85 volume projections. However, before estimating infrastructure costs, it is important to recognize that these vehicles may not operate exclusively on E-85. In PADD I we assumed annual E-85 sales of 180,000 gallons per unit for Study Case C, raising the average from the 132,000 gallons annually in Study Case B1. Here we are reluctant to take an approach this optimistic. In PADD I there are more areas of greater population density. There are also more fleets in PADD I that could frequent E-85 facilities and there would be a greater number of vehicles around properly positioned E-85 units, allowing for higher volumes. Conversely, exclusive of areas such as Chicago, Detroit, Minneapolis/St. Paul, and St. Louis it would be difficult to envision per unit sales in PADD II approaching those in PADD I. In Study Case B1, we assumed PADD II E-85 facilities could average 132,000 gallons annually. For Study Case C we are assuming annual per unit volumes of 150,000 gallons (12,500 gallons monthly) for E-85 facilities. This is based on the premise that these units will serve both fleet consumers that operate on E-85 a majority of the time as well as some regular customers likely operating on E-85 approximately 50% of the time. This would raise the number of vehicles required to support the volume from the 833,000 vehicles cited above to something in excess of 1,500,000 vehicles. However, since Study Case C is likely to not occur before 10 years, this is not an unreasonable vehicle requirement estimate given current production volumes of these vehicles.

An average facility with one duel nozzle dispenser could easily dispense 5 fills per hour at 10 gallons per fill for 10 hours per day. This equates to 500 gallons daily. However due to lower anticipated sales on weekends, when many fleets are idle, we are lowering that figure to ~ 410 gallons per day equating to 12,500 gallons monthly and 150,000 gallons annually. Initial projections for retail infrastructure would then be a total of 3333 units as indicated in the following table.

**Table 5-28 Study Case C - PADD II E-85 Infrastructure Requirements (Initial)**

| | |
|---|---|
| Total targeted sales | 0.5 bgy |
| Total annual sales per facility | 150,000 gallons |
| Total number of facilities required | 3333 |
| (serving approximately 1.5 million vehicles in PADD II) | 10 gallons per fueling event= 1250 fueling events per unit month or 41 per unit day |

Whether at retail or commercial fleet fueling facilities, the dispensing of E-85 requires a dedicated tank and certain special equipment (1,2). In some cases E-85 could displace a low sales volume grade such as diesel or heating oil. However, this would still require retrofitting the tank. Depending on the type of tank, retrofitting could cost $19,000 to $30,000 based on estimates for M-85 which has near identical requirements (3). It is unlikely that many facility operators would chose to displace a grade providing a known revenue stream for a product that would provide low volume sales in its initial years. We are therefore assuming that only 10% of E-85 fueling facilities will be retrofits at an average cost of $25,000 each.

If the decision is made to install new tankage, it may be possible to install above ground tanks in a few cases, but in most cases underground tanks will be required. Estimated cost for a new underground tank system is $62,407 (3) and some estimates are higher. (4) Here we use a cost of $62,000 per unit.

As described in Study Case B1, yet another system for E-85 fueling is “Mobile Fueling”.(5) Here we assume that mobile fueling will displace approximately 10% of the retail facilities requirement for Study Case B1 only (190 facilities) with no further increase for Study Case C. Our reasoning here is that this fleet fueling level is already equivalent to 28,500,000 gallons annually and to anticipate higher volumes for this mode of distribution may be overly optimistic. The aforementioned revised breakdown would then be as follows.

**Table 5-29 Study Case C - PADD II E-85 Infrastructure Requirements (Revised)**

| | |
|---|---|
| Initial fueling facility requirement | 3333 |
| Less Mobile Fueling (facility equivalent) | 190 |
| Revised fueling facility requirements | 3143 |
| Less existing facilities from Study Case B1 | 1704 |
| Subtotal - remaining fuel facilities needed | 1439 |
| Retrofits at existing facilities | 143 |
| New installations at existing facilities | 1296 |

Cost estimates for E-85 infrastructure in PADD II for Case C are then estimated in the following table.

**Table 5-30 Study Case C - PADD II E-85 Infrastructure Cost Estimate**

| | | | | |
|---|---|---|---|---|
| 143 retrofits | @ | $25,000 per | = | $3,575,000 |
| 1296 new facilities | @ | $62,000 per | = | $80,352,000 |
| Total | | | | $83,927,000 |

### E-10 Information

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

In order to achieve the Study Case C targeted ethanol volume sales number of 3.3 bgy for use in E-10 blends, most stations in PADD II will need to be converted to dispense gasoline ethanol blends (since gasoline sales were 37.7 bgy in 1998). The retail outlet count in PADD II is 52,652, for a current average of 717,477 gallons per year. In Study Case B1 we raised the per unit volume estimate to 850,000 gallons annually because sales were directed primarily into metropolitan areas where station volumes are higher. However, for Study Case C it becomes necessary to expand sales into smaller towns and rural areas where station volumes are lower. Partially offsetting this is the likely increase in volume at retail stations from increased demand. Based on this we are estimating that average station volume will increase to 750,000 gallons by the time Study Case C ethanol production volumes can be achieved, This results in the estimates in the following table.

**Table 5-31 Study Case C - PADD II Station Retail Conversion Requirements (bgy)**

| | Blend Sales | Ethanol Required |
|---|---|---|
| Targeted volume | 33.0 | 3.3 |
| Number of facilities required | | 44,000 |
| (@ 750 mgy - 83.5% of station population) | | |
| Less existing facilities and Study Case B1 conversions | | 23,529 |
| Number of new retail conversions for Study Case C | | 20,471 |

The 33 bgy of E-10 volume would require 44,000 total retail facilities (over 83% of the station population). Conversions already accomplished in Study Case B1, plus estimated existing facilities handling ethanol blends equate to 23,529 units, leaving 20,471 more retail locations to be converted for Study Case C. Based on the cost information in Appendix E, estimated retail conversion costs would be $12,077,890 as covered in the following table:

**Table 5-32 Study Case C - PADD II Retail Unit Conversion Cost Estimate**

| | |
|---|---|
| Number of facilities converted | 20,471 |
| Estimated cost per facility | $590 |
| Total cost | $12,077,890 |

Table 5-33 recaps all of the estimated terminal and retail expenses associated with distributing 3.7 bgy of ethanol in PADD II based on 3.3 bgy being sold in E-10 blends and 0.4 bgy sold in E-85 blends. Capital investments at the terminal level are estimated to be $51,715,000 while the capital cost for the retail structure for E-85 is $83,927,000. One time costs for converting retail units to E-10 blends are estimated to be $12,077,890 bringing the combined total to $147,719,890.

**Table 5-33 Study Case C - PADD II Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| Terminaling Costs | |
| Cost for new additional tankage | $9,950,000 |
| Cost for conversion of existing tankage | $375,000 |
| Cost for blending system | $35,700,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $3,550,000 |
| Contingency-Piping/site work etc. | $2,140,000 |
| Total capital expenditure at terminal level | $51,715,000 |
| E-10 conversion costs (one time cost at retail) | $12,077,890 |
| E-85 infrastructure (capital expenditure at the retail level) | $83,927,000 |
| PADD II Total Costs | $147,719,890 |

Table 5-34 calculates the cost on an amortized dollars per gallon of new ethanol volume basis using a 20 year equipment life cycle. (See Appendix E for discussion of amortization). The total amortized cost for the additional 1.5 bgy of ethanol volume in Study Case C for PADD II is $0.0154. However, the E-85 portion of this is $0.0655 per gallon reflecting the high cost of the retail infrastructure needed for E-85. If the E-10 portion is calculated separately, the amortized cost for E-10 is only $0.0077 per gallon.

**Table 5-34 Study Case C -PADD II Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | 1.3 bgy increase | $63,792,890 | $0.0077 |
| Total cost for E-85 infrastructure | 0.2 bgy increase | $83,927,000 | $0.0655 |
| Total all | (1.5 bgy increase) | $147,719,890 | $0.0154 |

Also note that although 0.2 bgy of the ethanol terminaled is actually for use in E-85, all terminal equipment charges are assigned to the E-10 category. New ethanol volume for use in E-85 is 13.33% of total new PADD II ethanol volume for Study Case C.

**Study Case C - PADD III:** In Study Case C, ethanol volume use in PADD III increases from the 0.7 bgy used in Study Case B1 to a total of 1.8 bgy. This necessitates higher E-10 volume in cities/MSAs used in Study Case B1 which in turn increases the number of terminals required to handle ethanol. It is also necessary to expand into outlying rural areas and smaller towns in order to achieve the targeted volume. This also expands the number of terminals involved.

In Study Case B1 there were 158 terminals in the servicing areas for designated markets. The designated market area for Study Case C encompasses 191 terminals. Of these, 49 are indicated to have water access capability while 21 have rail capability. Only 12 terminals indicate availability of ethanol storage. Of those terminals disclosing storage capabilities, 18 have storage of under 100m bbl, 78 have a storage capacity of 100m bbl to 250m bbl , and 44 are over 250m bbl of storage capacity.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 5-35 Study Case C- PADD III Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size mbbl |
|---|---|
| 8 | 2 |
| 14 | 3 |
| 38 | 5 |
| 30 | 10 |
| 6 | 25 |

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification and storage that could be used with modification (e.g., piping reconfiguration, floating internal cover, etc.). The balance is assumed to require installation of new tanks. These revisions are covered in the following table.

| Table 5-36 Study Case C - PADD III Revised Tank Requirement Estimate | | | | | |
|---|---|---|---|---|---|
| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
| 2 | 8 | 1 | 1 | 1 | 5 |
| 3 | 14 | 2 | 1 | 1 | 10 |
| 5 | 38 | 2 | 4 | 2 | 30 |
| 10 | 30 | - | 2 | 3 | 25 |
| 25 | 6 | - | - | - | 6 |
| Total | 96 | 5 | 8 | 7 | 76 |

Based on the above estimates for Study Case C, PADD III would require modifications to 7 tanks ranging in size from 2m to 10m bbl and the installation of 76 tanks ranging in size from 2m to 25m bbl. In addition only 5 of the terminals were estimated to already have ethanol, so a total of 91 terminals would require installation of blending units and attendant piping modifications.

A discussion of cost estimates for building new tanks, converting existing tanks, and terminal blending systems is included in Appendix E. Estimates for new tank costs are included in the following Table.

| Table 5-37 Study Case C - PADD III Cost Estimate for New Tanks | | | |
|---|---|---|---|
| Total # of Tanks | Tank Size | Cost per barrel | Total Cost |
| 5 | 2 @ | $20 per steel barrel = | $200,000 |
| 10 | 3 @ | $20 per steel barrel = | $600,000 |
| 30 | 5 @ | $15 per steel barrel = | $2,250,000 |
| 25 | 10 @ | $15 per steel barrel = | $3,750,000 |
| 6 | 25 @ | $12 per steel barrel = | $1,800,000 |
| 76 | Total | | $8,600,000 |

Estimates for converting existing tankage are included in the following Table.

**Table 5-38 Study Case C - PADD III Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 1 | 2 | $8,000 |
| 1 | 3 | $12,000 |
| 2 | 5 | $15,000 |
| 3 | 10 | $90,000 |
| 7 | Total | $125,000 |

We assume that all terminals not estimated to currently have ethanol will require new blending systems. Estimates for terminal blending system costs, as discussed in Appendix E, are listed in the following table.

**Table 5-39 Study Case C - PADD III Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 91 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $27,300,000 |

In Study Case C, 0.7 bgy of the 1.8 bgy of the ethanol volume used in PADD III will be imported from PADD II. A number of terminals (at least 49) in PADD III are water accessible and 21 have rail capability. We would therefore expect a large portion of ethanol to be barged to terminals and then transferred to other terminals via truck. However, we would expect at least a few additional terminals to install rail facilities given the expected 50/50 transportation split estimate which is covered in the next table. Note that this initial estimate is for determining needs at the terminal level. A more detailed analysis of transportation modes is included in the Transportation Analysis section.

**Table 5-40 Study Case C - PADD III Transportation Modes Estimate**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of river barges | Monthly # of river barges |
|---|---|---|---|---|
| 0.350 bgy (8.3mmbbl) | 11,666 | 972 | | |
| 0.350 bgy (8.3mmbbl) | | | 833 | 69 |

With only 21 terminals offering rail capability (4 more from new servicing terminals) and 10 terminals added for Study Case B1, an estimated additional 10 terminals would need to add rail capabilities with costs as estimated in the following table.

**Table 5-41 Study Case B1 - PADD III Estimated Cost of Rail Spur Installation**

| No. of terminals rail | Average cost per terminal | Total Cost |
|---|---|---|
| 10 | $355,000 | $3,550,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for all terminals requiring tank conversions or new tanks. These costs are estimated in the following table

**Table 5-42 Study Case C - PADD III Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 83 | $20,000 | $1,660,000 |

### Retail Costs

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

### E-85 Infrastructure

We have not estimated any use of E-85 for Case C - PADD III.

### E-10 Information

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD III in 1998 was 19,035,571,897 gallons (1,241 mbcd). The retail outlet count in PADD III is 35,656 (6). This indicates a per unit average annual volume of 533,867 gallons (34.8 bcd).

In Study Case B1 we directed ethanol blend sales into major metropolitan areas and raised the per unit sales to an average volume of 700,000 gallons per unit year. However in Study Case C, the targeted volumes dictate expansion into smaller towns and outlying rural areas. While per unit volume will increase in the time frame that Study Case C would require to reach targeted volumes, we believe it prudent to lower the average per unit volume estimate to 600,000 gallons.

Targeted ethanol volume for use in E-10 blends for PADD III is 1.8 bgy resulting in 18 bgy of E-10 blend. At an average of 600,000 gallons per unit year, a total of 30,000 (84.2% of the station population) conversions would be necessary. However, 10,000 units were operational for Study Case B1, leaving the number of required new conversions totaling 20,000. This is covered in the following table.

**Table 5-43 Study Case C - PADD III Station Retail Conversion Requirements (bgy)**

| | Blend Sales | Ethanol Required |
|---|---|---|
| Targeted ethanol volume | 18 | 1.8 |
| Number of facilities required @ average volume of 600 mgy per unit(84.1% of station population) | | 30,000 |
| Less existing & Study Case B1 conversions | | 10,000 |
| Number of new conversions | | 20,000 |

Using the cost estimates from Appendix E, conversion costs of $590 per facility are calculated in the following table.

**Table 5-44 Study Case C - PADD III Retail Unit Conversion Cost Estimate**

| | |
|---|---|
| Number of facilities converted | 20,000 |
| Estimated cost per facility | $590 |
| Total cost | $11,800,000 |

Table 5-44 recaps all of the estimated expenses associated with distributing 1.8 bgy of ethanol in PADD III based on all product being sold in E-10 blends. Capital investments at the terminal level are estimated to be $40,545,000. One time costs for converting retail units to E-10 blends are estimated to be $11,800,000 bringing the total to $52,345,000.

**Table 5-45 Study Case C- PADD III Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| Terminaling Costs | |
| Cost for new additional tankage | $8,600,000 |
| Cost for conversion of existing tankage | $125,000 |
| Cost for blending system | $27,300,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $3,550,000 |
| Contingency-Piping/site work etc. | $1,660,000 |
| Total capital expenditure at terminal level | $41,235,000 |
| E-10 conversion costs (one time cost at retail level) | $11,800,000 |
| E-85 infrastructure | $--- |
| PADD III Total costs | $53,035,000 |

Table 5-46 calculates the cost on an amortized dollars per gallon of new ethanol volume basis using a 20 year equipment life cycle. (See Appendix E for discussion of amortization). The total amortized cost for the additional 1.1 bgy of ethanol volume in Study Case C, for PADD III, is $0.0074.

**Table 5-46 Study Case C - PADD III Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversions | (1.1 bgy increase) | $53,035,000 | $0.0075 |

**Study Case C- PADD IV:** In Study Case C, the amount of ethanol used in PADD IV is increased from the 0.1 bgy in Study Case B1 to 0.4 bgy, all of which is now produced within PADD IV. This, of course, necessitates much higher levels of blend sales in the larger cities used in Study Case B1, as well as the addition of cities in the 100,00 to 250,000 population size range and some small towns /rural areas.

In Study Case B1 there were 19 terminals servicing the designated markets. Due to the above referenced expansion into outlying areas, there are now 40 operating terminals servicing the designated markets. Of these, one is indicated to have water access. Six have rail capability and 4 are listed as having ethanol. Of those disclosing storage capacity, 5 are indicated to have less than 100m bbl of storage, 12 are indicated to have 150m bbl to 250m bbl of storage capacity, and 11 are listed as having over 250m bbl of storage capacity.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 5-47 Study Case C - PADD IV Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 4 | 2 |
| 4 | 3 |
| 12 | 5 |
| 8 | 10 |

In Study Case C, all ethanol used in PADD IV is produced within the PADD, i.e. no imports from PADD II as in Study Case B1. Still, due to increased volumes we have used larger tanks in many cases.

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification, and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.). The balance is assumed to require installation of new tanks. These revisions are covered in the following table.

**Table 5-48 Study Case C - PADD IV Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 2 | 4 | 1 | - | 1 | 2 |
| 3 | 4 | 1 | - | 1 | 2 |
| 5 | 12 | - | 4 | 2 | 6 |
| 10 | 8 | - | 2 | 2 | 4 |
| Total | 28 | 2 | 6 | 6 | 14 |

Based on the above estimates, PADD IV would require modifications to 6 tanks ranging in size from 2m to 10m bbl and the installation of 14 tanks in the same size range. In addition 26 of the terminals would require installation of blending units and attendant piping modifications.

A discussion of cost estimates for building new tanks and converting existing tanks, and terminal equipment, is included in Appendix E. Estimates for new tank costs are included in the following Table.

**Table 5-49 Study Case C - PADD IV Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 2 | 2 @ | $20 per steel barrel = | $80,000 |
| 2 | 3 @ | $20 per steel barrel = | $120,000 |
| 6 | 5 @ | $15 per steel barrel = | $450,000 |
| 4 | 10 @ | $15 per steel barrel = | $600,000 |
| Total | | | $1,250,000 |

Estimates for converting existing tankage (based on Appendix E) are included in the following Table.

**Table 5-50 Study Case C - PADD IV Cost Estimate for Converting Existing Tanks**

| Total # of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 1 | 2 | $8,000 |
| 1 | 3 | $12,000 |
| 2 | 5 | $30,000 |
| 2 | 10 | $60,000 |
| 6 | Total | $110,000 |

We assume that all terminals not already estimated to handle ethanol will require new blending systems. Estimates for terminal blending system costs (as described in Appendix E) are included in the following table.

**Table 5-51 Study Case C - PADD IV Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 26 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $7,800,000 |

Unlike Study Case B1, all ethanol used in PADD IV for Study Case C is produced within the PADD. However, given the reasonably vast geography of PADD IV, some of this ethanol will still move by rail. Study Case B1 rail capability included 4 terminals and 3 more were added bringing the total to 7 for Case B1. Since all ethanol used in PADD IV for Study Case C is produced within the PADD, we have not made a transportation mode estimate since movements within the PADD are covered in the transportation analysis section. The addition of more servicing terminals increases the number of rail capable terminals by two bringing the total to 9. However, we are estimating that two more rail spurs would be required to handle intra-PADD product movement for Case C which would bring the total number of rail capable terminals to 11.

Cost estimates to install rail capabilities as described in Appendix E are estimated in the following table.

**Table 5-52 Study Case C - PADD IV Estimated Cost of Rail Spur Installation**

| No. of terminals rail | Average cost per terminal | Total Cost |
|---|---|---|
| 2 | $355,000 | $710,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal for terminals converting tanks to ethanol use or installing new tanks.

**Table 5-53 Study Case C - PADD IV Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 20 | $20,000 | $400,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

Given the low population density and small number of fleets operating in PADD IV, we have not included any estimates for E-85 distribution.

**E-10 Information**

Once blended at the terminal, E-10 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD IV in 1998 was 4,415,963,142 (288 mbcd). The retail outlet count in PADD IV is 6,118 (6) yielding an average per unit volume of 721,798 gpy (47 bcd). We used 800,000 gallons per year as an average annual per unit volume in Study Case B1 because we could direct product into higher volume metropolitan areas. Study Case C requires directing product to lower volume/rural areas. Consequently, we are not increasing the number here even though some level of increase in annual unit volume is likely. At 4 bgy E-10 sales and an average volume of 800,000 gallons per unit, it would be necessary to convert a total of 5000 units. Since 1250 facilities were operational in Study Case B1, this leaves 3750 retail outlets to be converted in Study Case C. This is covered in the following table.

**Table 4-54 Study Case C - PADD IV Station Retail Conversion Requirements (bgy)**

| | Blend Sales | Ethanol Required |
|---|---|---|
| Targeted volume | 4 | 0.4 |
| Number of facilities required @ 800 mgy (81.70% of station population) | | 5000 |
| Less existing and Study Case B1 conversions | | 1250 |
| Number of new conversions for Study Case C | | 3750 |

Based on the cost information in Appendix E, estimated retail conversion costs would be $2,212,500 as covered in the following table.

| Table 5-55 Study Case C - PADD IV Retail Unit Conversion Cost Estimate | |
|---|---|
| Number of facilities converted | 3750 |
| Estimated cost per facility | $590 |
| Total cost | $2,212,500 |

Table 5-54 recaps all of the estimated expenses associated with distributing 0.4 bgy of ethanol in PADD IV based on all ethanol being sold in E-10 blends. Capital investments at the terminal level are estimated to be $10,270,000. One time costs for converting retail units to E-10 blends are estimated to be $2,212,500 bringing the total to $12,482,5000.

| Table 5-56 Study Case C - PADD IV Cost for All Ethanol Infrastructure and Conversions | |
|---|---|
| Terminaling Costs | |
| Cost for new additional tankage | $1,250,000 |
| Cost for conversion of existing tankage | $110,000 |
| Cost for blending system | $7,800,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $710,000 |
| Contingency-Piping/site work etc. | $400,000 |
| Total capital expenditure at terminal level | $10,270,000 |
| E-10 conversion costs (one time cost at retail level) | $2,212,500 |
| E-85 infrastructure | $--- |
| PADD IV Total costs | $12,482,500 |

Table 5-57 calculates the cost on an amortized dollars per gallon of new ethanol volume basis using a 20 year equipment life cycle. (See Appendix E for discussion of amortization). The total amortized cost for PADD IV in Study Case C is $0.0065 per gallon of ethanol.

**Table 5-57 Study Case C - PADD IV Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10 investments/conversion | (0.3 bgy increase) | $12,482,500 | $0.0065 |

**Study Case C- PADD V:** In Study Case C the amount of ethanol used in PADD V increases from the Study Case B1 volume of 0.8 bgy to 1.4 bgy. In Study Case B1 0.6 bgy of ethanol was imported from PADD II whereas in Study Case C the amount imported from PADD II increases to 0.9 bgy.

The higher targeted volumes necessitate increasing market share in some areas from Study Case B1 volumes, as well as expansion into smaller cities and towns and some outlying rural areas. Consequently, the number of servicing terminals increases from the 95 used in Study Case B1 to 143 terminals for Study Case C. Of these, at least 53 have water capability and 23 have rail capability. There are 15 terminals that indicate they currently offer ethanol storage. Of those terminals disclosing storage capacity, 27 have less than 100m bbl storage, while 37 have 100m to 250m bbl storage. A total of 56 have storage capacity in excess of 250m bbl.

In analyzing PADD V a few important assumptions need to be noted. First, all federal RFG oxygen requirement areas in California will have already converted to ethanol well in advance of any time where Case B1 and Case C volume production projections would be realized. Tanks and terminal equipment are currently being installed and/or converted and all terminals in those areas will have ethanol. The expenses incurred for these conversions will already have taken place and are not included in the cost figures for this analysis (Study Case B1 or Study Case C). Secondly, it is assumed that ethanol in California is blended at the 5.7v% level due to the NOx penalty of higher oxygen levels included in the CARB Predictive Model. In Study Case B1, larger tank sizes were used due to the need to maintain higher inventory levels in the event of any shipping or rail delays. In Study Case C ethanol imports increase by 0.3 bgy but there is also in-state supply and many more terminals handling ethanol. This allows some terminals to operate on smaller inventories due to a greater number of supply options. This allows many of the terminals added for Case C to utilize smaller tanks for ethanol storage.

Initial tankage requirements based solely on information in the *Petroleum Terminal Encyclopedia* would indicate a need for the following:

**Table 5-58  Study Case C - PADD V Preliminary Tank Requirement Estimate**

| Number of Tanks | Tank Size (mbbl) |
|---|---|
| 4 | 3 |
| 17 | 5 |
| 15 | 10 |
| 4 | 20 |
| 4 | 25 |

Using the above listing of tankage requirements, estimates were made to reflect ethanol storage already in use but not listed in the *Petroleum Terminal Encyclopedia*, storage which could be used without modification, and storage that could be used with modification (e.g. piping reconfiguration, floating internal cover, etc.).  The balance is assumed to require installation of new tanks.  These revised estimates are covered in the following table.

**Table 5-59  Study Case C - PADD V  Revised Tank Requirement Estimate**

| Tank Size (mbbl) | Total # of Tanks Required | Estimated Already In Use | Estimated Use Without Conversion | Estimated Use With Conversion | New Tanks Required |
|---|---|---|---|---|---|
| 3 | 4 | 1 | - | - | 3 |
| 5 | 17 | 1 | 2 | 4 | 10 |
| 10 | 15 | - | 2 | 1 | 12 |
| 20 | 4 | - | - | - | 4 |
| 25 | 4 | - | - | - | 4 |
| Total | 44 | 2 | 4 | 5 | 33 |

Based on the above estimates, PADD V would require modifications to 5 tanks (4 - 5 m bbl and 1 - 10 m bbl) and installation of 33 tanks ranging in size from 3m bbl to 25m bbl. Installation of an estimated 42 blending systems would also be required.

A discussion of cost estimates for building new tanks and converting existing tanks and terminal equipment is included in Appendix E. Estimates for new tank costs are included in the following table.

**Table 5-60 Study Case C - PADD V Cost Estimate for New Tanks**

| Total # of Tanks | Tank Size (mbbl) | Cost per barrel | Total Cost |
|---|---|---|---|
| 3 | 3 @ | $20 per steel barrel = | $180,000 |
| 10 | 5 @ | $15 per steel barrel = | $750,000 |
| 12 | 10 @ | $15 per steel barrel = | $1,800,000 |
| 4 | 20 @ | $15 per steel barrel = | $1,200,000 |
| 4 | 25 @ | $12 per steel barrel = | $1,200,000 |
| 33 | Total | | $5,130,000 |

Estimates for converting existing tankage are included in the following table.

**Table 5-61 Study Case C - PADD V Cost Estimate for Converting Existing Tanks**

| Total # Of Conversions | Tank Size (mbbl) | Total Cost |
|---|---|---|
| 4 | 5 | $60,000 |
| 1 | 10 | $30,000 |
| 5 | Total | $90,000 |

We assume that all terminals not estimated to already have ethanol available will require new blending systems. Estimates for terminal blending system costs, which are discussed in Appendix E, are covered in the following table.

**Table 5-62 Study Case C - PADD V Cost Estimate for Blending Systems**

| | |
|---|---|
| Number of terminals requiring blending systems | 42 |
| Estimated cost per terminal | $300,000 |
| Total estimated cost for blending systems | $12,600,000 |

PADD V will import, from PADD II, 0.9 bgy of the total 1.4 bgy used. Our estimate for transportation demand splits (for purposes of estimating terminal requirements) are included in the following table. For waterborne cargoes we assume an average of 125,000 barrel cargoes (5.25 million gallons).

**Table 5-63 Study Case C - PADD V Transportation Modes Estimate**

| Gallons (bbl) | Total # of rail car shipments | # Rail car shipments monthly | Total # of ship cargo | Monthly # of ships |
|---|---|---|---|---|
| 0.40 bgy (9.5 mmbbl) | 13,333 | 1,111 | -- | -- |
| 0.50 bgy (11.9 mmbbl) | -- | -- | 95 | 8 |

Seventeen terminals from Case B1 already have rail access and new servicing terminal areas add four more rail capable terminals. We estimate only three additional terminals would need to install rail . Other terminals would truck product from these and other transfer points, as well as from in-state plants. The cost of rail spur installations (as covered in Appendix E) is estimated in the following table.

**Table 5-64 Study Case C - PADD V Estimated Cost of Rail Spur Installation**

| No. of terminals rail | Average cost per terminal | Total Cost |
|---|---|---|
| 3 | $355,000 | $1,065,000 |

We have also included a contingency for other terminal costs such as piping changes for off-loading, site work, and miscellaneous expense of $20,000 per terminal, for each terminal requiring installation of new tanks or conversion of existing tanks, as covered in the following table.

**Table 5-65 Study Case C - PADD V Miscellaneous Contingency Cost**

| No. of terminals | Average cost per terminal | Total Cost |
|---|---|---|
| 38 | $20,000 | $760,000 |

**Retail Costs**

In addition to costs for terminaling and storage, there would be costs associated with converting stations to E-10 blends (E-5.7 blends in California) as well as significant costs in developing any E-85 infrastructure. These costs are discussed below.

**E-85 Infrastructure**

We have not estimated for any E-85 volume in PADD V. This is due to California's focus on other alternative fuels as well as the fact that many of the Flexible Fuel Vehicles (FFVs) placed in the market thus far are not certified to meet California's emissions standards.

**E-10 and E-5.7 Information**

Once blended at the terminal, E-10 or E-5.7 is handled like any other gasoline product delivered to retail. However when the station is first switched from non-ethanol blends to ethanol blends, certain costs are incurred. Items included in arriving at our estimated cost of converting retail facilities are included in Appendix E.

Gasoline demand in PADD V in 1998 was 22,120,932,954 (1,443 mbcd). The retail outlet count in PADD V is 19,145 (6). This indicates a per unit average annual volume of 1,155,442 gallons (75 bcd).

Unlike Study Case B1, we cannot direct ethanol blend sales solely into major metropolitan areas. However, per unit volumes will have increased by the time frame in which Study Case C ethanol production is achieved. Consequently, we continue to use an average sales volume of 1.2 million gallons per unit year.

For PADD V, we are taking a slightly different approach to estimating costs for retail conversion costs. First, as noted in Case B1, California will soon be converted to ethanol. Indications are that refiners in California will blend at 5.7v% due to the NOx penalties assessed at higher ethanol levels in the CARB Predictive Model. It is not possible to determine if this limitation will carry through far enough into the future to be applicable in Study Case C, but for purposes of this analysis we have assumed it will. This blend level will create a demand for 0.6 bgy of ethanol in 2003. Since these retail facilities will be converted prior to anything close to the time that Study Case C (or even Study Case B1) ethanol production volume is achieved, they are not included here. For Study Case B1 additional cities in California were estimated to use 0.145 bgy of ethanol, also at the 5.7v% level, bringing total ethanol use to 0.745 bgy. For Study Case C, we are estimating total California ethanol volume to be 0.834 bgy. The remaining 0.566 bgy used in PADD V will be used in other states at the 10v% level. For California the 0.834 bgy of ethanol would result in 14.631 bgy of E-5.7 blends. After subtracting Case B1 demand of 13.07 bgy this results in new Case C E-5.7 blend volumes of 1.561 bgy which would require 1300 additional unit conversions. For the other states in PADD V, 0.566 bgy of ethanol would be used in E-10 yielding 5.66 bgy of E-10 blend. After subtracting Case B1 volumes, new demand for E-10 blends in Case C is 4.81 bgy. This would require 4008 new E-10 conversions. This brings the total of new station conversions to 5308. These calculations are covered in the following table.

| Table 5-66 Study Case C - PADD V Station Retail Conversion Requirements - bgy | Blend Sales | Ethanol Required |
|---|---|---|
| Targeted E-5.7 volume | 14.631 | 0.834 |
| Less existing (2003)& Study Case B1 E-5.7 volume | 13.070 | 0.745 |
| Balance of new E-5.7 sales | 1.561 | 0.089 |
| Number of new E-5.7 California conversions | | 1300 |
| Targeted E-10 volume | 5.660 | 0.566 |
| Less existing & Study Case B1 E-10 volume | .850 | 0.085 |
| Balance of new E-10 volume | 4.810 | 0.481 |
| Number of new E-10 conversions | | 4008 |
| Total number of new conversions | | 5308 |

Using the estimates for applicable conversion costs (addressed in Appendix E)for the new conversions equates to $3,131,720 as recapped in the following table.

| Table 5-67 Study Case C - PADD V Retail Unit Conversion Cost Estimate | |
|---|---|
| Number of facilities converted | 5308 |
| Estimated cost per facility | $590 |
| Total cost | $3,131,720 |

Retail conversions would result in a total of approximately 16,909 facilities offering ethanol blends which equates to 88.3% of the station population.

Table 5-68 recaps all of the estimated expenses associated with distributing 1.4 bgy of ethanol in PADD V based on 0.834 bgy being sold in E-5.7 blends and 0.566 bgy being sold in E-10 blends. Capital investments at the terminal level are estimated to be $19,645,000. One time costs for converting retail units to E-5.7 and E-10 blends are estimated to be $3,131,720 bringing the total to $22,776,720.

**Table 5-68 Study Case C - PADD V Cost for All Ethanol Infrastructure and Conversions**

| | |
|---|---|
| Terminaling Costs | |
| Cost for new additional tankage | $5,130,000 |
| Cost for conversion of existing tankage | $90,000 |
| Cost for blending system | $12,600,000 |
| Cost of modification for water receipt | $0 |
| Cost of modification for rail receipt | $1,065,000 |
| Contingency-Piping/site work etc. | $760,000 |
| Total capital expenditure at terminal level | $19,645,000 |
| E-10/E-5.7 conversion costs (one time expense at retail level) | $3,131,720 |
| Total PADD V costs | $22,776,720 |

The amortized costs for PADD V on a dollars per gallon of new ethanol volume basis is $0.0059 as covered in Table 5-69.

**Table 5-69 Study Case C - PADD V Amortized Cost for Ethanol Infrastructure & Conversions**

| Item | New Ethanol Volume | Total Cost | Amortized dollars per gallon |
|---|---|---|---|
| Total cost for E-10/E-5.7 investments & conversion | (0.6 bgy increase) | $22,766,720 | $0.0059 |

Note that in the case of PADD V, there are also considerations such as tankage for staging product in New Orleans or other Gulf Coast locations as well as tankage to receive ships. These considerations and their costs are covered in the Transportation Analysis section.

## 5.5 Study Case C Summary of Expenses at the Terminal and Retail Levels

This section discusses the requirements and costs of the terminal improvements and retail conversions necessary to increase ethanol distribution volumes from the 5.1 bgy in Study Case B1 to the 10.0 bgy level for Case C, a 4.9 bgy increase.

The collective totals for all PADDs indicate there are at least 1063 terminals servicing the targeted ethanol markets, Of these, at least 297 have water access and at least 111 have rail access. While the terminal atlas lists 122 as having ethanol storage available, the number is known to be much higher. For instance, nearly all terminals in the Chicago and Milwaukee markets have ethanol, as do all Minnesota terminals. Additionally, as was the case for Study Case B1, by the time Study Case C production volumes could be achieved, most California terminals (in federal RFG markets) would have ethanol storage. These factors have all been taken into account.

Not all terminals provide information on total storage capability. Among those that do there are 76 whose storage is less than 100 mbbl, while 392 list storage capabilities of 100m to 250 mbbl. An additional 361 terminals list storage of over 250 mbbl. The aforementioned details are recapped in the following table.

**Table 5-70 Overview of Terminal Operations -Study Case C**

| | Operating Terminals | Water | Rail | Existing Ethanol | S1 | S2 | S3 |
|---|---|---|---|---|---|---|---|
| PADD I | 288 | 126 | 23 | 11 | 12 | 104 | 123 |
| PADD II | 401 | 68 | 38 | 80 | 14 | 161 | 127 |
| PADD III | 191 | 49 | 21 | 12 | 18 | 78 | 44 |
| PADD IV | 40 | 1 | 6 | 4 | 5 | 12 | 11 |
| PADD V | 143 | 53 | 23 | 15 | 27 | 37 | 56 |
| TOTALS | 1063 | 297 | 111 | 122 | 76 | 392 | 361 |

Note: S1-terminals with under 100 mbbl storage capacity, S2-terminals with 100 mbbl to 250 mbbl storage capacity, S3-terminals with over 250 mbbl storage capacity

In order to develop estimates on tankage requirements a preliminary estimate was made of transportation mode splits for ethanol imported into each PADD and movements for use within PADD II. These initial numbers indicate a total of 76,898 rail car shipments annually (6408 monthly). Barge shipments equate to 2,154 annual river barge movements (~180 monthly) and 386 ocean barge movements (~32 monthly). Ship cargoes in 5.25mm gallon (125 mbbl)lots will require 160 shipments annually (~13 monthly cargoes).

The above figures do not include product movements within each PADD (other than rail and barge for PADD II). This is strictly an estimate of the shipment modes for product exported from PADD II to the other PADDs. A more detailed analysis of movements within each PADD is included in the Transportation Analysis section. A recap of the above referenced shipments is included in the following table.

**Table 5-71 Preliminary Estimate of Transportation Modes (Exports from PADD II) - Study Case C**

| | Total Volume By Rail Cars Annual/Monthly | Total Volume by Barge or Ocean Barge Annual/Monthly | Total Volume by Ship Annual/Monthly |
|---|---|---|---|
| PADD I | 21,666/1,805 | 386/32 (20M) | 65/5.4 |
| PADD II | 30,833/2,569 | 1321/110 (10M) | -- |
| PADD III | 11,666/972 | 833/69 (10M) | -- |
| PADD IV | All movements within PADD | -- | -- |
| PADD V | 13,333/1,111 | -- | 95/8 |
| TOTALS | 76,898/6,408 | 2,540/212 | 160/13 |

It is estimated that a total of 44 tanks, of various sizes, with 700,000 barrels of storage will need to be converted and placed into ethanol service. A total of 298 new tanks of various sizes, totaling 2.836 mmbl of storage will need to be built. This equates to 148,512,000 gallons of new ethanol storage which at an average of three turns per month could handle slightly over 4.4 billion gallons of ethanol volume. Here we have assumed three inventory turns per month, since ethanol is available in so many more terminals and production is available within each PADD. This provides more supply options than Study Case B1 allowing terminals to operate on a lower inventory level, thereby achieving greater inventory turns. Estimated tank conversions and new tankage needs by PADD are listed in the following table.

**Table 5-72 Total Estimated Tank Conversions & New Tank Installations - Study Case C**

| | Number of Conversions | Total Capacity (MBBLs) of Tanks Converted | Number of New Tanks | Total Capacity (mbbl) of New Tanks |
|---|---|---|---|---|
| PADD I | 7 | 65 | 87 | 1,137 |
| PADD II | 19 | 120 | 88 | 670 |
| PADD III | 7 | 45 | 76 | 590 |
| PADD IV | 6 | 35 | 14 | 80 |
| PADD V | 5 | 30 | 33 | 359 |
| TOTALS | 44 | 295 | 298 | 2,836 |

A profile of the total number of terminals with ethanol, water capabilities, and rail capabilities, after conversion for Study Case C is provided in Table 5-73. This profile includes existing ethanol terminals and those added in Case B1 and Case C. In total there are 1063 terminals servicing the designated markets. Of these, 908 (85.4%) would handle ethanol. Among the terminals handling ethanol an estimated 177 (19.5%) would receive at least some ethanol via waterborne delivery (barge or ship). Of the terminals handling ethanol, 181 (19.9%) would have rail capabilities.

| Table 5-73 Profile of Ethanol Terminaling Capabilities After Case C Conversions | | | |
|---|---|---|---|
| PADD | Number of terminals with ethanol | Estimated number of water capable ethanol terminals | Estimated number of rail capable ethanol terminals |
| I | 201 of 288 | 90 | 44 |
| II | 368 of 401 | 40 | 61 |
| III | 183 of 191 | 32 | 41 |
| IV | 39 of 40 | 0 | 11 |
| V | 117 of 143 | 15 | 24 |
| Totals | 908 of 1063 (85.4%) | 177 | 181 |

Table 5-74 below provides a break down of total retail facilities offering ethanol blends by PADD, including existing facilities, Case B1 conversions, Case C conversions and total facilities offering ethanol blends after Case C conversion.

| Table 5-74 Case C Estimated Retail Unit Conversions | | | | |
|---|---|---|---|---|
| PADD | Existing | Conversions Case B1 | Conversions Case C1 | Total Facilities |
| I | 980 | 11,020 | 12,000 | 24,000 |
| II | 10,919 | 12,611 | 20,470 | 44,000 |
| III | 1,058 | 8,942 | 20,000 | 30,000 |
| IV | 725 | 525 | 3,750 | 5000 |
| V | 9,234* | 2,116 | 5,308 | 16,658 |
| Total | 22,916 | 35,214 | 61,528 | 119,658 |

* Includes California facilities to be converted by 2003

Estimated facilities offering ethanol blends after Study Case C conversions total 119,658 representing 68.3% of the station population. Of the total, 22,916 stations were estimated to be existing facilities (including California stations that will be converted prior to 2003) and 35,214 facilities were converted in Case B1. An additional 61,528 stations require conversion in Case C.

For Case C, capital investments at the terminal level include expenditures for new tanks totaling $40,045,000. Investments for tank conversions are $880,000 while the cost of blending systems is $113,700,000. An estimated $9,585,000 would be spent on rail spur installations. Combined with the contingency estimate of $6,840,000 and estimated expense for retail conversions of $36,302,110, this would bring the total expenditure for the terminal and retail levels, for E-10/E-5.7 blends, to $207,352,110. The total new ethanol volume used in E-10/E-5,7 for Case C is 4.5 bgy. The volume does not include the 0.4 bgy for ethanol used in E-85. As noted earlier, the terminal equipment costs are assigned to E-10/E-5.7 blends. New ethanol volume used in E-85 represents 0.4 bgy in Case C or 8.2% of the total 4.9 bgy increase. The amortized cost on a dollars per gallon of new ethanol volume (used in E-10/E-5.7) basis for all PADDs combined is $0.0072. The above information is recapped in the following table.

**5-75 Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7 - Case C**

| | New ethanol Volume (bgy) | Cost of New Tanks | Cost of Tank Conversion | Cost of Blending Systems | Modification for Rail Receipt | Contingency | Retail Conversions | Total | Amortized cost per gallon |
|---|---|---|---|---|---|---|---|---|---|
| PADD I | 1.2 | $15,115,000 | $180,000 | $30,300,000 | $710,000 | $1,880,000 | $7,080,000 | $55,265,000 | $0.0072 |
| PADD II | 1.3 | $9,950,000 | $375,000 | $35,700,000 | $3,550,000 | $2,140,000 | $12,077,890 | $63,792,890 | $0.0077 |
| PADD III | 1.1 | $8,600,000 | $125,000 | $27,300,000 | $3,550,000 | $1,660,000 | $11,800,000 | $53,035,000 | $0.0075 |
| PADD IV | 0.3 | $1,250,000 | $110,000 | $7,800,000 | $710,000 | $400,000 | $2,212,500 | $12,482,500 | $0.0065 |
| PADD V | 0.6 | $5,130,000 | $90,000 | $12,600,000 | $1,065,000 | $760,000 | $3,131,720 | $22,776,720 | $0.0059 |
| TOTALS | 4.5 | $40,045,000 | $880,000 | $113,700,000 | $9,585,000 | $6,840,000 | $36,302,110 | $207,352,110 | $0.0072 |

Study Case C also looked at the expense of expanding the retail infrastructure to the levels necessary to raise the amount of ethanol used in E-85 from the 0.3 bgy in Case B1 to 0.7 bgy in Case C, a 0.4 bgy increase of ethanol used in E-85. Our estimates indicate that after allowing for some "mobile fueling", there would be a need to retrofit 245 systems at existing facilities and install 2,217 additional systems as new units at existing facilities. The cost then to achieve this additional 0.4 bgy of ethanol used in E-85 would be $140,004,000 which on an amortized basis would equate to $0.0546 per gallon. The cost of E-85 infrastructure is recapped in the following table.

**Table 5-76 Estimated Cost for E-85 Retail Infrastructure - Case C**

| | Number of New Facilities/Retrofit Conversions | Cost | Amortized Cost per Gallon |
|---|---|---|---|
| PADD I | 921/102 | $59,652,000 | $0.0465 |
| PADD II | 1296/143 | $80,352,000 | $0.0627 |
| TOTALS | 2217/245 | $140,004,000 | $0.0546 |

As noted in Case B1, when included in total cost, the E-85 program cost distorts the amortized costs for PADDs I and II, causing them to appear more expensive than the other PADDs. Table 5-77 lists the amortized dollars per gallon cost for ethanol used in E-10/E-5.7, ethanol used in E-85, as well as their collective total.

**Table 5-77 Amortized Cost Per Gallon Recap - Case C**

| PADD | New Ethanol Volume E10/E5.7 bgy | Amortized Cost Per Gallon | New Ethanol Volume E85 bgy | Amortized Cost Per Gallon | Total New Ethanol Volume bgy | Total Ethanol Amortized Cost Per Gallon |
|---|---|---|---|---|---|---|
| I | 1.2 | $0.0072 | 0.2 | $0.0465 | 1.4 | $0.0128 |
| II | 1.3 | $0.0077 | 0.2 | $0.0627 | 1.5 | $0.0150 |
| III | 1.1 | $0.0074 | -- | -- | 1.1 | $0.0074 |
| IV | 0.3 | $0.0065 | -- | -- | 0.3 | $0.0065 |
| V | 0.6 | $0.0059 | -- | -- | 0.6 | $0.0059 |
| Total | 4.5 | $0.0072 | 0.4 | 0.0546 | 4.9 | $0.0110 |

## 5.6 Operating Costs

It should be noted that there could be very modest increases in operating costs for some terminals to handle ethanol. Storage and load out of ethanol would basically be similar to gasoline so operating costs (utilities, personnel, etc.) should be the same. One possible area of increased operating expense may be for product receipt, especially for pipeline terminals. Pipeline terminals receive their gasoline by pipeline which is fairly automated. However, their ethanol would be delivered by rail or truck and could therefore necessitate more manpower to spot and unload rail cars or handle truck deliveries. Any such costs would depend on the current operational parameters of the terminal, the volume of ethanol received, and the mode of ethanol delivery. Consequently, these costs cannot be accurately estimated and are not included here but are likely to be on the order of hundreths of cents per gallon.

## 5.7 Discussion and Observations

This report section examines the terminal upgrade requirements, and retail unit conversion costs of distributing an additional 4.5 bgy of ethanol for use in E-10 and E-5.7 blends in Case C. The requirements and costs of the retail infrastructure necessary to distribute an additional 0.4 bgy for use in E-85 blends are also estimated.

Clearly, ethanol plants will not be built in every identical location hypothesized in this study. However the locations used are sufficient to provide reasonably accurate estimates for the scenarios studied.

This exercise assesses the requirements, and their costs, ultimately reaching an amortized cost on a dollars per gallon of new ethanol volume basis.

The total terminal and retail costs for all 4.9 bgy of ethanol sales in this section equates to $0.0110 per gallon of ethanol on an amortized basis. However, breaking costs down by PADD or type of investment offers more detail.

The amortized cost per ethanol gallon for E-10/E-5.7 blends is $0.0072 with PADD V being the lowest at $0.0059, followed by PADD IV at $0.0065, PADD I at $0.0072, PADD III at $0.0075 and PADD II at $0.0077.

Examining E-85 shows that this is by far the most expensive portion of the scenario studied. Just to achieve a volume increase of 0.4 bgy of ethanol for use in E-85 through an additional 2462 facilities (plus some mobile fueling) requires 40.4% of the total investment in Study Case C. The amortized cost for ethanol used in E-85 is $0.0546 per gallon of ethanol. Essentially it raised PADD I amortized costs from $0.0072 for 1.2 bgy of E-10 to $0.0128 to achieve only an additional 0.2 bgy of ethanol used in E-85. In PADD II the amortized cost is increased from $0.0077 for 1.3 bgy of ethanol used in E-10 to $0.0150 per ethanol gallon for an additional volume of 0.2 bgy of ethanol for use in E-85. Even if the costs for the 0.4 bgy of ethanol in E-85 are spread across the entire 4.9 bgy volume increase of Study Case C, it raises amortized costs from $0.0072 for 4.5 bgy in E-10 to $0.0110 for the total of the 4.9 bgy of ethanol, with only 0.4 bgy of that being used in E-85.

There are also certain expenses that may seem disproportionate. As in Case B1, by far the largest total expense at the terminal level is for blending systems, representing over half of E-10 blending costs. This is in part because, while many terminals may be able to use or convert existing tankage, nearly every terminal, not already blending ethanol, will need to install blending systems.

The cost of rail spur installation is much lower in Study Case C than Case B1. This is largely because a higher number of terminals in Study Case C will receive product from local plants via transport truck and also because product can be redistributed from terminals that would have installed rail spurs in Study Case B1.

Also, as in Study Case B1, the costs for retail conversion expenses are nearly as much as the expense for new tanks. This is, of course, due to the greater number of retail facilities requiring conversion compared to terminals. Only 298 terminals were estimated to require new tanks in Study Case C. Retail conversion expenses, while obviously much lower on a per unit basis, were required at 61,528 facilities to accommodate the volumes in Study Case C.

## 5.8 Study Case C Recommendations for the Terminal and Retail Levels

The recommendations for Study Case C remain the same as in Study Case B1 (page 4-79). The major cost component at the terminal level is for blending systems. Therefore, if it is possible to design some type of use-specific blending system at a lower cost than current systems, this would lower program costs.

In the case of E-85, the cost of installing a new system with new underground tanks and new dispensing systems is high for the total ethanol volume contribution of E-85 expansion. Development of some type of modular and relocatable system would not only lower program costs, but could accelerate the market introduction of E-85 to additional facilities (as discussed in Case B1).

## 5.9 Cumulative Requirements of Case B1 and C - Terminal and Retail

The expansion of ethanol volumes in Study Cases B1 and C can be viewed separately in the preceding sections. For planning and public policy purposes, it may also be beneficial to view the collective requirements and costs of the combined cases. This report section examines the key requirements and costs of Cases B1 and C when combined.

Table 5-78 lists, by PADD, the total number of terminal tank conversions and their capacity, and new tank installations and their capacity, for each study case, and the combined total for Study Case B1 plus Study Case C.

For the combined study cases, a total of 107 tanks with a combined capacity of 766 mbbl are converted to ethanol use. New tank installations required for ethanol use, for the combined study cases, require 479 new tanks with a total capacity of 4,415 mbbl. Collectively, the tank conversion plus new tanks for ethanol result in 5,181 mbbl of ethanol storage capacity (217,602,000 gallons). At three inventory turns per month, this new capacity could handle approximately 7.8 bgy of new ethanol volume. When combined with existing ethanol storage, and tanks put into service without major conversion requirements, this should prove adequate storage capacity to handle the 10.0 bgy for Study Case C.

**Table 5-78 Total Estimated Tank Conversions & New Tank Installations - Study Case B1 + C**

| | Number of Conversions by Case | | | Total Capacity (mbbls) of Tanks Converted by Case | | | Number of New Tanks by Case | | | Total Capacity (mbbls) of New Tanks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **B1** | **C** | **Total** | **B1** | **C** | **Total** | **B1** | **C** | **Total** | **B1** | **C** | **Total** |
| PADD I | 18 | 7 | 25 | 235 | 65 | 300 | 45 | 87 | 132 | 660 | 1137 | 1797 |
| PADD II | 27 | 19 | 46 | 86 | 120 | 206 | 74 | 88 | 162 | 326 | 670 | 996 |
| PADD III | 15 | 7 | 22 | 115 | 45 | 160 | 47 | 76 | 123 | 388 | 590 | 978 |
| PADD IV | 1 | 6 | 7 | 10 | 35 | 45 | 5 | 14 | 19 | 50 | 80 | 130 |
| PADD V | 2 | 5 | 7 | 25 | 30 | 55 | 10 | 33 | 43 | 155 | 359 | 514 |
| TOTALS | 63 | 44 | 107 | 471 | 295 | 766 | 181 | 298 | 479 | 1579 | 2836 | 4415 |

In addition to new and converted tanks, we estimate that a total of 666 terminals will need to install blending systems at a total estimated cost of $199,800,000 and 76 will need to install rail spurs at an estimated cost of $26,980,000. The $20,000 contingency for miscellaneous expenses such as modification for truck receipt and piping modifications was estimated to be required at 586 terminals at an estimated total cost of $11,720,000. The following table breaks down these requirements by Study Case.

**Table 5-79 Case B1 + Case C - Other Terminal Requirements**

| | Number of Blending Systems | Number of Rail Spurs | Number of Terminals with Contingency Expense |
|---|---|---|---|
| Case B1 | 287 | 49 | 244 |
| Case C | 379 | 27 | 342 |
| Case B1 + C | 666 | 76 | 586 |

Table 5-80 lists the total number of existing retail facilities and those requiring conversion to ethanol blends for each Study Case. Estimating that there are 22,916 retail facilities currently offering ethanol (including stations in California that will be converted by 2003), it would be necessary to convert an additional 96,742 facilities at an estimated cost of $57,078,370 to achieve the total volume of 9.3 bgy of ethanol used in E-10/E-5.7 blends. This will bring total retail facilities offering these blends to 119,658 representing 68.3% of the retail outlet population.

**Table 5-80 Case B1 + Case C - Estimated Requirement for Retail Unit Conversions**

| PADD | Existing | Conversions Case B1 | Conversions Case C1 | Total Facilities Converted |
|---|---|---|---|---|
| I | 980 | 11,020 | 12,000 | 23,020 |
| II | 10,919 | 12,611 | 20,470 | 33,081 |
| III | 1,058 | 8,942 | 20,000 | 28,942 |
| IV | 725 | 525 | 3,750 | 4,275 |
| V | 9,234* | 2,116 | 5,308 | 7,424 |
| Total | 22,916 | 35,214 | 61,528 | 96,742 |

* Includes California facilities to be converted by 2003

Table 5-81 combines all the terminal and retail level expenditures from Cases B1 and C for the E-10/E-5.7 portion of the volume. The total cumulative B1 + C expenses for the 7.487 bgy of new ethanol volume used in E-10/E-5.7 is $360,927,370. Of the total, $63,100,000 is for new tanks, $2,249,000 is for conversion of existing tanks, $199,800,000 is for blending systems, $26,980,000 is for rail spur installations, and $11,720,000 is for the miscellaneous contingency category. The cost of converting retail facilities is estimated at $57,078,370. The total cost of the E-10/E-5.7 volume when amortized over a 20 year equipment life cycle (for the 7.487 bgy new ethanol volume) equates to $0.0075 per gallon. It is probably worth mentioning here that these costs are calculated on a per gallon of ethanol basis. When costs are amortized over the blended gallon, the total amortized cost is, of course, reduced to only 10% of that listed. Viewed in this manner, total blend program costs equate to only $0.00075 per gallon of gasoline ethanol blend.

**Table 5-81 Case B1 + Case C - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7**

| | New ethanol Volume (bgy) | Cost of New Tanks | Cost of Tank Conversion | Cost of Blending Systems | Modification for Rail Receipt | Contingency | Retail Conversions | Total | Amortized Cost per Gallon |
|---|---|---|---|---|---|---|---|---|---|
| **PADD I** | | | | | | | | | |
| Case B1 | 1.102 | $8,850,000 | $645,000 | $24,300,000 | $7,100,000 | $1,260,000 | $6,501,800 | $48,656,800 | $0.0069 |
| Case C | 1.200 | $15,115,000 | $180,000 | $30,300,000 | $710,000 | $1,880,000 | $7,080,000 | $55,265,000 | $0.0072 |
| I Total | 2.302 | $23,965,000 | $825,000 | $54,600,000 | $7,810,000 | $3,140,000 | $13,581,800 | $103,921,800 | $0.0070 |
| **PADD II** | | | | | | | | | |
| Case B1 | 1.072 | $5,395,000 | $309,000 | $33,000,000 | $5,325,000 | $2,020,000 | $7,440,490 | $53,489,490 | $0.0078 |
| Case C | 1.300 | $9,950,000 | $375,000 | $35,700,000 | $3,550,000 | $2,140,000 | $12,077,890 | $63,792,890 | $0.0077 |
| II Total | 2.372 | $15,345,000 | $684,000 | $68,700,000 | $8,875,000 | $4,160,000 | $19,518,380 | $117,282,380 | $0.0077 |
| **PADD III** | | | | | | | | | |
| Case B1 | 0.626 | $5,735,000 | $340,000 | $22,200,000 | $3,550,000 | $1,240,000 | $5,275,780 | $38,340,780 | $0.0096 |
| Case C | 1.100 | $8,600,000 | $125,000 | $27,300,000 | $3,550,000 | $1,660,000 | $11,800,000 | $53,035,000 | $0.0075 |
| III Total | 1.726 | $14,335,000 | $465,000 | $49,500,000 | $7,100,000 | $2,900,000 | $17,075,780 | $91,375,780 | $0.0083 |
| **PADD IV** | | | | | | | | | |
| Case B1 | 0.042 | $750,000 | $20,000 | $2,400,000 | $1,065,000 | $120,000 | $309,750 | $4,664,750 | $0.0173 |
| Case C | 0.300 | $1,250,000 | $110,000 | $7,800,000 | $710,000 | $400,000 | $2,212,500 | $12,482,500 | $0.0065 |
| IV Total | 0.342 | $2,000,000 | $130,000 | $10,200,000 | $1,775,000 | $520,000 | $2,522,250 | $17,147,250 | $0.0078 |
| **PADD V** | | | | | | | | | |
| Case B1 | 0.145 | $2,325,000 | $55,000 | $4,200,000 | $355,000 | $240,000 | $1,248,440 | $8,423,440 | $0.0091 |
| Case C | 0.600 | $5,130,000 | $90,000 | $12,600,000 | $1,065,000 | $760,000 | $3,131,720 | $22,776,720 | $0.0059 |
| V Total | 0.745 | $7,455,000 | $145,000 | $16,800,000 | $1,420,000 | $1,000,000 | $4,380,160 | $31,200,160 | $0.0065 |
| **TOTAL B1** | 2.987 | $23,055,000 | $1,369,000 | $86,100,000 | $17,395,000 | $4,880,000 | $20,776,260 | $153,575,260 | $0.0080 |
| **TOTAL C** | 4.500 | $40,045,000 | $880,000 | $113,700,000 | $9,585,000 | $6,840,000 | $36,302,110 | $207,352,110 | $0.0072 |
| **TOTAL B1+C** | 7.487 | $63,100,000 | $2,249,000 | $199,800,000 | $26,980,000 | $11,720,000 | $57,078,370 | $360,927,370 | $0.0075 |

**Table 5-82 Case B1 +Case C Estimated Cost for E-85 Retail Infrastructure**

| | Ethanol in E-85 (bgy) | | | Number of New Facilities/Retrofit Conversions | | | Cost | | | Amortized Cost per Gallon | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B1 | C | Total | B1 | C | Total | B1 | C | Total | B1 | C | Total |
| PADD I | 0.1 | 0.2 | 0.3 | 795/95 | 921/102 | 1716/197 | $49,309,000 | $59,652,000 | $108,961,000 | $0.0769 | $0.0465 | $0.0567 |
| PADD II | 0.2 | 0.2 | 0.4 | 1514/190 | 1296/143 | 2810/333 | $98,618,000 | $80,352,000 | $178,970,000 | $0.0769 | $0.0627 | $0.0698 |
| TOTALS | 0.3 | 0.4 | 0.7 | 2309/285 | 2217/245 | 4526/530 | $147,927,000 | $140,004,000 | $287,931,000 | $0.0769 | $0.0546 | $0.0642 |

| | |
|---|---|
| Total FacilitiesB1 | 2,594 |
| Total FacilitiesC | 2,462 |
| Total FacilitiesB1+C | 5,056 |

The study also included estimates for the cost of expanding ethanol used in E-85 in PADDs I and II. The ethanol volume used in E-85 for Cases B1 and C totals 0.7 bgy. The total estimated investment to accomplish this volume is $287,931,000 which equates to an amortized cost of $0.0642 per gallon of ethanol. These items are covered in table 5-82.

The costs of the E-85 portion of the new ethanol volume is extensive for the volume increase achieved, and can distort the comparative total cost numbers for PADDs I and II compared to the other PADDs. Table 5-83 lists the new ethanol volumes for E-10/E-5.7 and for E-85 along with their amortized costs by category, and in total.

In PADD I the amortized cost of the E-10 program for Cases B1 and C combined is $0.0070 per gallon. When E-85 expenditures are added, the amortized cost increases to $0.0128 per gallon.

**Table 5-83 Case B1 + C - Amortized Cost Per Gallon Recap**

| PADD | New Ethanol Volume E10/E5.7 bgy | | | Amortized Cost per Gallon | | | New Ethanol Volume E85 bgy | | | Amortized Cost per Gallon | | | Total New Ethanol Volume bgy | | | Total Ethanol Amortized Cost per Gallon | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B1 | C | B1+C | B1 | C | B1+C | B1 | C | B1+C | B1 | C | B1+C | B1 | C | B1+C | B1 | C | B1+C |
| I | 1.102 | 1.200 | 2.302 | $0.0069 | $0.0072 | $0.0070 | 0.1 | 0.2 | 0.3 | $0.0769 | $0.0465 | $0.0567 | 1.202 | 1.400 | 2.602 | $0.0127 | $0.0128 | $0.0128 |
| II | 1.072 | 1.300 | 2.372 | $0.0078 | $0.0077 | $0.0077 | 0.2 | 0.2 | 0.4 | $0.0769 | $0.0627 | $0.0698 | 1.272 | 1.500 | 2.772 | $0.0187 | $0.0150 | $0.0167 |
| III | 0.626 | 1.100 | 1.726 | $0.0096 | $0.0075 | $0.0083 | -- | -- | -- | -- | -- | -- | 0.626 | 1.100 | 1.726 | $0.0096 | $0.0074 | $0.0082 |
| IV | 0.042 | 0.300 | 0.342 | $0.0173 | $0.0065 | $0.0078 | -- | -- | -- | -- | -- | -- | 0.042 | 0.300 | 0.342 | $0.0173 | $0.0065 | $0.0078 |
| V | 0.145 | 0.600 | 0.745 | $0.0091 | $0.0059 | $0.0065 | -- | -- | -- | -- | -- | -- | 0.145 | 0.600 | 0.745 | $0.0091 | $0.0059 | $0.0065 |
| Total | 2.987 | 4.500 | 7.487 | $0.0080 | $0.0072 | $0.0075 | | 0.4 | 0.7 | | $0.0546 | $0.0642 | 3.287 | 4.900 | 8.187 | $0.0143 | $0.0110 | $0.0115 |

Similarly in PADD II, the E-10 portion of the program for the combined cases has an amortized cost of $0.0077. When expenditures for E-85 are added, the amortized cost increases to $0.0167.

Even when the E-85 costs are spread over the total national volume, it increases amortized costs from $0.0075 per ethanol gallon to $0.0115 per ethanol gallon. This is simply a reflection of the significant costs associated with installing new tanks and dispensing systems at the numerous locations necessary to achieve the targeted E-85 volume.

A few observations comparing Study Cases B1 and C, as well as their collective total, are in order. Since the primary focus of the study is E-10/E-5.7 blends, Table 5-84 ranks the PADDs by lowest amortized cost for both Cases B1 and C, as well as the combined total for E-10/E-5.7 blends.

**Table 5-84 E-10/E-5.7 Blends - PADDs Ranked by Lowest Amortized Costs Per Gallon**

| Case B1 PADD | Case B1 Amortized cost per gallon | Case C PADD | Case C Amortized cost per gallon | Case B1 + C PADD | Case B1 + C Amortized cost per gallon |
|---|---|---|---|---|---|
| I | $0.0069 | V | $0.0059 | V | $0.0065 |
| II | $0.0078 | IV | $0.0065 | I | $0.0070 |
| V | $0.0091 | I | $0.0072 | II | $0.0077 |
| III | $0.0096 | III | $0.0075 | IV | $0.0078 |
| IV | $0.0173 | II | $0.0077 | III | $0.0083 |
| National | $0.0080 | National | $0.0072 | National | $0.0075 |

In Case B1, PADD I has the lowest amortized cost which is attributed to the ability to move all ethanol volume into large population centers of 250,000 or more residents, necessitating fewer terminal conversions. PADD II is next lowest. We attribute this to the ability to utilize some existing infrastructure and also the use of smaller tanks at terminal locations, because of lower inventory requirements, resulting from multiple nearby ethanol supply sources. PADD IV had higher than average costs which we attribute to the small volumes involved across such a sparsely populated region.

In Case C, PADD V has the lowest amortized cost which we attribute to the increased in-PADD production lowering terminal inventory requirements and enabling installation of some smaller tanks. Also, the higher than average station volume would require fewer station conversions for the volume involved.

PADD IV had the second lowest amortized cost in Case C. We attribute this to low requirements for rail spur installation compared to other areas, and for the volume involved.

Surprisingly, PADD II had the highest amortized cost in case C. This is attributed to the fact that to reach the volumes specified for PADD II in Case C, it was necessary to extend E-10 markets into rural areas where terminal volumes are low, resulting in more blending system expense at low volume terminals. The low volume retail outlets in these rural areas also increased total costs because they incurred the same expense per unit, but for lower volumes.

Finally, in looking at the combined amortized costs of Case B1 plus Case C, the numbers change yet again, PADD V has the lowest amortized cost. We attribute much of this to the fact that there were only 44 terminals added in Case C to achieve the additional Case C volume increase. By comparison PADD III required 98 terminal conversions in Case C and PADD II required an additional 140. So on a volume basis, terminal expenses were higher for PADDs II and III in the combined cases.

PADD I has the second lowest amortized cost for the combined cases. Again, we attribute this to the fact that target volumes could be achieved without moving into small towns and rural markets.

PADD III had the highest amortized costs for the combined cases. This appears to be a result of the greater numbers of terminals converted in Case C (compared to other PADDs) to achieve targeted volumes. This resulted in significant expense for blending equipment. Also, the low station volume in PADD III resulted in comparatively more stations requiring conversion to achieve targeted volumes.

For the combined Study Cases, the range of program costs for E-10/E-5.7, on an amortized cents per gallon of new ethanol volume basis, are not that much different among PADDs. They range from $0.0065 per gallon to $0.0082 per gallon. The National average is $0.0075 per gallon.

If one looks only at Case B1 volumes, it would appear that emphasis should be directed to PADDs I and II. However, from the higher ethanol volume achieved by combining Cases B1 and C, the economics appear to favor PADD V and PADD I followed by PADD II.

## 5.10 Transportation Analysis and Costs - Study Case C

### 5.10.1 Introduction

The terminal analysis section included preliminary estimates of transportation mode splits for ethanol imported into PADDs I, III, and V (from PADD II) and also for intra-PADD movements in PADD II. These preliminary estimates were used primarily to help identify terminal requirements for rail and water receipt capabilities. In this section, the analysis is much more detailed because the intent here is to determine the increased demands for transportation equipment, and on the transportation infrastructure system itself. This includes projected rail use, barge traffic on the inland waterways, ocean-going shipments, and their related requirements.

Moreover, this section includes not only analysis of ethanol transportation from PADD II to the other PADDs, but also includes a review of intra-PADD movements.

### 5.10.2 Additional Assumptions for Transportation Analysis

The assumptions discussed for Study Case B1 are also utilized for Study Case C. These assumptions are discussed in detail in Section 4.8.2 (pages 4-80 to-490).

Note that here we look at the infrastructure requirement for increasing ethanol use from the 5.1 bgy in Study Case B1 to the 10.0 bgy level for Study Case C.

## 5.11 Transportation Analysis - Study Case C

In assessing transportation demands for increased ethanol production, we have divided the assessment into two major areas, imports/exports between PADDs, and intra-PADD shipments (i.e., movements within each PADD). The latter category includes intra-PADD transfers, in-state shipments, and intra-PADD redistribution. In doing this we start with the following table.

**Table 5-85 Study Case C Ethanol Use, Imports/Exports by PADD (bgy)**

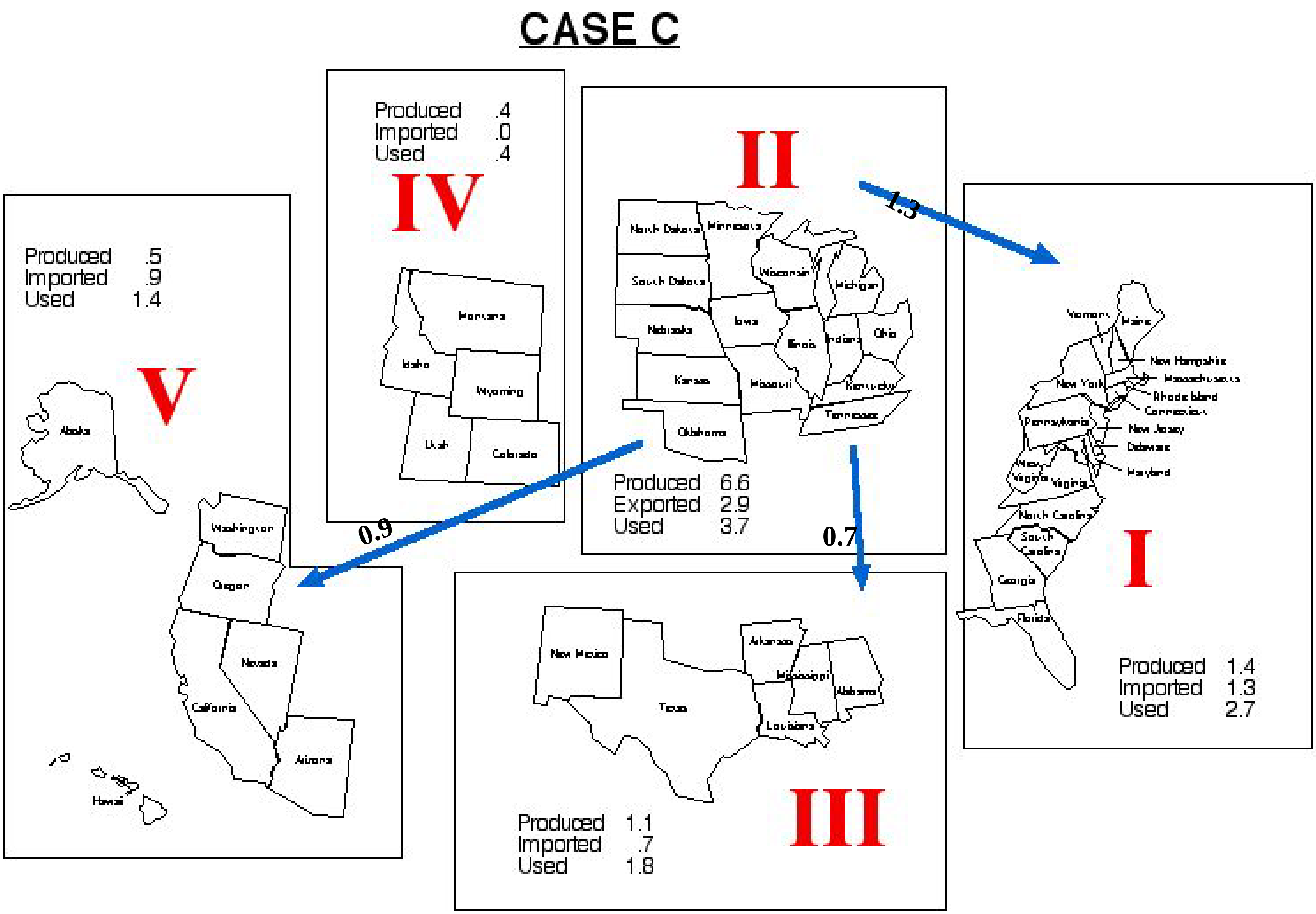
| PADD | Ethanol Used in PADD | Produced in PADD | Imported | Exported |
|---|---|---|---|---|
| | (B1) C | (B1) C | (B1) C | (B1) C |
| I | (1.3) 2.7 | (0.2) 1.4 | (1.1) 1.3 | (0.0) 0.0 |
| II | (2.2) 3.7 | (4.5) 6.6 | (0.0) 0.0 | (2.3) 2.9 |
| III | (0.7) 1.8 | (0.2) 1.1 | (0.5) 0.7 | (0.0) 0.0 |
| IV | (0.1) 0.4 | (0.0) 0.4 | (0.1) 0.0 | (0.0) 0.0 |
| V | (0.8) 1.4 | (0.2) 0.5 | (0.6) 0.9 | (0.0) 0.0 |
| Total | (5.1) 10.0 | (5.1) 10.0 | (2.3) 2.9 | (2.3) 2.9 |

Here we assume that all ethanol produced in PADDs I, III, IV, and V are used within the PADD where it is produced. PADD II uses 3.7 billion gallons of its ethanol production within the PADD and exports 2.9 billion gallons to PADDs I, III, and V to meet their import demand for ethanol. For comparison, the numbers from Study Case B1 are provided in parentheses in Table 5-85. Study Case C ethanol movements between PADDs are depicted in Figure 5-2.

## 5.12 PADD Imports/Exports - Study Case C

In Study Case C, a large portion of increased ethanol production and use is in PADDs other than PADD II. PADDs I, III, and V still import ethanol from PADD II while PADD IV production and use are in balance. As in Study Case B1, there are no exports from any PADD other than PADD II. This is done to conform to the scenarios provided by TMS. This may create some minor anomalies because there could be some exports on the fringes of the PADDS, but these volumes, if any, would be minor and are not analyzed here.

**Figure 5-2 Study Case C Ethanol Movements Between PADDS**



In order to determine where imports in a given PADD are needed, it is first necessary to determine where in-PADD production might be directed. The balance can then be presumed to be imported from PADD II. Note that this section focuses on imports/exports between PADDs. Consequently specific movements within PADDs are covered in more detail in the section on intra-PADD movements. However, the transportation demands from PADD II, to stage product in New Orleans for shipment to PADDs I and V, are included here.

Table 5-86 places product produced in each PADD into the closest logical market. These are listed as Supply In-State or Supply Intra-PADD as applicable. The remaining imports from PADD II are then estimated by mode, i.e., ship (or compartment thereof), ocean or river barge, or rail. The previous total volumes by category for Study Case B1 are provided in parentheses at the end of each PADD for reference and comparison. A discussion and recap of each PADD is provided after the table. PADDs II and IV are omitted from the tables since all their ethanol is supplied from within the PADD.

## Table 5-86 Study Case C Estimated Ethanol Supply - Instate, Intra-PADD, and Imports from PADD II

| PADD I Cities | Ethanol Total Volume (mmgy) | Supply In-State Production | Supplying Intra-PADD Production | Import from PADD II | Ship | Ocean Barge | River Barge | Rail | Truck |
|---|---|---|---|---|---|---|---|---|---|
| Albany/Schenectady/Troy NY | 30 | 30 | | | | | | | |
| Allentown/Bethlehem/Easton PA | 15 | 15 | | | | | | | |
| Atlanta GA | 100 | 50 | | 50 | | | | 50 | |
| Augusta/Aiken GA | 10 | | | 10 | | | | 10 | |
| Boston/Worcester/Lawrence MA | 165 | 100 | 5 | 60 | 60 | | | | |
| Buffalo/Niagra Falls NY | 40 | 40 | | | | | | | |
| Charleston/North Charleston SC | 15 | | 15 | | | | | | |
| Charleston WV | 5 | 5 | | | | | | | |
| Charlotte/Gastonia/Rock Hill NC/S | 40 | 40 | | | | | | | |
| Columbia SC | 15 | | 15 | | | | | | |
| Columbus GA | 5 | | | 5 | | | | 5 | |
| Daytona Beach FL | 15 | 15 | | | | | | | |
| Erie PA | 10 | | | 10 | | | | 10 | |
| Fayetteville NC | 5 | 5 | | | | | | | |
| Fort Myers/Cape Coral FL | 10 | | | 10 | | 10 | | | |
| Fort Pierce/Port St. Lucie FL | 10 | | | 10 | | 10 | | | |
| Greensboro/Winston Salem/High Po | 30 | 30 | | | | | | | |
| Greenville/Spartanburg/Anderson S | 25 | | 25 | | | | | | |
| Harrisburg/Lebanon/Carisle PA | 20 | 20 | | | | | | | |
| Hartford CT | 35 | 30 | | 5 | | | | 5 | |
| Hickory/Morganton/Lenoir NC | 10 | 10 | | | | | | | |
| Jacksonville FL | 30 | 30 | | | | | | | |
| Lakeland/Winter Haven FL | 10 | | | 10 | | | | 10 | |
| Lancaster PA | 15 | 15 | | | | | | | |
| Macon GA | 5 | | | 5 | | | | 5 | |
| Melbourne/Titusville/Palm Bay FL | 10 | | | 10 | | | | 10 | |
| Miami/Fort Lauderdale | 100 | 50 | | 50 | | 50 | | | |
| New London/Norwich CT | 10 | | | 10 | | | | 10 | |
| New York/Long Island/et.al. NY/N | 700 | 210 | | 490 | 350 | | | 140 | |
| Norfolk/Virginia Beach/Newport Ne | 45 | 45 | | | | | | | |
| Orlando FL | 40 | | | 40 | | | | 40 | |
| Pensacola FL | 10 | | | 10 | | | | 10 | |
| Philadelphia/Wilmington/Atl. City | 180 | 120 | 40 | 20 | 20 | | | | |

## PADD I CONTINUED

| Cities | Ethanol Total Volume (mmgy) | Supply In-State Production | Supply Intra-PADD Production | Import from PADD II | Ship | Ocean Barge | River Barge | Rail | Truck |
|---|---|---|---|---|---|---|---|---|---|
| Pittsburgh PA | 70 | 30 | 25 | 15 | | | | 15 | |
| Providence/Fall River/Warwick R | 35 | 35 | | | | | | | |
| Raleigh-Durham/Chapel Hill NC | 30 | 30 | | | | | | | |
| Reading PA | 10 | | | 10 | | | | 10 | |
| Richmond/Petersburg VA | 25 | 5 | 10 | 10 | | | | 10 | |
| Rochester NY | 35 | 35 | | | | | | | |
| Sarasota/Bradenton FL | 15 | | | 15 | | | | 15 | |
| Savannah GA | 5 | | | 5 | | | | 5 | |
| Scranton/Wilkes-Barre/Hazelton P | 20 | 20 | | | | | | | |
| Springfield MA | 20 | | | 20 | | | | 20 | |
| Syracuse NY | 25 | 25 | | | | | | | |
| Tallahassee FL | 5 | 5 | | | | | | | |
| Tampa/St. Petersburg/Clearwater | 60 | 55 | | 5 | | 5 | | | |
| Utica/Rome NY | 10 | 10 | | | | | | | |
| Washington/Baltimore DC/MD/VA/ | 230 | 150 | | 80 | 60 | | | 20 | |
| West Palm Beach/Boca Raton FL | 30 | | | 30 | | 30 | | | |
| York PA | 10 | 5 | | 5 | | | | 5 | |
| E-85 | 300 | | | 300 | 200 | 10 | | 90 | |
| TOTALS | 2,700 | 1,265 | 135 | 1,300 | 690 | 115 | 0 | 495 | 0 |
| (Case B1 comparative totals) | (1,300) | (200) | (0) | (1,100) | (490) | (50) | (0) | (560) | (0) |

**Note: PADD II is all intra-PADD movements and exports.**

## PADD III

| Cities | Volume (mmgy) | In-State Production | Intra-PADD Production | from PADD II | Ship | Barge | Barge | Rail | Truck |
|---|---|---|---|---|---|---|---|---|---|
| Albuquerque NM | 45 | 45 | | | | | | | |
| Austin/San Marcos TX | 60 | 30 | 30 | | | | | | |
| Baton Rouge LA | 30 | 30 | | | | | | | |
| Beaumont/Port Arthur TX | 20 | | 20 | | | | | | |
| Biloxi/Gulfport/Pascagoula MS | 20 | 20 | | | | | | | |
| Birmingham Al | 50 | 25 | 25 | | | | | | |
| Brownsville/Harlingen/San Benito | 15 | | 15 | | | | | | |
| Corpus Cristi TX | 20 | | 20 | | | | | | |
| Dallas/Fort Worth TX | 250 | 130 | 85 | 35 | | | | 35 | |
| El Paso TX | 35 | 20 | 15 | | | | | | |
| Fayetteville/Springdale/Rogers AR | 15 | 15 | | | | | | | |
| Houston/Galveston/Brazoria TX | 235 | 90 | 60 | 85 | | | 70 | 15 | |
| Huntsville AL | 15 | | 15 | | | | | | |
| Jackson MS | 20 | 20 | | | | | | | |
| Killeen/Temple TX | 15 | | | 15 | | | | 15 | |
| Lafayette LA | 20 | 20 | | | | | | | |
| Little Rock/North Little Rock AR | 30 | 30 | | | | | | | |
| McAllen/Edinburg/Mission TX | 30 | | | 30 | | | | 30 | |
| Mobile AL | 30 | 30 | | | | | | | |
| Montgomery AL | 15 | 15 | | | | | | | |
| New Orleans LA | 70 | 70 | | | | | | | |
| San Antonio TX | 85 | 50 | | 35 | | | 35 | | |
| Shreveport/Bossier City LA | 20 | 20 | | | | | | | |
| Abilene TX | 6 | | | 6 | | | | 6 | |
| Alexandria LA | 7 | 7 | | | | | | | |
| Amarillo TX | 11 | | | 11 | | | | 11 | |
| Anniston AL | 6 | | 6 | | | | | | |
| Auburn/Opelika AL | 5 | | 5 | | | | | | |
| Bryan/College Station | 7 | | | 7 | | | | 7 | |
| Decatur AL | 7 | | 7 | | | | | | |
| Dothan AL | 7 | | 7 | | | | | | |
| Florence AL | 7 | | 7 | | | | | | |
| Fort Smith AR | 10 | 10 | | | | | | | |

## PADD III CONTINUED

| Cities | Ethanol Tota Volume (mmgy) | Supply In-State Production | Supply Intra-PADD Production | Import from PADD II | Ship | Ocean Barge | River Barge | Rail | Truck |
|---|---|---|---|---|---|---|---|---|---|
| Gadsden AL | 5 | | 5 | | | | | | |
| Hattiesburg MS | 6 | 6 | | | | | | | |
| Houma LA | 10 | 10 | | | | | | | |
| Lake Charles LA | 9 | 9 | | | | | | | |
| Laredo TX | 10 | | | 10 | | | | 10 | |
| Las Cruces NM | 9 | 9 | | | | | | | |
| Longview/Marshall TX | 11 | | | 11 | | | | 11 | |
| Lubbock TX | 12 | | | 12 | | | | 12 | |
| Monroe LA | 8 | 8 | | | | | | | |
| Odessa/Midland TX | 13 | | | 13 | | | | 13 | |
| San Angelo TX | 5 | | | 5 | | | | 5 | |
| Santa Fe NM | 7 | 7 | | | | | | | |
| Sherman/Denison TX | 5 | | | 5 | | | | 5 | |
| Texarkana TX/AR | 6 | | | 6 | | | | 6 | |
| Tuscaloosa AL | 8 | | 8 | | | | | | |
| Tyler TX | 9 | | | 9 | | | | 9 | |
| Waco TX | 11 | | | 11 | | | | 11 | |
| Wichita Falls TX | 7 | | | 7 | | | | 7 | |
| Outlying Areas | 431 | | 44 | 387 | | | 50 | 337 | |
| | | | | | | | | | |
| TOTALS | 1,800 | 726 | 374 | 700 | 0 | 0 | 155 | 545 | 0 |
| (Case B1 comparative totals) | (700) | (200) | (0) | (500) | (0) | (35) | (50) | (415) | (0) |

**Note: PADD IV is all intra-PADD movements.**

## PADD V

| Cities | Ethanol Tota Volume (mmgy) | Supply In-State Production | Supply Intra-PADD Production | Import from PADD II | Ship | Ocean Barge | River Barge | Rail | Truck |
|---|---|---|---|---|---|---|---|---|---|
| Anchorage AK | 10 | | | 10 | 10 | | | | |
| Bakersfield CA | 16 | | | 16 | | | | 16 | |
| Eugene OR | 13 | 13 | | | | | | | |
| Fresno CA | 22 | 22 | | | | | | | |
| Honolulu HI | 25 | 25 | | | | | | | |
| Las Vegas NV/AZ | 60 | 20 | | 40 | | | | 40 | |
| Los Angeles/Riverside/Orange Cty, | 420 | 67 | | 353 | 300 | | | 52.7 | |
| Modesto CA | 11 | | | 11 | | | | 11 | |
| Phoenix/Mesa AZ | 90 | 50 | | 40 | | | | 40 | |
| Portland/Salem OR/WA | 95 | 77 | | 18 | | | | 18 | |
| Reno NV | 14 | | | 14 | | | | 14 | |
| Sacramento/Yolo CA | 46 | 46 | | | | | | | |
| Salinas | 10 | | | 10 | | | | 10 | |
| San Diego CA | 75 | 10 | | 65 | 50 | | | 15 | |
| San Francisco/Iakland/San Jose CA | 175 | 57 | | 118 | 80 | | | 38 | |
| Santa Barbara/Santa Maria/Lompoc | 10 | | | 10 | | | | 10 | |
| Seattle/Tacoma/Bremerton WA | 120 | 88 | | 32 | 15 | | | 17.3 | |
| Spokane WA | 15 | | | 15 | | | | 15 | |
| Stockton-Lodi CA | 15 | 15 | | | | | | | |
| Tucson AZ | 25 | | | 25 | | | | 25 | |
| Visalia/Tulare/Pottersville CA | 10 | | | 10 | | | | 10 | |
| Chico/Paradise CA | 5 | 5 | | | | | | | |
| Flagstaff AZ | 5 | | | 5 | | | | 5 | |
| Medford/Ashland OR | 7 | | | 7 | | | | 7 | |
| Merced CA | 5 | | | 5 | | | | 5 | |
| Redding CA | 4 | | | 4 | | | | 4 | |
| Richland/Kennewick/Pasco WA | 7 | | | 7 | | | | 7 | |
| San Luis Obispo/Atascadero/Paso R | 6 | | | 6 | | | | 6 | |
| Yakima WA | 8 | | | 8 | | | | 8 | |
| Yuba City CA | 4 | | | 4 | | | | 4 | |
| Yuma AZ | 5 | | | 5 | | | | 5 | |
| Outlying Areas | 67 | 5 | | 62 | | | | 62 | |
| TOTALS | 1,400 | 500 | 0 | 900 | 455 | 0 | 0 | 445 | 0 |
| (Case B1 comparative totals) | (800) | (200) | (0) | (600) | (365) | (0) | (0) | (235) | (0) |

**PADD I:** In PADD I, 1.3 bgy is imported from PADD II. This is an increase of 0.2 bgy compared to Study Case B1. It is estimated that 0.69 bgy would move by ship and ship compartment† compared to 0.49 bgy in Study Case B1. Ocean barge movements are estimated to be 0.115 bgy compared to 0.05 bgy in Study Case B1. Rail movements†† are estimated at 0.495 bgy compared to 0.56 bgy in Study Case B1.

Of the 0.69 bgy moving by ship, it is estimated that there would be 48 shipments annually (4 monthly) in full ships at 250 mbbl (~ 10.5 million gallons) each. This would leave 0.186 bgy to be shipped in ship compartments of 125 mbbl (5.25 million gallons) requiring 36 shipments annually (35.4 rounded to 36) or 3 per month.

This varies slightly from the initial transportation mode split estimate developed in the terminal analysis section in that 0.805 bgy is being delivered in ships and ocean barges with a drop in projected rail movements to 0.495 bgy. This is a result of the economic and logistic advantage of moving ships to New York and ocean barges to Miami and other southeast coastal markets.

**Table 5-87 Study Case C- PADD I Ship Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Shipments (of 10.5mm gallons/250 mbbl) | 48 | 4.0 |
| Ship compartments (of 5.25 mm gallons/125,000 bbl) | 36.0 | 3.0 |
| (35.4 actual rounded to 36) | | |

Since movement by ships is unique to PADDs I and V, the total impact on shipping is discussed collectively at the end of this report section. However, rail cars and ocean barges are discussed here.

*† Many clean product vessels are compartmentalized enabling them to segregate multiple products on the same shipment. For instance, gasoline might comprise 3 or 4 compartments while ethanol would be hauled in the 4th or 5th compartment.*

*†† For purposes of this report, a rail car movement represents delivery of 30,000 gallons of product in one rail car. Thus a unit train of 100 rail cars is 100 rail car movements.*

- Ocean Barges - A total of 0.115 bgy would move by ocean barge from the New Orleans staging areas for use in Florida markets, i.e., Fort Meyers, Fort Pierce, Miami, Tampa, and West Palm Beach. This would require an average of 11.4 ocean barge movements a month (137 annually). This is a very small volume by this mode and would not be expected to have any major impact on the demand for ocean going barges especially given the short turn around times for these short distances.

**Table 5-88 Study Case C - PADD I Ocean Barge Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Ocean barge (20M bbl) | 137 | 11.4 |

- Rail Cars - While unit trains would be the preferred mode for rail shipment, not many terminals can handle this many cars. Also, most terminals would not require the volumes and inventory levels required to justify unit train volumes. We therefore assume unit train shipments would be limited to a few key markets with hub terminal operations (i.e., Atlanta, and New York City). Based on this, we estimate shipment of only 2 unit trains per month (100 cars @ 30,000 gallons = 3,000,000 gallons), with the remainder being smaller shipments. Based on industry estimates, unit trains could be expected to achieve a turn around time (from the Midwest) of 14-15 days, while smaller shipments would likely require 21-23 days. With 0.495 bgy moving by rail annually, this equates to 16,500 annual rail car deliveries or 1,375 per month. Table 5-89 shows that the 200 rail car deliveries by unit train would require 100 rail cars in use. The remaining 1175 rail car shipments would require 904 rail cars in use. Note that turn around times on smaller rail car shipments have been increased slightly from Case B1 (i.e. lowered turns per month to 1.3) due to increased rail volume to Atlanta and Orlando.

**Table 5-89 Study Case C PADD I Imports - Rail Car Demand**

| | Rail Cars Needed |
|---|---|
| 200 rail cars in unit trains at 2 turns per month = | 100 |
| 1,175 rail cars monthly in smaller quantities at 1.30 turns per month = | 904 |
| Total rail car demand = | 1,004 |

To accommodate some shift in rail car markets, rail receipt capability is added at two terminals, bringing the total number of rail capable terminals in PADD I to 44. Based on these estimates, the actual rail car demand in PADD I is slightly lower in Study Case C than in Study Case B1. This is primarily due to an increase in waterborne cargo deliveries, combined with in-PADD production, servicing markets in Study Case C, that were serviced by rail from PADD II in Study Case B1.

**PADD II:** Ethanol movements in PADD II are all intra-PADD movements. Rail shipments to other PADDs are covered under imports to those PADDs. Here we are only concerned with the requirements to move ethanol to the Gulf Coast, for staging and shipment to PADDs I and V. PADD I requires 0.805 bgy to move by ship, ship compartment, or ocean barge. PADD V would receive 0.455 bgy by ship or ship compartment. Collectively, this indicates a need for staging a total of 1.26 bgy. This equates to 3,000 barge movements annually or 250 per month. Barges could achieve 2 turns per month so 250 barge shipments will require 125 river barges as recapped in the following table.

**Table 5-90 Study Case C River Barge Movements for Staging Waterborne Cargoes in New Orleans**

| | River Barges Needed |
|---|---|
| 250 river barges (2 turns per month) | 125 |

Resulting barge demand is discussed further in the section “Transportion Equipment Demand-Waterborne Cargoes”, because there are also intra-PADD barge shipments in Case C.

The above information also helps estimate the required capacity of staging tanks. A rough estimate indicates that monthly shipments would be approximately 0.105 bgy. While industry could probably operate on a ten day supply of 0.035 bgy, they will likely want some additional storage capacity to take care of production swings, seasonal production variations, problems with river traffic, and market conditions. It is more likely, then, that adequate storage would be at least a 20 day supply storage level capability or approximately 0.07 bgy equating to about 1.67 million barrels.

**PADD III:** In PADD III there are no movements by ship and no imports from PADD II by ocean barge (for Case C). It is estimated that 0.155 bgy would move by river barge primarily for use in Houston, and also to Houston for transfer to other outlying areas. This would require 369 barge movements annually or about 31 per month. As noted above, waterborne cargoes are covered collectively in the section "Transportation Equipment Demand-Waterborne Cargoes".

**Table 5-91 Study Case C PADD III -River Barge Movements Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| River Barge | 369 | 31 |

- Rail cars - Rail shipments are projected to be 0.545 bgy equating to 18,166 rail car deliveries annually or an average of 1,514 monthly. As with other areas, unit trains would be the preferred method of rail delivery. However, not many terminals can handle this number of rail cars, nor do they require these inventory levels. Since rail volumes in Study Case C are 0.13 bgy higher than Study Case B1, we have assumed that the number of shipments by unit train would increase to two per month. Industry estimates put turn around time for unit trains on these routes at 14 to 15 days allowing for two turns per month. Smaller shipments will require 20-21 days allowing for 1.33 turns per month. As indicated in the next table, this results in a demand of 100 rail cars for unit train movements and 988 for other shipments. Thus, PADD III imports by rail require 1,088 railcars, an increase of 247 cars over Study Case B1.

**Table 5-92 Study Case C PADD III Imports - Rail Car Demand**

| | Rail Cars Needed |
|---|---|
| 200 rail cars in unit trains at 2 turns per month = | 100 |
| 1,314 rail cars monthly in smaller quantities at 1.33 turns per month = | 988 |
| Total rail car demand = | 1,088 |

Rail capable terminals are increased from the 27 in Study Case B1 to 41 in Study Case C to handle extra volume and some new markets.

**PADD IV:** In Study Case C the ethanol produced in PADD IV is equal to the ethanol demand. Consequently there are no imports from PADD II.

**PADD V:** For Study Case C, imports into PADD V are 0.9 bgy, a 0.3 bgy increase compared to Study Case B1. Of this amount, an estimated 0.455 bgy would move by ship compared to 0.365 bgy for Study Case B1. The remaining 0.445 bgy would move by rail, compared to 0.235 bgy in Study Case B1. These volumes are reasonably close to the transportation mode split estimates developed in the terminal analysis section, although waterborne cargoes have been reduced slightly with a corresponding increase in rail.

The 0.455 bgy moved by ship would likely move on small ships of 250,000 barrel capacity (~ 10,500,000 gallons) or as ship compartments of 125,000 barrels (~ 5,250,000 gallons). It is estimated that 0.3 bgy are shipped in full ship quantity requiring 28.6 shipments a year (2.4 monthly average) at ~ 10.5 million gallons each. The remaining 0.155 bgy would move in ship compartments requiring 29.5 such shipments per year (2.5 monthly average). The implications on demand for ships are combined with PADD I and discussed in more detail in Section 5.10. The following table recaps ship movements to PADD V in Study Case C

**Table 5-93 Study Case C - PADD V Ship Cargo Profile**

| | Total Annual Shipments | Total Monthly Shipments |
|---|---|---|
| Shipments (of 10.5mm gallons/250M bbl) | 28.6 | 2.4 |
| Ship compartments (of 5.25 mm gallons/125,000 bbl) | 29.5 | 2.5 |

• Rail Cars - The 0.445 bgy shipped by rail would require 14,833 rail car deliveries annually or an average of 1236 monthly. As with Study Case B1, shipments to the west coast will represent significant volumes over long distances, which favors unit trains. However, there are some limitations due to congestion in rail yards and the receiving capabilities of the terminals. Consequently, we estimate that only three unit trains per month would be shipped. Unit trains can be expected to experience turn around times in the 15 to 16 day range, or two turns per month. Smaller shipments are likely to experience turn around times of up to 26-27 days allowing for only 1.1 turns per month. The rail car demand would then equate to 150 cars for unit train movements and 851 for smaller quantity shipments, a total of 1,001 rail cars. This is an increase of 490 cars required for PADD V shipments, compared to Study Case B1.

**Table 5-94 Study Case C PADD V Imports from PADD II- Rail Car Demand**

| | Rail Cars Needed |
|---|---|
| 300 rail cars in unit trains at 2 turns per month = | 150 |
| 936 rail cars monthly in smaller quantities at 1.1 turns per month = | 851 |
| Total rail car demand = | 1001 |

Rail capabilities at servicing terminals are increased from 17 in Study Case B1 to 24 in Study Case C, to handle increased shipments by rail.

## 5.13 Study Case C Transportation Equipment Demand for Imports from PADD II to Other PADDs - Waterborne Cargo

The following table recaps the waterborne cargo movements previously discussed.

**Table 5-95 Study Case C Recap of Waterborne Cargo Movements**

| PADD | Ship Annual/Monthly | Ship Compartment Annual/Monthly | Ocean Barge Annual/Monthly | River Barge Annual/Monthly |
|---|---|---|---|---|
| I | 48/4.0 | 36/3 | 137/11.4 | - |
| II | - | - | - | 3000/250 |
| III | - | - | -- | 369/31 |
| IV | - | - | - | - |
| V | 28.6/2.4 | 29.5/2.5 | - | - |
| Totals | 76.6/6.4 | 65.5/5.5 | 137/11.4 | 3369/281 |

Ships: A total of 76.6 ship cargoes ( at 250 mbbl/~ 10.5 million gallons) would be shipped each year or an average of 6.4 per month. From a transportation time standpoint, 2.4 shipments per month would go to PADD V (primarily California) and 4.0 ships per month would go to PADD I. As in Case B1, we would envision that at least 2 ships per month (one each to PADDs I and V) would move as undenatured product (pure spirits) and would therefore not require OPA90 double hulled vessels. The 65.5 shipments as ship compartments would equate to 5.5 total shipments per month to PADDs I and V. Since these shipments would have space on a vessel with petroleum products, they would be moving on an OPA90 double hulled vessel. These shipments are profiled in the following table.

**Table 5-96 Case B1 PADD I and V Combined Ship Cargo Profile Shipments Annual/Monthly**

| | Non OPA90 Vessels | OPA90 Vessels | Ship Totals | OPA90 Ship Compartments |
|---|---|---|---|---|
| PADD I | 12/1 | 36/3.0 | 48/4.0 | 36/3.0 |
| PADD V | 12/1 | 16.6/1.4 | 28.6/2.4 | 29.5/2.5 |
| Total | 24/2 | 52.6/4.4 | 76.6/6.4 | 65.5/5.5 |

Turn around times from the Gulf Coast to PADDs I and V will, of course, be a factor. The distance from New Orleans to, for instance, San Diego (the closest PADD V port) via the Panama Canal is ~ 4,222 nautical miles. At a speed of 10 knots, time usage would be 17 days, 14 hours. However, there could also be delays at the Panama Canal or for weather conditions. The time to New York harbor would be less than half that of shipments to southern California (estimated at 6 to 7 days). So the 1.4 average monthly shipments of denatured product to California would tie up two small vessels. The average of 3 monthly shipments of denatured product to the upper East Coast could probably be handled by two vessels as well.

With regards to available equipment, the following is noted. The two ships per month of undenatured product would move in vessels that are currently idle or underutilized due to retirement from petroleum product service. The shipments listed as non-OPA90 vessels in Table 5-96 are undenatured product (pure spirits) and could be moved in single hulled ships that have retired from petroleum product service. No investment would be required for these ships/shipments.

The 4.4 average ships per month that are denatured would move in double hulled vessels. After considering recent ship retirements, the fleet of smaller ships, i.e. under 50,000 Dead Weight Tons (DWT), in clean product service currently includes 10 ships. However, of these, 3 will be retired in the 2005 to 2007 time frame and 4 will be retired in the 2011 to 2014 time frame. Consequently, by the time the ethanol production levels in Study Case C are achieved there would only remain 3 vessels, of this smaller size, in clean product service, plus any new OPA90 compliant vessels that are built.

The availability of OPA90 compliant Jones Act vessels is the subject of some debate. As noted in Case B1, some recent studies have projected a shortage of OPA90 vessels.(9) The American Waterways Operators, however, indicate there are 50 coastal, U.S. flagged double hulled ships capable of transporting ethanol from the Gulf Coast to the East and West Coasts. Other industry members of the AWO when questioned about shipping as much as 0.6 bgy to California stated, "There is ample U.S. flag tonnage available to satisfy the required shipment of ethanol to California." It should be noted that to date, new construction of double hulled, U.S. flag, tank ships has consistently proven cost prohibitive. The last tank ships built were at a cost of $80 + million each.(21) As the above referenced smaller ships are retired from service, it will likely become necessary to ship more ethanol in compartments of larger ships or by rail, if new Jones Act/OPA90 vessels are not placed in service. Of course, with the large ethanol volumes involved, it is also likely that some ethanol could move in ships currently hauling gasoline since gasoline demand would be reduced to a significant degree by the amount of ethanol blended.

As in Case B1, the Case C ethanol shipments to PADD V would largely be displacing current MTBE shipments to California. The California Energy Commission (23) estimates that California currently imports 40,200 barrels per day of MTBE from the Gulf Coast. This equates to approximately 0.62 bgy. The total ethanol movement to the West Coast via ship is only 0.455 bgy and of that 0.126 bgy would move in non-OPA90 vessels, as pure spirits, leaving only 0.329 bgy to move in OPA90 compliant vessels. This is less than 60% of the volume of MTBE being shipped from the Gulf Coast. Consequently there should be no need for additional Jones Act tonnage for California deliveries as compared to a continuation of MTBE shipments.

Similarly, on the East Coast the volume of ethanol delivered by ship would be 0.69 bgy. However 0.126 bgy of this volume would be undenatured and move in Non OPA90 vessels. This leaves only 0.564 bgy to move in OPA90 compliant vessels. Reasonably large volumes of gasoline are moved from the Gulf Coast to the northeast by ship and ethanol would be largely displacing gasoline volume on these shipments. So again we see no need for additional Jones Act tonnage to service PADD I, in Case C, compared to what would otherwise be required for gasoline shipments.

Combining the small volumes moved to PADD I and V by ship in Case C (1.145 bgy) should not require additional Jones Act tonnage if, in fact, the estimated 0.252 bgy of undenatured ethanol can move in non OPA90 vessels (handling undenatured product).

Ocean Barges: Ocean barges are also readily available for the small volumes moved by that mode, i.e., an average of13 movements per month. These barges would be used primarily to ship ethanol from the New Orleans staging area to other points in the Gulf Coast area. With the quick 5 to 12 day turn around time, the resulting demand would be less than 5 ocean barges.

River Barges: River barges, on the other hand, will likely require some new barges be placed in service. The calculations in table 5-95 indicate an average of 281 river barge movements monthly. Industry estimates (21) indicate that there are about 2900 inland barges, of which approximately 1800 would be suitable to transport ethanol. Further, marine transport companies indicate that the supply and demand for such barges are nearly in balance.

The American Waterways Operators (AWO) has indicated there are 2300 double hulled tank barges operating on the inland waterways and further that "any of these could be placed in ethanol service after a quick cleaning." The higher AWO number includes barges which are currently in other service, but that could be redirected to ethanol transport if demand dictated. Although it is likely that some existing barges could be reassigned to ethanol service, we are assuming here that any new demand will be met with newly constructed barges. This then should be considered an upper bound estimate.

The exports of ethanol from PADD II to PADDs I and V would require 250 river barge movements monthly (3,000 annually) to move ethanol to the Gulf Coast for staging, plus product moved directly from PADD II to Houston by river barge requiring 31 monthly shipments (369 annually). This then represents a total of 281 monthly river barge shipments as covered in Table 5-97. As discussed in Case B1, barges from Illinois to New Orleans can be expected to achieve a minimum of 2 turns (round trips) per month. So 281 barge movements to New Orleans and Houston will require 141 barges. In Case B1, it was estimated that 42 barges were already in ethanol service and 51 were added for Case

B1. This total of 93 barges is subtracted from the Case C barge requirements of 141 yielding a total of 48 new barges required.

Rather than build 10,000 barrel barges for service from the Midwest to the Gulf Coast, it is far more likely that 30,000 barrel barges would be built for this service. These barges would run in 6 barge tows equating to the same as an 18 barge tow of current sized barges. Utilizing this approach it is estimated that the inland tow boat fleet is of sufficient size. The current construction cost on a new barge of this size is approximately 1.6 million dollars. If the required 48 barges of 10 mbbl capacity are replaced with 30 mbbl barges, only 16 new barges would be required. These calculations are covered in the following table.

| **Table 5-97 Study Case C Demand for New Inland Waterway Barges** | |
|---|---|
| 281 barge shipments per month @ 2 turns per month = 140.5 (rounded) | 141 new barges |
| Less requirement included for Study Case B1 (10 mbbl equivalent) | (93 barges) |
| Additional Barge Requirement at 10 mbbl capacity | 48 barges |
| Additional Barge Requirement for Study Case C† | 16 new barges |
| *† Assumes 1 - 30,000 barrel barge replaces 3 - 10,000 barrel barges* | |

Total costs for new barges required is covered in the following table.

| **Table 5-98 Study Case C Cost for New Inland Waterway Barges** | |
|---|---|
| 16 barges† @ $1.6 million each = | $25,600,000 |
| *† 30 mbbl capacity equivalent to 3 current river barges* | |

Based on the above tables, the estimated cost of increasing the inland waterway barge fleet for PADD II exports is $25,600,000. When the cost is amortized across the 4.9 bgy of new ethanol volume in Case C this equates to $0.0009 per gallon (see Appendix E for discussion of amortization). The current projected lead time on 30,000 barrel barge construction is nine months to one year, for the first barges in a series, with delivery capability of about one per month thereafter.

## 5.14 Study Case C Transportation Equipment Demand for Imports From PADD II to Other PADDs - Rail Shipments

Preceding tables in this section listed annual and monthly rail car shipments, turn around times, and projected rail car demand. The following table recaps the estimate of the total number of rail cars needed to handle PADD II exports to the other PADDs and also compares this demand to Study Case B1.

**Table 5-99 Increased Demand for Rail Cars**

| PADD | # of Cars Required B1 | # of Cars Required C |
|---|---|---|
| I | 1,118 | 1,004 |
| II | - | - |
| III | 842 | 1088 |
| IV | 208 | 0 |
| V | 511 | 1,001 |
| Total | 2,679 | 3,093 |
| Case C new rail car demand (above Study Case B1) | | 414 |

From the above table it can be seen that Case C shipments for ethanol exports from PADD II to the other PADDs would require 3,093 rail cars, an increase of 414 cars over Case B1. Ethanol would be moved in DOT-111A100W1 tank cars, which could carry ~30,000 gallons each (T108 cars with a gross weight on rail of 263K pounds) or nearly 33,000 gallons (T109 cars with a gross weight on rail of 286K pounds). Use of the larger cars would require an exemption granted by the U.S. DOT. Use of the 286K pound cars may also require additional investments on the lines (including bridges) of regional or short line railroads involved in handling the traffic. This can only be determined by analyzing the specifics of each movement and the routes traversed. Consequently we are assuming here that the T108 cars would be used. The Association of American Railways (AAR) indicates that 30,000 gallon tank cars

(263K pounds) could cost up to $60,000 each based upon discussion with the manufacturers and a review of cars installed in recent years. T108 cars installed and registered from January 1 through December 15, 2000, have cost an average of $62,000 (with a minimum cost of $52,000). A 286K pound (i.e., T109) tank car might cost 5-10% more, but would haul as much as 9% more product. Other rail industry estimates put the cost of T108 cars in the $57,000 per car range.(17) Here we are using $60,000 as an average cost equating to a total investment of $24,840,000 for the new rail cars, to handle the increased rail volume for Study Case C over Study Case B1. See table below. If amortized across the new Case C volume of 4.9 bgy, this equates to $0.0009 per ethanol gallon (see Appendix E for discussion of amortization).

| Table 5-100 Study Case C Increased Demand for Rail cars - Imports from PADD II | |
|---|---|
| 414 T108 rail cars at $60,000 each = | $24,840,000 |

The AAR also indicates that up to 7,000 additional tank cars of this type could be constructed annually without significant disruptions. Freight car builders produced about 7,500 tank cars (and a total of 43,850 cars of all types) in the first three quarters of 2000, down slightly from the peak activity levels of the past couple of years. "We believe that they have sufficient capacity to begin building additional cars almost immediately," says AAR. Based on this, lead time for rail cars should not be an issue.

Some industry contacts also noted that there are a number of old 26,000 gallon cars sitting idle, or underutilized, that could be used for any transitional period where car supply is constrained. (22) However, given the freight car builders capacity, it is not likely that such use would be required, since ethanol volume will increase in small increments as plants are built.

The demand on the railway system itself is discussed is more detail later in this section.

## 5.15 Study Case C Recap of Transportation Equipment Costs for Imports from PADD II to Other PADDs - Rail & River Barge

As the tables in the previous sections indicate, the total additional transportation equipment investment for Study Case C imports into PADDs I, III, and V would then include $24,840,000 for rail cars and $25,600,000 for river barges for a total of $50,440,000. If amortized over the 4.9 bgy of new ethanol volume for Study Case C, this equates to $0.0017 per gallon on a 15 year life cycle ( see Appendix E for discussion of amortization).

**Table 5-101 Study Case C Transportation Investments**

| **Capital Investments** | |
|---|---|
| Rail cars | $24,840,000 |
| River barges | $25,600,000 |
| Total | $50,440,000 |
| Total new ethanol volume | 4.9 bgy |
| **Amortized cost per new ethanol gallon** | **$0.0017** |

No calculations were made for operating expenses since they would be the same as for any other petroleum product shipped by these modes. While these modes of transportation are higher than pipeline expenses, such incremental costs are reflected in their freight expenses.

Jones Act/OPA90 Vessels: In both Study Cases B1 and C, we did not include an investment charge for Jones Act/OPA90 compliant vessels. Shipments of ethanol would largely be replacing MTBE and gasoline shipments, especially in Case B1. The following table lists the total OPA90 compliant shipments for both Cases B1 and C.

| Table 102 Study Cases B1 and C Estimate of Jones Act/OPA90 Compliant Shipments Annual/Monthly | | |
|---|---|---|
| | OPA90 Vessel @250 mbbl | OPA90 Vessel Compartment(s) @ 125 mbbl |
| Case B1 | 46/3.8 | 23/4.2 |
| Case C | 52.6/4.4 | 65.5/5.5 |

The 250 mbbl shipments in Case B1 amounts to 3.8 cargoes monthly and the 125 mbbl cargoes in ship compartments would require space on 4.2 vessel monthly. For Case C the volumes are 4.4 monthly ship cargoes of 250 mbbl and 5.5 monthly cargoes of 125 mbbl. Given the turn around time of the destinations involved, Case B1 would utilize the equivalent of 4.5 small vessels monthly (i.e., 250 mbbl capacity) and in Case C an equivalent of 7.7 such vessels monthly. If new OPA90 vessels are not built and chartered, some could argue that these shipping demands should be considered as program costs. One could also argue that even if you are considering ethanol as replacing gasoline on these vessels, the energy difference should be considered. Since ethanol only contains about 67% of the energy content of gasoline one could argue that this is a factor in calculating program cost as well. However, here we assume that marine companies are chartering these vessels and any investment that is program related is reflected in the freight charges for these loads. It is also difficult to assign costs solely to one product since new vessels would be largely for petroleum products transport.

As noted in Study Case B1, if a shortage of Jones Act/OPA90 compliant vessels develops, this could result in price spikes for chartering these vessels. If this were to occur, it could become necessary to ship more product by rail, requiring more rail capable terminals. This in turn would necessitate more investments at the terminal level for rail spurs. Of course, another option would be to ship greater ethanol volumes on an undenatured basis, since this would not require OPA90 compliant vessels.

## 5.16 Study Case C Transportation Costs for Exports from PADD II to Other PADDs

As noted in Study Case B1, the price of ethanol to the refiner or blender is based on its value as a blend component (including octane value and oxygenate compliance value when applicable). Consequently, formulas used to price ethanol are keyed off of gasoline prices in the destination market. While transportation costs do not have a significant impact on ethanol's market price, they do impact the economic viability for certain plants to supply certain markets and, of course, affect the net revenue/profitability of plants. They also have economic impact in other sectors, especially for the transportation industry. This section covers composite transportation cost estimates for shipping ethanol from PADD II to the importing PADDs.

In the case of PADDs I and V, large volumes of ethanol is sent via river barge to New Orleans where they are staged in tanks, in sufficient quantity, to facilitate loading ships and ocean barges . The total cost of shipping to these markets on the water, then, includes river barge freight, terminaling fees at staging areas, and in some cases terminaling fees at destination markets, in the case of hub terminal operations.

A sufficient quantity of large tanks for staging product is already available. Such facilities are generally operated as common carrier terminals and routinely do not maintain their own inventory of product, but rather provide a warehousing service. Such tankage was not built specifically for ethanol use but rather to provide receipt, storage, and distribution, of petroleum products, petrochemicals, and in some cases, a variety of other liquid products. These tanks can be placed in, or removed from, service as circumstances dictate, typically without modification. Since these warehouse tank facilities were not built especially for ethanol, their costs were not included in the terminal analysis. However, ethanol producers will need to either lease these tanks or arrange for a throughput agreement of some type.

There are generally two ways to do this, a "shell capacity lease" or "throughput agreement" with guaranteed minimums. A shell capacity lease is much like leasing any other space. The company utilizing the tank would essentially lease the tank at a flat charge based on its total capacity. As an example, the lessor might lease a 500,000 barrel (21 million gallon) tank for $1.00 per barrel of capacity per year ($500,000). The actual cost per gallon would then depend on the number of inventory turns. If the inventory turn is one per month the cost equates to $0.083 per barrel or $0.002 per gallon. If the lessor achieves three inventory turns per month (36 per year), the cost drops to one third of that on a per barrel or per gallon basis, equating to $0.028 per barrel or $0.0007 per gallon. The terminal operator will usually add some type of unloading and loading fee on a per barrel basis.

In the case of throughput agreements, the terminal operator provides tankage to one or more ethanol producers and charges a throughput fee usually in the $0.15-$0.40 per barrel range and requests a minimum guarantee from the company utilizing the agreement to assure adequate revenues for the use of their assets. In this case, unloading and loading fees are not usually charged since the cost is incorporated into the throughput charge. In many cases, these fees may approach or even exceed $0.01 per gallon of ethanol at the current time This is largely in instances where throughput volumes are relatively low. However, with the larger volumes envisioned in the Study Cases, it is more likely that the ethanol industry would enjoy rates similar to those for the petroleum or petrochemical industries. These are at the lower end of the $0.15 to $0.40 per barrel range cited above.

Likewise, large tanks capable of receiving ship quantities (250,000 barrels or 10.5 million gallons) will be required at the destination markets. A similar system and fee would be expected at these larger destination terminals as well, if they are hub terminal operations from where product would be redistributed.

The above costs are included as part of the transportation cost estimates. For example, the cost of shipping from the Midwest to northern PADD I includes the freight charge for river barge movement to New Orleans, terminal fees for staging products there, freight for the ship delivering product to, for example, New York, and terminaling fees there. Where applicable, a terminaling fee has been incorporated into composite freight rate estimates.

Based on the above, composite estimated freight rates and costs for waterborne cargoes would be as listed in the following table (see pages 4-90 for discussion of how composite freight rates were constructed).

**Table 5-103 Study Case C Composite Freight Rates for Waterborne Cargoes Imported from PADD II**

| PADD | Ship or compartment | Ocean barge (southern PADD I) River Barge (PADD III) |
|---|---|---|
| I | $0.11 per gal/$4.62 per barrel | $0.07 per gal/$2.94 per barrrel |
| II | NA | NA |
| III | NA | $0.03 per gal/$1.26 per barrel |
| IV | NA | NA |
| V | $.14 per gal/$5.88 per barrel | NA |

The above composite rates are applied to the volume exported to each PADD in the following table.

**Table 5-104 Study Case C Annual Transportation Volumes and Costs for Waterborne Cargo by PADD - Imported from PADD II**

| PADD | Ship or Compartment | Ocean barge/River barge | Total |
|---|---|---|---|
| I | 690 million gal @ $0.111 per = $76,590,000 | 115 million gal @ $0.07 per= $3,450,000 | $80,040,000 |
| II | NA | NA | -- |
| III | NA | 155 million gal @ $0.03 per = $4,650,000 | $4,650,000 |
| IV | NA | NA | -- |
| V | 455 million gal @ $0.14 per = $63,700,000 | NA | $63,700,000 |
| Totals | 1.145 bgy | 0.270 bgy | $148,390,000 |

Similarly, a composite rail freight rate for each PADD was developed. It is assumed that PADD I rail shipments will be sourced primarily from Illinois at a composite freight rate of $0.125 per gallon.

For PADD III it is assumed that product is sourced from Illinois, Iowa, Kansas, and Nebraska at a composite freight rate of $0.085. There are no exports to PADD IV. Finally, for PADD V it is assumed that product is sourced from a composite of all states exporting from PADD II except Illinois which will presumably ship the majority of its shipments to PADD V via waterborne cargo. The composite rail freight rate for PADD V is $0.14. These composite freight rates are calculated against their respective volumes by PADD in the following table.

**Table 5-105 Study Case C Total Annual Cost of Rail Shipments Imported from PADD II by PADD**

| PADD | Rail volume | Composite Freight Rate | Total |
|---|---|---|---|
| I | 0.495 bgy | $0.125 | $61,875,000 |
| II | NA | NA | -- |
| III | 0.545 bgy | $0.085 | $46,325,000 |
| IV | NA | NA | -- |
| V | 0.445 bgy | $0.14 | $62,300,000 |
| Totals | 1.485 bgy | - | $170,500,000 |

The following table lists the combined costs of water and rail transportation by PADD.

**Table 5-106 Study Case C Total Transportation Cost for Imports from PADD II by PADD**

| PADD | Total Water | Total Rail | Total |
|---|---|---|---|
| I | $80,040,000 | $61,875,000 | $141,915,000 |
| II | -- | -- | -- |
| III | $4,650,000 | $46,325,000 | $50,975,000 |
| IV | -- | -- | -- |
| V | $63,700,000 | $62,300,000 | $126,000,000 |
| Totals | $148,390,000 | $170,500,000 | $318,890,000 |

As can be seen in the above table, annual estimated transportation costs for all ethanol imported into other PADDs from PADD II totals $318,890,000. This equates to $0.11 per gallon when averaged across total volume of 2.9 bgy exported from PADD II to the other PADDs.

## 5.17 Study Case C Transportation Analysis - Mode of Transportation for Intra-PADD Movements

Next, the ethanol produced within each state of each PADD is analyzed assuming that this production would be used in the state produced, if demand warrants, or the next closest state (within the PADD) where such demand exists. The following table covers this exercise by PADD/State.

**Table 5-107 Study Case C Ethanol Supply Demand Balance by State**

| PADD I | Ethanol Produced | Ethanol Demand | Production Shortfall | Intra-PADD Transfer Exported |
|---|---|---|---|---|
| CT | 30.0 | 45.0 | 15.0 | |
| DE | 0.0 | 0.0 | | |
| DC/MD | 150.0 | 230.0 | 80.0 | |
| FL | 155.0 | 345.0 | 190.0 | |
| GA | 50.0 | 125.0 | 75.0 | |
| ME | 0.0 | 0.0 | | |
| MA | 100.0 | 185.0 | 85.0 | |
| NH | 0.0 | 0.0 | | |
| NJ | 40.0 | 0.0 | | 40.0 |
| NY | 350.0 | 840.0 | 490.0 | |
| NC | 180.0 | 115.0 | | 65.0 |
| PA | 225.0 | 350.0 | 125.0 | |
| RI | 40.0 | 35.0 | | 5.0 |
| SC | 0.0 | 55.0 | 55.0 | |
| VT | 0.0 | 0.0 | | |
| VA | 50.0 | 70.0 | 20.0 | |
| WV | 30.0 | 5.0 | | 25.0 |
| E-85 | | 300.0 | 300.0 | |
| **Total** | **1400** | **2700.0** | **1435.0** | **(135.0)** |
| **Less Intra-PADD Transfer** | | | **(135.0)** | |
| **Total Imported from PADD II** | | | **1300.0** | |

| PADD II | Ethanol Produced | Ethanol Demand | Product Shortfall | Intra-PADD Transfer Exported |
|---|---|---|---|---|
| IN | 450.5 | 176.0 | | 274.5 |
| IA | 455.5 | 69.0 | | 386.5 |
| KS | 276.1 | 37.0 | | 239.1 |
| KY | 153.0 | 89.0 | | 64.0 |
| MI | 325.0 | 405.0 | 80.0 | |
| MN | 415.6 | 170.0 | | 245.6 |
| MO | 630.0 | 246.0 | | 384.0 |
| NE | 775.6 | 47.0 | | 728.6 |
| ND | 163.9 | 9.0 | | 154.9 |
| OH | 332.2 | 474.0 | 141.8 | |
| OK | 45.0 | 98.0 | 53.0 | |
| SD | 229.0 | 9.0 | | 220.0 |
| TN | 278.5 | 211.0 | | 67.5 |
| WI | 194.7 | 169.0 | | 25.7 |
| Outlying Areas | 0.0 | 571.0 | 571.0 | |
| E-85 | 0.0 | 400.0 | 400.0 | |
| **Total** | **6600.0** | **3700.0** | **1245.8** | **(4145.8)**† |
| **Less Intra-PADD Transfer** | | | | **1245.8** |
| **Total Exported from PADD II** | | | | **2900.0** |

† *Includes exports*

| **PADD III** | **Ethanol Produced** | **Ethanol Demand** | **Product Shortfall** | **Intra-PADD Transfer Exported** |
|---|---|---|---|---|
| AL | 70.0 | 155.0 | 85.0 | |
| AR | 140.0 | 55.0 | | 85.0 |
| LA | 240.0 | 174.0 | | 66.0 |
| MS | 180.0 | 46.0 | | 134.0 |
| NM | 150.0 | 61.0 | | 89.0 |
| TX | 320.0 | 878.0 | 558.0 | |
| Outlying Areas | | 431.0 | 431.0 | |
| **Total** | **1100.0** | **1800.0** | **1074.0** | **(374.0)** |
| **Less Intra-PADD Transfer** | | | **(374.0)** | |
| **Total Imported from PADD II** | | | **700.0** | |

| **PADD IV** | **Ethanol Produced** | **Ethanol Demand** | **Product Shortfall** | **Intra-PADD Transfer Exported** |
|---|---|---|---|---|
| CO | 101.5 | 173.0 | 71.5 | |
| ID | 106.0 | 21.0 | | 85.0 |
| MT | 70.0 | 7.0 | | 63.0 |
| UT | 50.0 | 80.0 | 30.0 | |
| WY | 72.5 | 0.0 | | 72.5 |
| Outlying Areas | 0.0 | 119.0 | 119.0 | |
| **Total** | **400.0** | **400.0** | **220.5** | **(220.5)** |
| **Less Intra-PADD Transfer** | | | **(220.5)** | |
| **Total Imported from PADD II** | | | **0.0** | |

| **PADD V** | **Ethanol Produced** | **Ethanol Demand** | **Product Shortfall** | **Intra-PADD Transfer Exported** |
|---|---|---|---|---|
| AK | 0.0 | 10.0 | 10.0 | |
| AZ | 50.0 | 125.0 | 75.0 | |
| CA | 222.3 | 834.0 | 611.7 | |
| HI | 30.0 | 25.0 | | 5.0† |
| NV | 20.0 | 74.0 | 54.0 | |
| OR | 90.0 | 115.0 | 25.0 | |
| WA | 87.7 | 150.0 | 62.3 | |
| Outlying Areas | | 67.0 | 67.0 | |
| **Total** | **500.0** | **1400.0** | **905.0** | **(5.0)** |
| **Less Intra-PADD Transfer** | | | **(5.0)** | |
| **Total Imported from PADD II** | | | **900.0** | |

† *Transferred to other islands*

It is assumed that each state directs their own in-state production to supply in-state demand. While there may be some carry-over in bordering states, this will generally balance out.

Intra-PADD transfers (the amount of product exported from states to other states within the same PADD) and the destination market and likely transportation mode are listed in the following table.

**Table 5-108 Case C Intra-PADD Exports from States within PADD**

| | Originating State | Million Gallons | Destination State(s) | Primary Delivery Mode |
|---|---|---|---|---|
| **PADD I** | New Jersey | 40 | PA (Philadelphia) | truck |
| | North Carolina | 65 | South Carolina/Virginia | truck |
| | Rhode Island | 5 | Massachusetts | truck |
| | West Virginia | 25 | Pennsylvania | truck |
| **PADD II** | Indiana | 274.5 | Michigan/Ohio | truck |
| | Kansas | 239.1 | Oklahoma | truck |
| **PADD III** | Arkansas | 85 | Texas | truck |
| | Louisiana | 66 | Texas | truck/barge |
| | Mississippi | 134 | Alabama | truck/barge |
| | New Mexico | 89 | Texas | truck |
| **PADD IV** | | | | |
| | Idaho | 85 | Utah/outlying areas | truck/rail |
| | Montana | 63 | Outlying areas | truck |
| | Wyoming | 72.5 | Colorado/outlying areas | truck/rail |
| **PADD V** | Hawaii | 5.0 | Outlying areas/island | ocean barge |
| | All other PADD V ethanol production is used in the state where it is produced (see discussion) | | | |

From the above table, and an examination of where plants would most likely send their production, estimates of transportation demands and costs can be made. For purposes of intra-PADD shipments, product movements have been broken down into three categories as follows.

1. Intra-PADD Transfers - represents states with excess production shipping to another state within the same PADD.

2. In-State Shipment - represents shipments from a producing plant to destinations within the same state.

NOTE: The total of the two above categories equals the ethanol production within the PADD except in PADD II where exports would also need to be added to equal total production.

3. Intra-PADD Redistribution - represents imported (from PADD II) product that is redistributed from a hub terminal operation to another terminal in the same PADD.

The above categories for each PADD are discussed below.

**PADD I**

With the numerous plants added in Case C, several plants are in locations where their ethanol production could be used in the immediate vicinity (e.g. Philadelphia, Pittsburgh, New York City). Consequently, these plants will be able to deliver their production to nearby markets by truck at attractive freight rates. There are some plants that would have to ship longer distances, or to other states. Among the states originating intra-PADD transfers are the following.

**Intra-PADD Transfers:** New Jersey's 40 million gallon plant in Trenton would direct its production to Philadelphia, a distance of less than 40 miles. North Carolina's four plants (totaling 180 million gallons annually) would collectively originate 65 million gallons, of which 55 million gallons would be shipped to South Carolina and 10 million gallons to Virginia. Distances could be a great as 250 miles and likely average 175 miles. Rhode Island's 40 million gallon Providence plant would ship its excess 5 million gallons of production to Boston, a distance of 56 miles. West Virginia's 30 million gallon plant in Beckley would ship 25 million gallons to Pittsburgh, a distance of 170 miles. All other production would be used in the state produced, usually in fairly close markets. Total intra-PADD shipments of 0.135 bgy would be transferred among the above states via truck. Based on the above destinations and volumes shipped, it is estimated that the composite freight rate for intra-PADD transfer would be $0.065 per gallon yielding a total freight cost of $8,775,000 and requiring 16,875 truck deliveries annually.

**In-state Shipments:** The remaining 1.265 bgy would be utilized in the states where it was produced and usually in markets located in close proximity to the plants. The estimated composite freight rate for truck deliveries is $0.0275 which yields a total freight cost of $34,787,500. Annual truck deliveries would total 158,125 shipments.

**Intra-PADD Redistribution:** In addition, some product shipped into the PADD (from PADD II) via ship, ocean barge, and rail would, in some cases, need to be redistributed to other smaller terminals via truck. After tankage addition for the Case C terminal analysis, there are 201 terminals handling ethanol, double the number for Study Case B1. Of these, about 90 could receive waterborne cargoes, some of which could take small river barges from other larger terminals. There are also 44 terminals that receive their PADD II imports by rail. With in-state production going into various truck terminals, the actual volume of product being redistributed should be no higher than in Study Case B1. It is estimated that 0.2 bgy would still move by barge to smaller water capable terminals at a composite freight rate of $0.02 per gallon. This would require 476 barge shipments annually at a total freight cost of $4,000,000. An estimated additional 0.2 bgy would move short distances by truck at an estimated composite freight rate of $0.03 per gallon. This would require 25,000 truck deliveries annually at a total freight cost of $6,000,000.

**PADD II**

**Intra-PADD Transfers:** In PADD II, states with excess production would supply those states within the PADD, with a production shortfall. With several plants located in each exporting state, shipments would likely shift periodically among plants since so many are involved. Indiana plants would ship 0.08 bgy to Michigan and 0.1418 bgy to Ohio. Kansas plants would ship 0.09 bgy to Oklahoma. With supplying states now closer, it is expected that truck shipments would replace barge shipments. However, some product would still move by rail. It is estimated that 0.150 bgy would move by rail at a composite freight rate of $0.03 per gallon. This would yield a total freight cost of $4,500,000 and require 5,000 annual rail car deliveries. The remaining 0.1618 bgy would be shipped by truck at a composite freight rate of $0.04 per gallon yielding a total freight cost of $6,472,000. A total of 20,225 truck deliveries annually would be required.

Any remaining excess production in each state is exported out of the PADD, either directly or via exchange. The above costs are just for transfer to states within the PADD.

**In-State Shipments:** With a total volume of ethanol used in PADD II of 3.7 bgy , this would leave 3.3882 bgy to move short distances within each state. With plants located throughout the PADD, product moved would seldom need to be shipped more than 50-100 miles to reach target markets. In Study Case C, the number of terminals handling ethanol increases to 368. Of these, 68 have water receipt capabilities and 61 have rail capabilities. Despite close proximity to plants and many terminals with small tankage, some in-state shipments are expected to still move by rail and barge due to some large high volume terminals preferring this mode of product receipt. It is estimated that 0.21 bgy would move via river barge at an estimated composite freight of $0.0175 (this might include some small amounts of product shipped just across state borders). This yields a total freight cost of $3,675,000 and requires 500 barge deliveries annually. An estimated 0.3 bgy would move by rail at an estimated composite freight rate of $0.03 yielding a total freight cost of $9,000,000 and requiring 10,000 rail car deliveries annually. The remaining 2.8782 bgy would move directly from plants to terminals via truck, at a composite freight rate of $0.0225. This yields a total annual freight cost of $64,759,500 and would require 359,775 truck deliveries annually.

**Intra-PADD Redistribution:** Due to plant locations in every state, intra-PADD transfers, and the number of terminals involved, there would be no need for intra-PADD redistribution in PADD II.

**PADD III**

**Intra-PADD Transfers:** In PADD III product shipped from states with excess production increases significantly compared to Study Case B1. Arkansas' 4 plants with 0.14 bgy of total production would ship 0.085 bgy via truck and rail to Texas. The 6 plants in Louisiana have 0.24 bgy of production, of which 0.066 bgy would be shipped to Texas via barge and some truck shipments. The 5 Mississippi plants, with a total of 0.18 bgy production, will ship 0.085 bgy to Alabama via barge and truck with the balance of 0.049 bgy being dispersed to miscellaneous outlying areas via truck. Finally, New Mexico's 4 plants would ship 0.089 bgy of their 0.15 bgy of production to western and central Texas via truck and rail. This yields a total of 0.374 bgy shipped as intra-PADD transfers in Study Case C. An estimated 0.140 bgy is shipped by barge at an estimated composite freight rate of $0.03 per gallon. The total freight cost is then $4,200,000 and the number of barge deliveries annually would be 333. An estimated 0.06 bgy would move by rail at an estimated composite freight rate of $0.0525 per gallon for a total freight cost of $3,150,000 and requiring 2,000 rail car deliveries annually.

Finally the remaining 0.174 bgy of intra-PADD transfers would move by truck at an estimated composite freight rate of $0.055 per gallon. Total freight cost would be $9,570,000. The number of annual truck deliveries would total 21,750.

**In-State Shipments:** In Study Case C the number of terminals with ethanol increases to 183 facilities, of which 49 have water access and 41 have rail capabilities. In-state shipments would be the 1.1 bgy produced in the PADD, less the above intra-PADD transfers of 0.374 bgy. So, 0.726 bgy would move as in-state shipments. With the above configuration of terminals, it is estimated that 0.105 bgy would move by barge at a composite freight rate of $0.02 per gallon yielding a total freight cost of $2,100,000. This would require 250 barge shipments annually.

An estimated 0.1 bgy would move by rail at a composite freight rate of $0.035 per gallon yielding total freight costs of $3,500,000 and requiring 3333 rail car deliveries annually.

The remaining 0.521 bgy would move by truck at an estimated composite freight rate of $0.06. Total freight costs would be $31,260,000. A total of 65,125 truck deliveries annually would be required.

**Intra-PADD Redistribution:** Due to the high volumes moved by truck in Study Case C, there should be no need for intra-PADD redistribution in PADD III.

**PADD IV**

**Intra-PADD Transfers:** In Study Case C, PADD IV has three states that produce more ethanol than required for in-state use. The 6 plants in Idaho have a total annual capacity of 0.106 bgy. They export 0.03 bgy to Utah and 0.055 bgy to multi-state outlying areas. Montana's two plants produce 0.07 bgy and export 0.063 bgy to multi-state outlying areas. Wyoming's 3 plants produce 0.0725 bgy and export 0.0715 bgy to Colorado and an additional 0.001 bgy to miscellaneous outlying areas.

In Study Case C, the number of terminals handling ethanol in PADD IV increases to 39, of which 9 have rail. Of the 0.2205 bgy that are transferred between states, only 0.1 bgy is estimated to move by rail due to limited access to Class I railroads in the northern portion of the PADD. The estimated composite freight rate for these movements is $0.085 per gallon. Total freight cost is $8,500,000. A total of 3333 rail car deliveries annually would be required.

The remaining 0.1205 bgy of intra-PADD transfers would move by truck, from the plants, directly to the terminals. The distances involved are, in most cases, substantial resulting in a composite freight rate of $0.1225 with total freight costs of $14,761,250. The volume would require 15,062 truck deliveries annually.

**In-State Shipments:** The remaining 0.1795 bgy of product in PADD IV would be used in the state where it was produced. The Colorado plants are in close proximity to their market as are Utah's.

Since these comprise a large volume of in-state shipments the estimated composite freight rate is only $0.035 resulting in total estimated freight costs of $6,282,500 and requiring 22,437 truck deliveries annually.

**Intra-PADD Redistribution:** Because of the high volumes of truck deliveries, no intra-PADD redistribution is expected to be necessary in PADD IV, for Study Case C.

**PADD V**

**Intra-PADD Transfers:** There are no intra-PADD transfers in PADD V. All ethanol produced in PADD is used in the state where it is produced.

**In-State Shipments:** In-state shipments are 0.5 bgy. Many of the plants in PADD V are located in close proximity to their destination markets. These include the plants in Phoenix, Fresno, San Diego, Los Angeles, San Francisco, Las Vegas, Portland, and Seattle. Most of the remaining plants are not great distances from their destination markets. It is estimated that all in-state production would move by truck allowing that imports would come in by rail and water. The small excess volume of ethanol (0.005 bgy) produced in Honolulu, is moved to the outlying islands by barge. However, for purposes of these estimates we have added it in the truck calculations since the composite freight rate for the small volume was comparable to the composite truck freight rate and no great demand is placed on the ocean barge fleet in the area. The estimated composite freight rate is $0.0325 yielding a total freight cost of $16,250,000. A total of 62,500 truck delieveries per year would be required.

**Intra-PADD Redistribution:** For Study Case C, imports into PADD V increase by 0.3 bgy to a total of 0.9 bgy. It was estimated that 0.445 bgy of these imports would be via rail and 0.455 bgy would move by ship. In Study Case C, there are 117 terminals with ethanol in PADD V. Of these, 15 would have water receipt capabilities and 24 have rail capabilities. As with Study Case B1, we estimate a small amount of ethanol would move via pipeline. In Study Case C, that estimate is raised to 0.08 bgy.

So 30 to 35 terminals would likely receive product directly as imports via ship or rail with perhaps another 8 to 10 terminals receiving ethanol that is redistributed to them via pipeline. Many of the remaining terminals would receive shipments from in-state sources. However, it is still estimated that 0.3 bgy would need to be shipped from hub terminals, receiving ship or unit train quantities, to smaller terminals via truck. These intra-PADD redistributions would move by truck over very short distances at an estimated composite freight rate of $0.025 yielding a total freight cost of $7,500,000 and requiring 37,500 truck deliveries annually.

Table 5-109 recaps the estimated freight costs for each intra-PADD shipment category by PADD. The combined total for all PADDs indicates that estimated freight cost would total $206,417,750 for truck shipments, $28,650,000 for rail shipments, and $13,875,000 for barge shipments. The total of all freight costs for the intra-PADD movement category is $249,042,750.

**Table 5-109 Study Case C Recap of Estimated Freight Costs for Intra-PADD Movements**

| PADD | Category | Truck | Rail | Barge |
|---|---|---|---|---|
| I | Intra-PADD Transfers | $8,775,000 | | |
| | In-state shipments | $34,787,500 | | |
| | Intra-PADD redistribution | $6,000,000 | - | $4,000,000 |
| | PADD Totals | $49,562,500 | -- | $4,000,000 |
| II | Intra-PADD Transfers | $6,472,000 | $4,500,000 | |
| | In-state shipments | $64,759,500 | $9,000,000 | $3,675,000 |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Totals | $71,231,500 | $13,500,000 | $3,675,000 |
| III | Intra-PADD Transfers | $9,570,000 | $3,150,000 | $4,200,000 |
| | In-state shipments | $31, 260,000 | $3,500,000 | $2,100,000 |
| | Intra-PADD redistribution | -- | -- | -- |
| | PADD Totals | $40,830,000 | $6,650,000 | $6,300,000 |
| IV | Intra-PADD Transfers | $14,761,250 | $8,500,000 | -- |
| | In-state shipments | $6,282,500 | -- | -- |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Totals | $21,043,750 | $8,500,000 | -- |
| V | Intra-PADD Transfers | -- | -- | -- |
| | In-state shipments | $16,250,000 | -- | -- |
| | Intra-PADD redistribution | $7,500,000 | -- | -- |
| | PADD Totals | $23,750,000 | -- | -- |
| National Total | | $206,417,750 | $28,650,000 | $13,975,000 |
| **Total cost all freight categories** | | **$249,042,750** | | |

Table 5-110 lists annual truck, rail, and barge shipments for the intra-PADD movement category.

**Table 5-110 Study Case C Recap of Transportation Demands for Intra-PADD Movements Annual Shipments by Mode**

| PADD | Category | Truck | Rail | Barge |
|---|---|---|---|---|
| I | Intra-PADD Transfers | 16,875 | -- | -- |
| | In-state shipments | 158,125 | -- | -- |
| | Intra-PADD redistribution | 25,000 | -- | 476 |
| | PADD Total | 200,000 | -- | 476 |
| II | Intra-PADD Transfers | 20,225 | 5,000 | -- |
| | In-state shipments | 359,775 | 10,000 | 500 |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Total | 380,000 | 15,000 | 500 |
| III | Intra-PADD Transfers | 21,750 | 2,000 | 333 |
| | In-state shipments | 65,125 | 3,333 | 250 |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Total | 86,875 | 5,333 | 583 |
| IV | Intra-PADD Transfers | 15,062 | 3,333 | -- |
| | In-state shipments | 22,437 | -- | -- |
| | Intra-PADD redistribution | -- | - | -- |
| | PADD Total | 37,499 | 3,333 | -- |
| V | Intra-PADD Transfers | -- | -- | -- |
| | In-state shipments | 62,500 | -- | -- |
| | Intra-PADD redistribution | 37,500 | -- | -- |
| | PADD Total | 100,000 | -- | -- |
| Grand Total | | 804,374 | 23,666 | 1,559 |

Table 5-110 indicates that annual truck shipments are 804,374 deliveries while rail movements equal 23,666 deliveries. Total barge deliveries annually are 1,559 shipments.. Table 5-111 breaks annual requirements into monthly requirements and estimates turn around times given the anticipated shipment destinations.

**Table 5-111 Case C Transportation Requirements for Intra-PADD Movements**

| | Transport Truck Demand | Rail Car Demand | Barge Demand |
|---|---|---|---|
| Annual | 804,374 | 23,666 | 1559 |
| Monthly | 67,031 | 1972 | 130 |
| Turns per month | 91 † | 3 | 5 |
| Unit requirements | 736 | 657 | 26÷3=9 (††)(rounded) |
| Less existing equipment | 427 | 148 | 12÷3=4 |
| New units required for Case C | 309 | 509 | 5 †† |

*(†) 3.5 loads per day 26 days per month = 91 turns monthly*
*(††) Assumes new larger 30,000 barrel barges replace 3-10,000 barrel barges*

In Case C we assume a slightly higher number of loads per tractor/trailer rig because shipping distances are much shorter, now that a greater number of plants are available in each PADD.

Here it can be seen that intra-PADD movements would require 309 tractor/trailer rigs, 509 rail cars, and 5 barges (assuming 9-30,000 barrel barges replace 26-10,000 barrel barges). These figures reflect equipment needs after subtracting equipment added in Case B1. Cost estimates for these units are covered in the following table.

**Table 5-112 Study Case C Transportation Equipment Investment for Intra-PADD Product Movement**

| | | | | |
|---|---|---|---|---|
| 309 tractor/trailer rigs | @ | $115,000 | = | $35,535,000 |
| 509 rail cars (T108) | @ | $60,000 | = | $30,540,000 |
| 5 - 30M barrel barges | @ | $1,600,000 | = | $8,000,000 |
| Total | | | | $74,075,000 |

Consequently, the analysis indicates that while total freight costs would be $249,042,750, it would be necessary to expend $74,075,000 for capital investments in transportation equipment for intra-PADD movements for Case C.

To calculate amortized costs we use new Case C ethanol volume of 4.9 bgy. As noted in Appendix E the life cycle of barges and rail cars is assumed to be 15 years while transport truck and trailer life cycle is assumed to be 10 years. Amortized costs are listed in the following table.

**Table 5-113 Study Case C Amortized Transportation Equipment Costs for New Equipment for Intra-PADD Movements**

| | Cost | Amortized cost per gallon |
|---|---|---|
| 309 Transport tractor/trailer rigs | $35,535,000 | $0.0015 |
| 509 T108 Rail cars | $30,540,000 | $0.0011 |
| 5 Barges (30 mbbl) | $8,000,000 | $0.00028 |

Operating Costs: As noted in the previous section, the assumption is made that the operating costs are similar to those for any other petroleum product or petrochemical. Any incremental costs related to these modes of transportation are, of course, reflected in the freight price.

## 5.18 Study Case C Combined Transportation Demand & Freight Costs

To get a total picture of the transportation costs and demand, it is necessary to combine the transportation requirements of the ethanol that is exported from PADD II to the other PADDs, as well as the requiremnents covered for intra-PADD movements. Table 5-114 below indicates total investment in river barges for Case C would total $33.6 million at an amortized cost of $0.0012 per gallon of new ethanol volume. Rail car investments total $55.38 million at an amortized cost of $0.0019 per gallon of new ethanol volume. Truck/transport rig investment totals $35.535 million at an amortized cost of $0.0015 per gallon.

**Table 5-114 Study Case C Total and Amortized Transportation Equipment Costs**

| Category | River barge | Rail cars | Truck transport rigs |
|---|---|---|---|
| Import/export between PADDs | $25,600,000 | $24,840,000 | -- |
| Intra-PADD movements | $8,000,000 | $30,540,000 | $35,535,000 |
| Totals | $33,600,000 | $55,380,000 | $35,535,000 |
| Amortized Costs Per Gallon | $0.0012 | $0.0019 | $0.0015 |

The amortized cost for truck/transport rigs is the same in Case C as Case B1. The amortized cost of river barges and rail cars are both lower in Case C than in Case B1, significantly so in the case of rail cars. This is because relatively modest investments are required for rail cars for the additional 4.9 bgy of increased volume in Study Case C. This results from the fact that many of the rail cars purchased in Case B1 are redeployed due to market shifts in Case C, allowing higher utilization on a comparative volume basis. The amortized cost would, of course, be recaptured by the transportation industry through the revenues on freight to deliver the ethanol. As mentioned in Study Case B1, equipment costs should not be considered additive to freight charges in calculating program expenses. The equipment demand and cost information is provided primarily to identify requirements that might be placed on the transportation industry.

**Total Freight Costs**

Table 5-115 recaps the total annual freight cost of all movements to transport (and where applicable to redistribute) the 10.0 bgy of ethanol volume in Case C.

**Table 5-115 Study Case C Total Freight Costs for All Ethanol Movements**

| Category | Ship† | Ocean Barge† | River Barge | Rail | Truck Transport | Totals |
|---|---|---|---|---|---|---|
| Imports/exports between PADDS | $140,290,000 | $8,100,000 | -- | $170,500,000 | -- | $318,890,000 |
| Intra-PADD Movements | -- | -- | $13,975,000 | $28,650,000 | $206,417,750 | $249,042,750 |
| Total | $140,290,000 | $8,100,000 | $13,975,000 | $199,150,000 | $206,417,750 | $567,932,750 |

† Includes freight for river barge to Gulf Coast and transfer to/from staging.

Average freight charge per gallon $0.0568

The total freight cost by all modes is $567,932,750 which equates to an average freight cost of $0.0568 per gallon of ethanol shipped (and where applicable, redistributed). This compares to an average freight cost of $0.0767 per gallon in Study Case B1. The lower average freight cost is Case C can be attributed to the greater geographical diversity of plants in all PADDs. While this results in more truck deliveries, and truck freight rates are higher than other modes of transportation on a per mile basis, the distances between many plants and their markets are now relatively short. This lowers the overall freight charges and consequently, the average freight cost.

Table 5-116 provides a breakdown of import/export shipment volume by mode of transportation. Note that the total volume shipped exceeds the actual total imported by other PADDs. Imports from PADD II total 2.9 bgy for Study Case C while actual shipments total 4.16 bgy. This is a reflection of the intermodal scenario of barging to the Gulf Coast, staging product, and then shipping it to other destinations. Consequently, the volume shipped exceeds the volume imported by 1.26 bgy, which is the volume shipped by barge for staging at the Gulf Coast.

**Table 5-116 Study Case C - Imports/Exports - Ethanol Volumes by Transportation Mode (bgy)**

| PADD | Ocean Barge | River Barge | Rail Car | Ship | Totals |
|---|---|---|---|---|---|
| I | 0.115 | - | 0.495 | 0.690 | 1.300 |
| II | - | 1.26† | - | - | 1.260 |
| III | - | 0.155 | 0.545 | - | 0.700 |
| IV | - | - | - | - | - |
| V | - | - | 0.445 | 0.455 | 0.900 |
| Totals | 0.115 | 1.415 | 1.485 | 1.145 | 4.160 |

† The 1.26 bgy of barge movements in PADD II are to stage product for loading onto ships and ocean barges for subsequent delivery to PADDs I, III, and V

Table 5-117 provides a breakdown of intra-PADD ethanol shipment volumes by transportation mode. These volumes represent the shipments of ethanol produced within each PADD as well as any volume redistributed from any hub terminal operation.

**Table 5-117 Study Case C- Intra-PADD Ethanol Shipment Volumes by Transportation Mode (bgy)**

| PADD | | Intra-PADD | In-State Shipment | Intra-PADD Redistribution | Totals |
|---|---|---|---|---|---|
| I | Truck | 0.1350 | 1.2650 | 0.2000 | 1.6000 |
| | Rail | - | - | - | - |
| | Barge | - | - | 0.2000 | 0.2000 |
| II | Truck | 0.1618 | 2.8782 | - | 3.0400 |
| | Rail | 0.1500 | 0.3000 | - | 0.4500 |
| | Barge | - | 0.2100 | - | 0.2100 |
| III | Truck | 0.1740 | 0.5210 | - | 0.6950 |
| | Rail | 0.0600 | 0.1000 | - | 0.1600 |
| | Barge | 0.1400 | 0.1050 | - | 0.2450 |
| IV | Truck | 0.1205 | 0.1795 | - | 0.3000 |
| | Rail | 0.1000 | - | - | 0.1000 |
| | Barge | - | - | - | - |
| V† | Truck | - | 0.5000 | 0.3000 | 0.8000 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| Totals | Truck | 0.5913 | 5.3437 | 0.5000 | 6.4350 |
| | Rail | 0.3100 | 0.4000 | - | 0.7100 |
| | Barge | 0.1400 | 0.3150 | 0.2000 | 0.6550 |
| Grand Total | | 1.0413 | 6.0587 | 0.7000 | 7.8000 |

†Note that 0.08 bgy per year in PADD V (California) is assumed to be transferred by pipeline as an intra-PADD redistribution

Table 5-118 provides a breakdown of transportation cost by mode, as well as an average freight cost per gallon of ethanol shipped, for each PADD.

In Study Case C, the average freight cost for PADD V remains the highest at $0.107 per gallon, reflecting the continual need to import large volumes of ethanol from PADD II. The average freight cost for PADD IV is the second highest at $0.0739 per gallon. This is largely a reflection of shipping intra-PADD production, by rail, to more distant markets within the PADD. Next in highest average freight cost is PADD I at 0.0724 per gallon. Though down significantly from the average freight cost in Study Case B1, PADD I still imports large volumes from PADD II.

PADD III has the next to lowest average freight cost at $0.0582 per gallon. This is due to high in-PADD production in Study Case C and, of course, its lower cost of importing product from PADD II, compared to other more distant markets in the other PADDs. As would be expected, PADD II again has the lowest average freight cost at $0.0239 per gallon. The PADD II average freight cost is also lower than in Study Case B1. The low freight costs are simply a reflection of the high number of production facilities spread across the entire geography of the PADD. Shipments therefore tend to be over short distances.

**Table 5-118 Study Case C Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II | | Intra-PADD Ethanol Shipments | | | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | Ship/ barge | Rail | Truck | Rail | Barge | | |
| I | 2.7 | $80,040,000 | $61,875,000 | $49,562,500 | -- | $4,000,000 | $195,477,500 | $0.0724 |
| II | 3.7 | -- | -- | $71,231,500 | $13,500,000 | $3,675,000 | $88,406,500 | $0.0239 |
| III | 1.8 | $4,650,000 | $46,325,000 | $40,830,000 | $6,650,000 | $6,300,000 | $104,755,000 | $0.0582 |
| IV | 0.4 | -- | -- | $21,043,750 | $8,500,000 | -- | $29,543,750 | $0.0739 |
| V | 1.4 | $63,700,000 | $62,300,000 | $23,750,000 | -- | -- | $149,750,000 | $0.1070 |
| TOTAL | 10.0 | $148,390,000 | $170,500,000 | $206,417,750 | $28,650,000 | $13,975,000 | $567,932,750 | $0.0568 |

## 5.19 Study Case C Demands on the U.S. Railroad System

In addition to demand for railroad tank cars, there are also demands placed on the railroad system itself. An overview of the U.S. railway system is provided in Section 4.18 (page 4-135). Items specific to Study Case C are discussed below.

**Rail Infrastructure Demands:** For Study Case C, the total combined number of rail car shipments for imports from PADD II, and intra-PADD transfers, is estimated to be 73,165 rail car shipments annually as broken down in the following table.

**Table 5-119 Study Case C Total Rail Car Movements**

| PADD | | Annual Rail Car Movements Per Year |
|---|---|---|
| I | | 16,500 |
| II | Intra-PADD transfers | 15,000 |
| III | 18,166 imports + 5,333 intra-PADD | 23,499 |
| IV | Intra-PADD transfers | 3,333 |
| V | | 14,833 |
| Total | | 73,165 |

Total rail car shipments in Case C represent an annual increase of 24,167 rail car deliveries over those in Case B1.

The 73,165 annual rail car shipments represent only 4.75% of annual tank car loadings by the Class I railroads and only 0.33% of all tank car loadings. Compared to all rail car loadings, these ethanol volumes represent relatively modest increases by railroad industry standards.

## 5.20 Study Case C Demands on the Inland and Intercoastal Waterway System

An expanded ethanol industry will result in more barge shipments on the inland and intercoastal waterway systems. This system is depicted in Appendix J, and as mentioned in Study Case B1 includes over 11,000 miles of waterway with 226 lock sites and 268 chambers.

Movements along intercoastal waterways, as a result of increased ethanol production in Case C, are minimal and not expected to have any major impact. However, increased barge movements on the inland waterways, resulting from Case C, need to be explored more closely.

Inland waterway traffic grew from less than 500 million tons annually in the early 1980s to almost 625 million tons in 1998. Traffic is projected to increase 1.3% yearly or nearly 34% by 2020, to roughly 830 million tons. The utilization of key waterways is expected to increase at higher rates depending on their commodity mix. One of the key concerns with increased inland waterway traffic is delays at locks. Delays due to undersized locks nearing capacity continue to increase on key waterways. Of the top 23 locks in terms of delay, 13 are on the Upper Mississippi and Illinois rivers where much of the ethanol shipments would originate. It should also be noted that the upper Mississippi and Missouri rivers are typically closed from December through February due to frozen waters.

A key problem on the Upper Mississippi and Illinois rivers, as well as the Tennessee river, is that locks are generally 600 ft. long requiring tows to be cut in half, which more than doubles lock passing time. This is also discussed in the report “Ethanol Logistics Colloquies Overview and Observations” in Appendix F.

Appendix J depicts key areas of lock delays, most of which would impact ethanol shipments given that they are located predominantly at the origination and staging areas for ethanol movement.

These delays can be more pronounced during peak traffic months, during which time they can increase several orders of magnitude as depicted in Appendix J.

Some locks are not only undersized but the increasing average age of these facilities means more maintenance and unexpected closures.

The Army Corps of Engineers does have major lock improvement programs underway. Six new larger locks are under construction while four are undergoing major rehabilitation. These are also depicted in Appendix J.

The Corps has a requirement needs assessment study in progress analyzing the needs at some 80 locks, including 37 on the Upper Mississippi and Illinois Rivers. However, implementing any identified needs for improvement will take several years of construction and, of course, will be subject to budget considerations.

The real question is how much traffic will ethanol add to, what in some sections, is an already strained system.

Study Case C estimates that 1.26 bgy of ethanol would be moved to New Orleans via barge, for staging and subsequent shipment to the East and West Coasts. An additional 0.610 bgy in annual barge shipments would be required for direct shipments to PADD III and intra-PADD product movements (exclusive of coastal movements in PADD I). Total movements would then be 1.87 bgy. At an average weight of 6.58 pounds per gallon, this equals 6.15 million short tons. This equates to only 0.98% of current tonnage moved.

While ethanol movements are a very small percentage of total tonnage moved on the inland waterway system, it should be noted that a large portion of these ethanol shipments will originate and terminate in the vicinity of some locks which have traditionally experienced delays. Therefore, any future major ethanol expansion should include a more detailed assessment (i.e., private industry study or assessment by the Army Corp of Engineers) to insure adequate capabilities.

### 5.21 Ethanol Plant Coproducts

Although not a formal part of this study, it should be noted that increased grain based ethanol production will result in increased coproducts such as Distillers Dried Grain and Solubles (DDGS), in the case of dry mills. Since the size of the plants will probably dictate largely dry mill operations, some rough estimates can be made.

For Study Case C, 4.5 billion gallons of ethanol production is grain based. At a yield of 2.65 gallons per bushel (denatured basis) this equates to 1.7 billion bushels of corn. Of this amount, 0.76 billion bushels is already being used in ethanol production at existing plants. Therefore, increased corn grind is 0.94 billion bushels. Each bushel of corn processed in a dry mill yields 18.5 pounds of DDGS equating to 17.39 billion incremental pounds or 8,695,000 short tons. These volumes would need to be shipped to various markets and coastal export centers, presumably by rail and river barge. This is a difficult area to assess because with increased production of DDGS, it is likely that large Midwestern cattle feed lots would use a larger volume of DDGS. This in turn would eliminate the need for long distance shipments to other markets (both domestic and foreign). Furthermore, any DDGS shipped would, at least to some degree, replace corn shipments that would otherwise be shipped to other areas for export. This, too, would offset some of the impact of increased DDGS shipments. Although not included in this analysis, the coproducts are mentioned here because they would place a simultaneous increased demand on rail and river traffic capabilities to the extent that they represent a net increase in tonnage shipped.

## 5.22 Case C Recommendations Resulting from Transportation Analysis

The recommendations for Case C remain the same as for Case B1. This includes a study to assess the impact of increased demands on the inland waterways systems and a more detailed assessment of Jones Act/OPA90 compliant vessels, or alternatives to their use (see Case B1, page 4-140 for a more detailed discussion).

**Section 5: Study Case C**

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# Section 6

## Summary, Observations, and Recommendations

## 6.0 Summary, Observations, and Recommendations

This section provides a summary comparison of Study Case B1 and Study Case C. The recommendations made in Sections 4 and 5 of the report are also discussed collectively in this section for the convenience of the reader.

## 6.1 Ethanol Production and Use

In Case B1, there are a total of 125 ethanol production facilities producing a total of 5.1 bgy. In Case C the number of plants increases to 241 with ethanol production capabilities of 10.0 bgy. These totals, and a breakdown by PADD, are listed in the following table.

**Table 6-1 Total Ethanol Production-Plants and Capacity by PADD**
**Number of Plants/Total Capacity (bgy)**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 6/0.2 | 31/1.4 |
| II | 103/4.5 | 144/6.6 |
| III | 5/0.2 | 28/1.1 |
| IV | 0.0† | 17/0.4 |
| V | 11/0.2 | 21/0.5 |
| Totals | 125/5.1† | 241/10.0 |

*† As discussed in the report, the TMS scenarios are schematic in design and do not pick up the small amount of existing production on PADD IV which is currently 4 plants producing 12.5 mmgy. This would bring the total number of plants to 129.*

Both study cases assume all ethanol production is used. Use by PADD, for both Study Cases B1 and C, is broken down in the following table.

**Table 6-2 Total Ethanol Use by PADD (bgy)**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 1.3 | 2.7 |
| II | 2.2 | 3.7 |
| III | 0.7 | 1.8 |
| IV | 0.1 | 0.4 |
| V | 0.8 | 1.4 |
| Totals | 5.1 | 10.0 |

The majority of ethanol used is blended in E-10 (or E-5.7 in the case of California). Case B1 represents a volume increase of 2.987 bgy for use in these blends. Case C represents an additional 4.5 bgy for this use. These figures are recapped, and separated by PADD, in the following table.

**Table 6-3 New Ethanol Volume Used In E-10/E-5.7 By PADD (bgy)**

| PADD | Existing | New Case B1 Volume | New Case C Volume | Total |
|---|---|---|---|---|
| I | 0.098 | 1.102 | 1.200 | 2.400 |
| II | 0.928 | 1.072 | 1.300 | 3.300 |
| III | 0.074 | 0.626 | 1.100 | 1.800 |
| IV | 0.058 | 0.042 | 0.300 | .400 |
| V† | 0.655† | 0.145 | 0.600 | 1.400 |
| Totals† | 1.813† | 2.987 | 4.500 | 9.300 |

† *Includes 0.6 bgy used in California that is projected to be in place by the end of 2002.*

The study also examined the requirement for expanded use of E-85. Ethanol used in E-85 totals 0.3 bgy in Case B1 and 0.7 bgy in Case C. All E-85 sales are in PADDs I and II as recapped in the following table.

| Table 6-4 Ethanol Use in E85 for PADDs I and II (bgy) | | |
|---|---|---|
| **PADD** | **Case B1** | **Case C** |
| I | 0.1 | 0.3 |
| II | 0.2 | 0.4 |
| III | -- | -- |
| IV | -- | -- |
| V | -- | -- |
| Totals | 0.3 | 0.7 |

## 6.2 Terminal Equipment Requirements and Retail Conversion Needs

To achieve the level of ethanol use studied (for sales in E-10/E-5.7 and E-85) significant investments at the terminal level, as well as at the retail level will be required. A much greater number of terminals will need to handle ethanol than is currently the case. In Case B1 an estimated 495 terminals would need to handle ethanol, while in Case C an estimated 908 terminals would be required. While an adequate number of terminals have water accessibility, a number of terminals will need to add rail spurs to accommodate receipt of rail cars. In Case B1 an estimated 49 terminals need to add rail spurs. In Case C an additional 27 terminals would need to add rail spurs. Once the terminals are converted and rail spurs are added, the terminal profile, by PADD, would be as listed in the following table.

**Table 6-5 Profile of Ethanol Terminals**

| PADD | Number of Terminals with Ethanol | | Number of Ethanol Terminals with Water Capability | | Number of Ethanol Terminals with Rail Capability | |
|---|---|---|---|---|---|---|
| | **Case B1** | **Case C** | **Case B1** | **Case C** | **Case B1** | **Case C** |
| I | 96 | 201 | 44 | 90 | 42 | 44 |
| II | 228 | 368 | 40 | 40 | 37 | 61 |
| III | 87 | 183 | 32 | 32 | 27 | 41 |
| IV | 11 | 39 | 0 | 0 | 7 | 11 |
| V | 73 | 117 | 10 | 15 | 17 | 24 |
| Totals | 495 | 908 | 126 | 177 | 130 | 181 |

To achieve the ethanol terminal profile listed in the above table would require significant terminal improvements such as new or converted tanks, blending systems, and in some cases installation of rail spurs.

In Case B1 an estimated 181 tanks totaling 1,579 mbbl capacity would need to be built. An additional 298 tanks totaling 2,836 mbbl capacity would need to be built in Study Case C. Collectively then, for Cases B1 and C combined, the total volume would require 479 new tanks with a capacity of 4,415 mbbl. These estimates are broken down by PADD in the following table.

**Table 6-6 Estimated Requirement for New Tanks**
**Tanks/Capacity (mbbl)**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | 45 / 660 | 87 / 1,137 | 132 / 1,797 |
| II | 74 / 326 | 88 / 670 | 162 / 996 |
| III | 47 / 388 | 76 / 590 | 123 / 978 |
| IV | 5 / 50 | 14 / 80 | 19 / 130 |
| V | 10 / 155 | 33 / 359 | 43 / 514 |
| Totals | 181 / 1,579 | 298 / 2,836 | 479 / 4,415 |

A number of existing tanks (either idle or underutilized) would also need to be converted to ethanol use. In Case B1 we estimate that 63 tanks totaling 471 mbbl of storage capacity would need to be converted. In Case C an additional 44 tanks totaling 295 mbbl of capacity would be converted. For the two cases combined, the tank conversions total 107 tanks with a capacity of 766 mbbl. These figures are broken down by PADD in the following table.

| **Table 6-7 Estimated Requirement for Tank Conversions Tanks/Capacity (mbbl)** | | | |
|---|---|---|---|
| **PADD** | **Case B1** | **Case C** | **Total** |
| I | 18 / 235 | 7 / 65 | 25 / 300 |
| II | 27 / 86 | 19 / 120 | 46 / 206 |
| III | 15 / 115 | 7 / 45 | 22 / 160 |
| IV | 1 / 10 | 6 / 35 | 7 / 45 |
| V | 2 / 25 | 5 / 30 | 7 / 55 |
| Totals | 63 / 471 | 44 / 295 | 107 / 766 |

Most terminals converting to ethanol for the first time will need to install blending systems to provide automated blending, and compliance documentation for various regulations. In Case B1, an estimated 287 terminals would need to install such systems. An additional 379 terminals would need to install such systems in Case C, bringing the combined total to 666 systems. Estimated requirements for blending systems are broken down by PADD in the following table.

| **Table 6-8 Estimated Number of Terminals Requiring Blending Equipment by PADD** | | | |
|---|---|---|---|
| **PADD** | **Case B1** | **Case C** | **Total** |
| I | 81 | 101 | 182 |
| II | 110 | 119 | 229 |
| III | 74 | 91 | 165 |
| IV | 8 | 26 | 34 |
| V | 14 | 42 | 56 |
| Totals | 287 | 379 | 666 |

Petroleum products terminals are typically not set up for delivery of product by rail. Since this is one of the major modes of transportation for ethanol, a number of terminals will need to add rail spurs to accommodate ethanol receipt by rail car. In Case B1 an estimated 49 terminals would need to install rail spurs, while in Case C 27 terminals would need to do so. This brings total rail spur installations for the combined Cases to 76. Estimated rail spur installation requirements by PADD are listed in the following table.

**Table 6-9 Estimated Number of Terminals Requiring Rail Spur Installation by PADD**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | 20 | 2 | 22 |
| II | 15 | 10 | 25 |
| III | 10 | 10 | 20 |
| IV | 3 | 2 | 5 |
| V | 1 | 3 | 4 |
| Totals | 49 | 27 | 76 |

There are likely to be unforeseen miscellaneous expenses at terminals installing new tanks or converting existing tanks. Such items could include additional site work, installation of a receiving station for ethanol delivery by truck, and things of this nature. This is addressed in the study by providing a contingency of $20,000 for each such terminal. In Case B1, 244 terminals were in this category, and in Case C, a total of 342 terminals were in this category. This brings the total for the combined Cases to 586 as broken down in the following table.

**Table 6-10 Estimated Number of Terminals With Miscellaneous Contingency Expense by PADD**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | 63 | 94 | 157 |
| II | 101 | 107 | 208 |
| III | 62 | 83 | 145 |
| IV | 6 | 20 | 26 |
| V | 12 | 38 | 50 |
| Totals | 244 | 342 | 586 |

A significant number of retail outlets would also need to be converted to achieve the E-10/E-5.7 volumes anticipated in the Study Cases. For Case B1, an estimated 25,214 retail outlets would need to be converted. An additional 61,528 would need to be converted in Case C. When complete, there is an estimated total of 119,658 retail outlets offering E-10/E-5.7 ethanol blends. The following table provides a profile of retail outlets by PADD, for each Study case.

**Table 6-11 Retail Outlet Profile**

| PADD | Existing | Case B1 | Case C | Total |
|---|---|---|---|---|
| I | 980 | 11,020 | 12,000 | 24,000 |
| II | 10,919 | 12,611 | 20,470 | 44,000 |
| III | 1,058 | 8,942 | 20,000 | 30,000 |
| IV | 725 | 525 | 3,750 | 5,000 |
| V† | 9,234† | 2,116 | 5,308 | 16,658 |
| Totals | 22,916† | 35,214 | 61,528 | 119,658 |

† *Includes California facilities to be converted by 2003.*

The study also examined the requirement and cost of expanding the distribution of E-85 in PADDs I and II. To achieve the targeted numbers in the study cases, 2556 E-85 installations (new and converted) are added in Case B1 and 2,462 additional units (new and converted) are added in Case C, bringing the total operable E-85 facilities to 5,018. These installations are broken down by PADD in the following table.

**Table 6-12 E-85 Dispensing Systems Installed in PADDs I and II**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | 852 | 1,023 | 1,875 |
| II | 1,704 | 1,439 | 3,143 |
| Totals | 2,556 | 2,462 | 5,018 |

Both Study Case B1 and C break down the expenditures for each of these expense categories by PADD. The total cost for all terminal and retail level expenditures for the E-10/E-5.7 portion of the study cases is $153,575,260 for Study Case B1 and $207,352,110 for Study Case C. This brings the total for the combined cases to $360,927,370. Of course, these investments would not take place all at one time. They will be phased in over time as new ethanol plants are brought on line. These expenses are broken down by PADD in the following table.

**Table 6-13 Terminal & Retail Level Expenses for E10/E5.7 by PADD**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | $48,656,800 | $55,265,000 | $103,921,800 |
| II | $53,489,490 | $63,792,890 | $117,282,380 |
| III | $38,340,780 | $53,035,000 | $91,375,780 |
| IV | $4,664,750 | $12,482,500 | $17,147,250 |
| V | $8,423,440 | $22,776,720 | $31,200,160 |
| Totals | $153,575,260 | $207,352,110 | $360,927,370 |

Just looking at total expenditures does not provide a good assessment tool because one must consider the volumes involved. In the study cases, we addressed this by amortizing these investments over the new volume of ethanol achieved in each program (per gallon of new ethanol volume). When this is done it can be seen that the amortized cost for terminal and retail level investments in Case B1 is $0.0080 per gallon, while the amortized cost of Case C is $0.0072. The amortized cost for the volume increase of the combined Study Cases is $0.0075. The following table provides the amortized costs on a cents per gallon of new ethanol volume basis for each PADD, in each study case.

**Table 6-14 Amortized Cost per Gallon for Terminal & Retail Unit Expenses for E10/E5.7 by PADD**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | $0.0069 | $0.0072 | $0.0070 |
| II | $0.0078 | $0.0077 | $0.0077 |
| III | $0.0096 | $0.0075 | $0.0083 |
| IV | $0.0173 | $0.0065 | $0.0078 |
| V | $0.0091 | $0.0059 | $0.0065 |
| Totals | $0.0080 | $0.0072 | $0.0075 |

It is also beneficial to look at the amortized cost on a per gallon on blended fuel basis since this is ultimately what impacts the price at the retail consumer level. Since E-10 represents one-tenth of the gallon in all PADDs except PADD V, the amortized cost on a per gallon basis is one-tenth of the amount listed in Table 6-14. For PADD V, the numbers are slightly different because ethanol is used at the 5.7 v% levels in California. In the case of PADD V the amortized cost on a per blended gasoline basis is $0.00053 for Study Case B1, $0.00053 for Study Case C, and $0.00052 for the combined Study cases.

The aforementioned costs do not include the investments, at the retail level, for the E-85 conversions and installations listed earlier. When these are included in the totals it makes it difficult to compare costs, since the higher cost of E-85 is only experienced in PADDs I and II. In Study Case B1 the investment for E-85 retail infrastructure is $147,927,000 and in Case C it is $140,004,000, The combined total for both cases is $287,931,000.

Because of the significant expense for retail infrastructure, the amortized cost of the E-85 program is $0.069 per gallon of new ethanol volume in Case B1 and $0.0546 per gallon in Case C. The amortization for the combined cases is $0.0642 per gallon of new ethanol used in E-85.

These figures are broken down in the following table. The numbers in parentheses following the total are the amortized costs on a dollars per gallon of new ethanol volume basis.

**Table 6-15 Estimated Cost of E-85 Retail Infrastructure by PADD**
**Total Cost (amortized cost per gallon)**

| PADD | Case B1 | Case C | Total |
|---|---|---|---|
| I | $49,309,000 ($0.0769) | $59,652,000 ($0.0465) | $108,961,000 ($0.0567) |
| II | $98,618,000 ($0.0769) | $80,352,000 ($0.0627) | $178,970,000 ($0.0698) |
| III | -- | -- | -- |
| IV | -- | -- | -- |
| V | -- | -- | -- |
| Totals | $147,927,000 ($0.0769) | $140,004,000 ($0.0546) | $287,931,000 ($0.0642) |

## 6.3 Ethanol Transportation Analysis

Because of the amount of ethanol exported from PADD II, to the other PADDs, and the fact that this ethanol moves by ship, barge, and rail, there are significant increases in the utilization of these transportation modes.

In Case B1 0.94 bgy of the exports from PADD II are moved by river barge to the Gulf Coast staging area and an additional 0.05 bgy moves by river barge directly to PADD III terminals. In Case C 1.26 bgy is shipped to the Gulf Coast staging area. A small amount transfers to ocean barge for delivery to PADD III, but the majority of the product will be loaded onto ships for transport to PADDs I and V. An additional 0.155 bgy moves by river barge directly to PADD III terminals. The following table breaks down the volumes of waterborne ethanol movements exported from PADD II in each Study Case.

**Table 6-16 Total Ethanol Volume for Waterborne Cargoes Exported from PADD II (bgy)**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 0.540 | 0.805 |
| II | -- | -- |
| III | 0.085† | 0.155† |
| IV | -- | -- |
| V | 0.365 | 0.455 |
| Totals | 0.990 | 1.415 |

† Moves by river barge directly to terminals in PADD III with no staging requirement.

The total freight costs for waterborne cargoes exported from PADD II include barge shipment, staging costs, and movement by ship to coastal markets. Total waterborne freight costs for Case B1 are $111,055,000. In Study Case C (representing the combined Case totals) freight charges for waterborne movements of ethanol are $148,390,000. These figures are broken down in the following table.

**Table 6-17 Total Freight Cost for Waterborne Cargoes Exported from PADD II**

| PADD | Case B1 | Case C |
|---|---|---|
| I | $57,400,000 | $80,040,000 |
| II | -- | -- |
| III | $2,555,000 | $4,650,000 |
| IV | -- | -- |
| V | $51,100,000 | $63,700,000 |
| Totals | $111,055,000 | $148,390,000 |

A significant amount of the ethanol volume exported from PADD II also moves by rail tank car. In Study Case B1 an estimated total of 43,665 annual rail car shipments are required. In Case C (representing the combined Case total) an estimated total of 49,499 rail cars are shipped annually. These estimates are broken down in the following table.

**Table 6-18 Total Annual Rail Car Shipments for PADD II Exports**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 18,666 | 16,500 |
| II | -- | -- |
| III | 13,833 | 18,166 |
| IV | 3,333 | -- |
| V | 7,833 | 14,833 |
| Totals | 43,665 | 49,499 |

The total freight charges for ethanol exported from PADD II, by rail, in Case B1 is $142,675,000. In Case C, the total freight charge for such shipments is $170,500,000. The increase is largely a reflection of the net increase of 0.175 bgy shipped, with more product moving by rail to California. These freight charges are broken down by PADD in the following table.

**Table 6-19 Total Freight Cost for Rail Shipments Exported from PADD II**

| PADD | Case B1 | Case C |
|---|---|---|
| I | $70,000,000 | $61,875,000 |
| II | -- | -- |
| III | $35,275,000 | $46,325,000 |
| IV | $4,500,000 | -- |
| V | $32,900,000 | $62,300,000 |
| Totals | $142,675,000 | $170,500,000 |

Table 6-20 provides a breakdown of import/export ethanol volumes to each PADD by transportation mode in Study Case B1 while Table 6-21 presents the same information for Study Case C.

**Table 6-20 Study Case B1 - Imports/Exports - Ethanol Volumes by Transportation Mode (bgy)**

| PADD | Ocean Barge | River Barge | Rail Car | Ship | Totals |
|---|---|---|---|---|---|
| I | 0.050 | - | 0.560 | 0.490 | 1.100 |
| II | - | 0.940† | - | - | 0.940 |
| III | 0.035 | 0.050 | 0.415 | - | 0.500 |
| IV | - | - | 0.100 | - | 0.100 |
| V | - | - | 0.235 | 0.365 | 0.600 |
| Totals | 0.085 | 0.990 | 1.310 | 0.855 | 3.240 |

† The 0.940 bgy of barge movements in PADD II are to stage product for loading onto ships and ocean barges for subsequent delivery to PADDs I, III, and V

**Table 6-21 Study Case C - Imports/Exports - Ethanol Volumes by Transportation Mode (bgy)**

| PADD | Ocean Barge | River Barge | Rail Car | Ship | Totals |
|---|---|---|---|---|---|
| I | 0.115 | - | 0.495 | 0.690 | 1.300 |
| II | - | 1.26† | - | - | 1.260 |
| III | - | 0.155 | 0.545 | - | 0.700 |
| IV | - | - | - | - | - |
| V | - | - | 0.445 | 0.455 | 0.900 |
| Totals | 0.115 | 1.415 | 1.485 | 1.145 | 4.160 |

† The 1.26 bgy of barge movements in PADD II are to stage product for loading onto ships and ocean barges for subsequent delivery to PADDs I, III, and V

Table 6-22 shows the net changes, between Study Case B1 and Study Case C, for ethanol volumes imported/exported by transportation mode. In Study Case C, PADD I imports 0.2 bgy more than in Case B1. PADD II has an increase in exports of 0.32 bgy. PADD III imports 0.2 bgy more volume. PADD IV imports 0.1 bgy less. PADD V imports an additional 0.3 bgy. The net change of shipments for Study Case C is an increase of 0.92 bgy over Study Case B1.

Comparing imports/exports in Study Case C to Study Case B1 by transportation mode shows that ocean barge shipments decrease by 0.03 bgy while river barge shipments increase by 0.425 bgy. Rail car shipments increase by 0.175 bgy and movements by ship increase 0.29 bgy.

**Table 6-22 Net Change In Imports/Exports-Ethanol Shipment Volumes by Transportation Mode - Case C Compared to Case B1 (bgy)**

| PADD | Ocean Barge | River Barge | Rail Cars | Ship | Total |
|---|---|---|---|---|---|
| I | 0.065 | - | (0.065) | 0.200 | 0.200 |
| II | - | 0.320 | - | - | 0.320 |
| III | (0.035) | 0.105 | 0.130 | - | 0.200 |
| IV | - | - | (0.100) | - | (0.100) |
| V | - | - | 0.210 | 0.090 | 0.300 |
| Net Change | (0.030) | 0.425 | 0.175 | 0.290 | 0.920 |

A significant amount of ethanol is also shipped intra-PADD. This category includes in-state shipments directly from the plant to a terminal in the same state, intra-PADD transfers which are shipments from a plant to a terminal location in a different state within the same PADD, and intra-PADD redistribution which is product reshipped from a hub terminal to a secondary terminal in the same PADD. These shipments are made by barge, rail, and truck.

Annual intra-PADD barge movements require 726 barge shipments in Case B1 and 1,559 barge shipments in Case C. These shipments are covered in the following table.

**Table 6-23 Annual Intra-PADD Barge Shipments by PADD**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 476 | 476 |
| II | 214 | 500 |
| III | 36 | 583 |
| IV | -- | -- |
| V | -- | -- |
| Totals | 726 | 1,559 |

Total freight charges for intra-PADD barge shipments are $7,450,000 in Case B1 and $13,975,000 in Case C, as recapped in the following table.

**Table 6-24 Total Freight Charges for Intra-PADD Barge Shipments by PADD**

| PADD | Case B1 | Case C |
|---|---|---|
| I | $4,000,000 | $4,000,000 |
| II | $3,150,000 | $3,675,000 |
| III | $300,000 | $6,300,000 |
| IV | -- | -- |
| V | -- | -- |
| Totals | $7,450,000 | $13,975,000 |

In PADD I, barge shipment volumes stay the same for both Study Cases, as do the projected freight costs. For PADD II, the number of barge shipments increases significantly in Case C. However, the associated freight charges increase only modestly as shipments are shifted more to in-state shipments as opposed to intra-PADD shipments. This results in shorter shipping distances and lower freight charges per gallon. Barge shipments increase significantly in PADD III resulting in increased freight charges for this category. This change in shipments by mode is discussed in greater detail later in this report section.

There are also intra-PADD ethanol shipments by rail. In Case B1 a total of 5,333 rail tank cars are shipped annually. In Case C such shipments rise to 23,666 cars annually. The increase is a result of increased shipments by this mode in PADDs II, III, and IV. These figures are recapped in the following table.

| Table 6-25 Number of Annual Rail Car Shipments for Intra-PADD Rail Shipments by PADD | | |
|---|---|---|
| PADD | Case B1 | Case C |
| I | -- | -- |
| II | 5,333 | 15,000 |
| III | --- | 5,333 |
| IV | -- | 3,333 |
| V | -- | -- |
| Totals | 5,333 | 23,666 |

The resulting freight charge for intra-PADD rail shipments totals $12,800,000 in Case B1 and $28,650,000 in Case C. Freight charges in PADDs III and IV are a reflection of increased shipments. In PADD II freight charges increase only slightly despite a near tripling in volume of shipments by this mode. This is because intra-PADD shipments decrease and in-state shipments increase, resulting in shorter shipping distances and lower average freight costs. These charges are broken down by PADD in the following table.

| Table 6-26 Total Freight Charges for Intra-PADD Rail Shipments by PADD | | |
|---|---|---|
| PADD | Case B1 | Case C |
| I | -- | -- |
| II | $12,800,000 | $13,500,000 |
| III | --- | $6,650,000 |
| IV | -- | $8,500,000 |
| V | -- | -- |
| Totals | $12,800,000 | $28,650,000 |

Finally significant amounts of intra-PADD shipments move by transport truck. In Case B1 an estimated 399,375 transport trucks of ethanol are delivered annually. In Case C the total rises to 804,374 annual transport truck deliveries of ethanol. These figures are broken down by PADD in the following table.

**Table 6-27 Annual Transport Truck Deliveries for Intra-PADD Truck Shipments by PADD**

| PADD | Case B1 | Case C |
|---|---|---|
| I | 50,000 | 200,000 |
| II | 243,750 | 380,000 |
| III | 35,625 | 86,875 |
| IV | 1,250 | 37,499 |
| V | 68,750 | 100,000 |
| Totals | 399,375 | 804,374 |

The resulting freight charges for these intra-PADD truck deliveries total $117,090,000 in Case B1 and $206,417,750 in Case C. While shipments by this mode more than doubled, total freight charges did not increase quite as much, due to a greater number of shipments being made over shorter distances in Case C. These freight charges are shown by PADD in the following table.

**Table 6-28 Total Freight Charges for Truck Deliveries for Intra-PADD Shipments by PADD**

| PADD | Case B1 | Case C |
|---|---|---|
| I | $13,125,000 | $49,562,500 |
| II | $77,940,000 | $71,231,500 |
| III | $8,025,000 | $40,830,000 |
| IV | $200,000 | $21,043,750 |
| V | $17,800,000 | $23,750,000 |
| Totals | $117,090,000 | $206,417,750 |

Table 6-29 provides a breakdown of Study Case B1 intra-PADD ethanol shipment volumes by mode for each PADD while Table 6-30 provides the same information for Study Case C.

**Table 6-29 Study Case B1 - Intra-PADD Ethanol Shipment Volumes by Transportation Mode (bgy)**

| PADD | | Intra-PADD | In-State Shipment | Intra-PADD Redistribution | Totals |
|---|---|---|---|---|---|
| I | Truck | 0.0250 | 0.1750 | 0.2000 | 0.4000 |
| | Rail | - | - | - | - |
| | Barge | - | - | 0.2000 | 0.2000 |
| II | Truck | 0.3876 | 1.5624 | - | 1.9500 |
| | Rail | 0.1600 | - | - | 0.1600 |
| | Barge | 0.0900 | - | - | 0.0900 |
| III | Truck | 0.0500 | 0.1800 | 0.1000 | 0.3300 |
| | Rail | - | - | - | - |
| | Barge | 0.0150 | - | - | 0.0150 |
| IV | Truck | - | - | 0.0100 | 0.0100 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| V† | Truck | 0.0300 | 0.1700 | 0.3500 | 0.5500 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| Totals | Truck | 0.4926 | 2.0874 | 0.6600 | 3.2400 |
| | Rail | 0.1600 | - | - | 0.1600 |
| | Barge | 0.1050 | - | 0.2000 | 0.3050 |
| Grand Total | | 0.7576 | 2.0874 | 0.8600 | 3.7050 |

†Note that 0.05 bgy per year in PADD V (California) is assumed to be transferred by pipeline as an intra-PADD redistribution

**Table 6-30 Study Case C- Intra-PADD Ethanol Shipment Volumes by Transportation Mode (bgy)**

| PADD | | Intra-PADD | In-State Shipment | Intra-PADD Redistribution | Totals |
|---|---|---|---|---|---|
| I | Truck | 0.1350 | 1.2650 | 0.2000 | 1.6000 |
| | Rail | - | - | - | - |
| | Barge | - | - | 0.2000 | 0.2000 |
| II | Truck | 0.1618 | 2.8782 | - | 3.0400 |
| | Rail | 0.1500 | 0.3000 | - | 0.4500 |
| | Barge | - | 0.2100 | - | 0.2100 |
| III | Truck | 0.1740 | 0.5210 | - | 0.6950 |
| | Rail | 0.0600 | 0.1000 | - | 0.1600 |
| | Barge | 0.1400 | 0.1050 | - | 0.2450 |
| IV | Truck | 0.1205 | 0.1795 | - | 0.3000 |
| | Rail | 0.1000 | - | - | 0.1000 |
| | Barge | - | - | - | - |
| V† | Truck | - | 0.5000 | 0.3000 | 0.8000 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| Totals | Truck | 0.5913 | 5.3437 | 0.5000 | 6.4350 |
| | Rail | 0.3100 | 0.4000 | - | 0.7100 |
| | Barge | 0.1400 | 0.3150 | 0.2000 | 0.6550 |
| Grand Total | | 1.0413 | 6.0587 | 0.7000 | 7.8000 |

†Note that 0.08 bgy per year in PADD V (California) is assumed to be transferred by pipeline as an intra-PADD redistribution

Table 6-31 shows the net change of volume by shipment mode for each intra-PADD category by PADD. These volumes represent the net change (increase or decrease) of volumes shipped for Case C compared to Case B1.

All PADDs have significant increases in shipments by truck owing to the greater number of plants in each PADD for Study Case C. The total increase of volume shipped by truck is 3.195 bgy. Barge shipments increased by 0.35 bgy, although the majority of that increase is more for in-state shipments in PADD II. This is a reflection of the high market penetration in PADD II which would result in some terminals preferring to accept ethanol by barge, primarily for convenience. Rail shipments increase by a modest 0.35 bgy. The increased intra-PADD shipment volumes by all modes in Study Case C total 4.095 bgy.

**Table 6-31 Intra-PADD Ethanol Shipment Volumes by Transportation Mode (bgy) - Case C compared to Case B1**

| PADD | | Intra-PADD | In-State Shipment | Intra-PADD Redistribution | Totals |
|---|---|---|---|---|---|
| I | Truck | 0.1100 | 1.0900 | - | 1.2000 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| II | Truck | (0.2258) | 1.3158 | - | 1.0900 |
| | Rail | (0.0100) | 0.3000 | - | 0.2900 |
| | Barge | (0.0900) | 0.2100 | - | 0.1200 |
| III | Truck | 0.1240 | 0.3410 | (0.1000) | 0.3650 |
| | Rail | 0.0600 | 0.1000 | - | 0.1600 |
| | Barge | 0.1250 | 0.1050 | - | 0.2300 |
| IV | Truck | 0.1205 | 0.1795 | (0.1000) | 0.2900 |
| | Rail | 0.1000 | - | - | 0.1000 |
| | Barge | - | - | - | - |
| V | Truck | (0.0300) | 0.3300 | 0.0500 | 0.2500 |
| | Rail | - | - | - | - |
| | Barge | - | - | - | - |
| Totals | Truck | 0.0987 | 3.2563 | (0.1600) | 3.1950 |
| | Rail | 0.1500 | 0.4000 | - | 0.5500 |
| | Barge | 0.0350 | 0.3150 | - | 0.3500 |
| Grand Total | | 0.2837 | 3.9713 | (0.1600) | 4.0950 |

The total freight charges for all categories is $391,070,000 in Case B1 and $567,932,750 in Case C. The average freight cost is $0.0767 per gallon in Case B1 and $0.0568 in Case C. These figures are recapped in the following table.

| Table 6-32 Total Freight Cost For All Categories | | |
|---|---|---|
| PADD | Case B1 | Case C |
| Ship | $105,000,000† | $140,290,000† |
| Ocean barge | $6,055,000† | $8,100,000† |
| River barge | $7,450,000 | $13,975,000 |
| Rail | $155,475,000 | $199,150,000 |
| Truck | $117,090,000 | $206,417,750 |
| Totals | $391,070,000 | $567,932,750 |
| Average per gallon | $0.0767 | $0.0568 |

*† The freight cost for river barges to ship to the Gulf Coast staging area for shipment to the East and West Coasts is added in the ship or ocean barge category as applicable.*

Table 6-33 provides a breakdown of Study Case B1 cost by mode for each PADD while Table 6-34 provides the same information for Study Case C.

**Table 6-33 Study Case B1 Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II | | Intra-PADD Ethanol Shipments | | | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | Ship/ barge | Rail | Truck | Rail | Barge | | |
| I | 1.3 | $57,400,000 | $70,000,000 | $13,125,000 | - | $4,000,000 | $144,525,000 | $0.1112 |
| II | 2.2 | - | - | $77,940,000 | $12,800,000 | $3,150,000 | $93,890,000 | $0.0427 |
| III | 0.7 | $2,555,000 | $35,275,000 | $8,025,000 | - | $300,000 | $46,155,000 | $0.0659 |
| IV | 0.1 | | $4,500,000 | $200,000 | - | - | $4,700,000 | $0.0470 |
| V | 0.8 | $51,100,000 | $32,900,000 | $17,800,000 | - | - | $101,800,000 | $0.1273 |
| TOTAL | 5.1 | $111,055,000 | $142,675,000 | $117,090,000 | $12,800,000 | $7,450,000 | $391,070,000 | $0.0767 |

**Table 6-34 Study Case C Average Freight Costs by PADD**

| PADD | Ethanol shipped (bgy) | Ethanol Imported From PADD II | | Intra-PADD Ethanol Shipments | | | Total | Average freight per Gallon |
|---|---|---|---|---|---|---|---|---|
| | | Ship/ barge | Rail | Truck | Rail | Barge | | |
| I | 2.7 | $80,040,000 | $61,875,000 | $49,562,500 | -- | $4,000,000 | $195,477,500 | $0.0724 |
| II | 3.7 | -- | -- | $71,231,500 | $13,500,000 | $3,675,000 | $88,406,500 | $0.0239 |
| III | 1.8 | $4,650,000 | $46,325,000 | $40,830,000 | $6,650,000 | $6,300,000 | $104,755,000 | $0.0582 |
| IV | 0.4 | -- | -- | $21,043,750 | $8,500,000 | -- | $29,543,750 | $0.0739 |
| V | 1.4 | $63,700,000 | $62,300,000 | $23,750,000 | -- | -- | $149,750,000 | $0.1070 |
| TOTAL | 10.0 | $148,390,000 | $170,500,000 | $206,417,750 | $28,650,000 | $13,975,000 | $567,932,750 | $0.0568 |

Table 6-35 shows the net changes in total freight charged and average freight costs for Study Case C compared to Study Case B1, Most categories, in most PADDs, show net increases due to greater volumes shipped. The exceptions are that freight for rail shipments in PADD I actually drop. This is due to less production being imported by rail from PADD II. Freight charges for truck shipments in PADD II also drop due to more shipments being in-state and fewer shipments being intra-PADD shipments in Case C compared to Case B1. In study Case C, PADD IV no longer imports its ethanol from PADD II. This results in a decrease for rail shipments from PADD II, but shipments by rail for intra-PADD redistribution increase by a similar amount. Also due to the shipping distance and lack of navigable waterways, truck shipments for intra-PADD redistribution in PADD IV increase significantly in Case C. PADD IV is the only PADD showing an increase in average freight costs comparing Case C to Case B1. This is largely because the ethanol shipments in Study Case B1 were rail shipments from the westernmost plants in PADD II. In Case B1, these shipments moved directly to the few terminals needed to achieve ethanol volumes. However, in Study Case C there is a significant increase of truck shipments. Consequently, the average freight cost for Study Case C actually increases in PADD IV.

| Table 6-35 Net Change in Transportation Costs for Study Case C Compared to Study Case B1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **PADD** | **Increase in Ethanol shipped (bgy)** | **Ethanol Imported From PADD II** | | **Intra-PADD Ethanol Shipments** | | | **Total** | **Average freight per Gallon** |
| | | **Ship/ barge** | **Rail** | **Truck** | **Rail** | **Barge** | | |
| I | 1.4 | $22,640,000 | ($8,125,000) | $36,437,500 | -- | -- | $50,952,500 | ($0.0388) |
| II | 1.5 | -- | -- | ($6,708,500) | $700,000 | $525,000 | ($5,483,500) | ($0.0188) |
| III | 1.1 | $2,095,000 | $11,050,000 | $32,805,000 | $6,650,000 | $6,000,000 | $58,600,000 | ($0.0077) |
| IV | 0.3 | -- | ($4,500,000) | $20,843,750 | $8,500,000 | -- | $24,843,750 | $0.0269 |
| V | 0.6 | $12,600,000 | $29,400,000 | $5,950,000 | -- | -- | $47,950,000 | ($0.0203) |
| TOTAL | 4.9 | $37,355,000 | $27,825,000 | $89,327,750 | $15,850,000 | $6,525,000 | $176,862,750 | ($0.0199) |

## 6.4 Transportation Equipment Demands

Obviously these increased movements will require an increase in available transportation equipment. In Case B1, it is necessary to add 254 transport truck rigs, 2,624 rail tank cars, and 21 barges (30 mbbl each). In Case C it is necessary to add 309 transport truck rigs, 924 rail tank cars, and 21 barges (30 mbbl each). Collectively this requires, for both cases, a total of 563 transport truck rigs, 3,548 rail tank cars, and 42 barges (30 mbbl each) to be added to the transportation equipment that is already available. These figures are recapped in the following table.

| Table 6-36 Additional Transportation Equipment Required | | | | |
|---|---|---|---|---|
| **PADD** | **Existing** | **Case B1** | **Case C** | **Total Added from B1 & C** |
| Tractor trailer rig | 173 | 254 | 309 | 563 |
| T108 rail car | 278 | 2,549 | 923 | 3,472 |
| 30 mbbl barge | 14† | 21 | 21 | 42 |

*† The 14 barges listed for existing use are actually 42 barges @ 10 mbbl but are projected as 30 mbbl equivalent for ease of comparison*

The estimated required investment for transportation equipment in Study Case B1 is $215,750,000, and in Study Case C it is $124,515,000. The combined investment requirement for transportation equipment, for the two study cases is $340,265,000. The table below lists investment by category, by case, and provides amortized cost by equipment category.

**Table 6-37 Total Amortized Transportation Equipment Costs (amortized cost per gallon)**

| PADD | Case B1 | Case C | Totals |
|---|---|---|---|
| Tractor trailer rig | $29,210,000 ($0.0015) | $35,535,000 ($0.0015) | $64,745,000 ($0.0016) |
| T108 rail car | $152,940,000 ($0.0067) | $55,380,000 ($0.0019) | $208,320,000 ($0.0040) |
| 30 mbbl barge | $33,600,000 ($0.0015) | $33,600,000 ($0.0012) | $67,200,000 ($0.0013) |
| Totals | $215,750,000 | $124,515,000 | $340,265,000 |

The above projection of equipment needs and related costs are provided primarily to identify the need for, and expense of, necessary transportation equipment. These investments would be recaptured through the freight revenues from the ethanol shipped and are not additional program costs.

## 6.5 Observations

The purpose of this study was to assess the infrastructure requirements for an expanded ethanol industry. Part of this assessment included determining the improvements that would be necessary at the petroleum products terminal level, as well as conversion costs at retail facilities. An assessment was also made to determine the volume of ethanol that would be shipped by each available transportation mode. This included estimated freight costs and an estimate for increased equipment needs and cost. Part of the assessment was also to determine if any major infrastructure barriers would be encountered, and if economies of scale would develop with the higher level of ethanol production in Study Case C compared to Study Case B1. Some of the key observations of the study include:

- No major infrastructure barriers exist in Study Case B1. The volume of product moved by rail and river barge is a very small percentage of products moved by those modes. Furthermore, both the rail freight car building industry and the barge building industry have the capacity to build equipment at a faster pace than that of increasing ethanol shipments from new plants.

- The volume of ethanol shipped in Study Case B1 that would move in Jones Act/OPA90 compliant vessels is less than the volume of MTBE it would be replacing.

- No major infrastructure barriers exist for Study Case C although more detailed study is needed to provide an accurate assessment of how many Jones Act/OPA90 compliant vessels will be available by the time frame when Case C production levels would be reached (i.e., probably 2015 or later).

- Terminal improvements represent significant capital investments for terminal operators although on an amortized basis, they equate to less than $0.01 per gallon of new ethanol volume and, of course, a fraction of that on a blended gallon basis. Still, terminal operators will not make such expenditures without some guarantee of throughput volumes sufficient to warrant such investments.

- The costs of retail conversion for E-10/E-5.7 are modest on a per unit basis and present no major obstacle.

- E-85 retail station infrastructure costs are high, exceeding $0.06 per gallon of new ethanol volume, for the combined Study Cases, due largely to the need for new underground tanks and dispenser systems.

- Ethanol will not be routinely shipped by pipeline in either study case. Volumes are not sufficient to justify the extra handling procedures. Furthermore, there are no operating pipelines originating in the major ethanol production areas. Pipeline shipments of ethanol will be limited to niche situations where pipeline operators will move ethanol, over short distances, in privately owned and operated systems.

- The most significant program costs will be for freight charges which exceed $391 million in Study Case B1, averaging $0.0767 per gallon. In Case C, total freight charges exceed $567 million and average $0.0568 per gallon.

Total freight costs are obviously high compared to pipeline shipments. Here, it is worth mentioning that many industry observers have viewed ethanol's inability to move by pipeline (primarily for logistic reasons) as a handicap. Recently, however, several industry observers have indicated that some pipelines are nearing capacity. If demand continues to escalate as it has historically, some pipelines will have difficulty moving additional volumes of gasoline.

If, in fact, this occurs, the established movement of ethanol by these alternative transportation modes may prove to be a positive attribute. Moreover, in many cases the decentralized structure of ethanol production facilities, especially in Study Case C, would actually preclude the need to ship significant portions of increased gasoline demand by pipeline.

## 6.6 Recommendations

Sections 4 and 5 of this report contain various recommendations which are collectively reiterated here.

- The most expensive single category for the expansion of an E-10/E-5.7 blend program is the investment in blending systems for the terminals. Blending systems represent over 56% of the estimated terminal and retail expenditures in Case B1 and over 55% in Case C.
  Some terminal operators install prefabricated, skid mounted, blending systems. Others may elect to design their own systems (or have them designed) using a variety of computer controls and variable proportioning pumps. Of course, the cost of these systems may drop with quantity purchases, such as those that would be necessary for the ethanol industry expansion levels studied here. However, it is recommended various ways to reduce the costs of these systems be explored. As an example, two or three basic systems for the most common terminal configurations could be designed. These systems could be "minimalist" in nature providing only the basic needs of blending the most common blend ratios of E-10 and E-5.7, (and possibly E-75, E-80, and E-85 for those terminals handling the higher blend ratio fuels). Also, several terminals now blend the mid-grade on site, using a blending system to mix the correct portion of premium and regular unleaded. If a more economical design could be developed to utilize these blenders, or develop a system that covers all blend requirements at the terminal, this could dramatically reduce the program costs associated with this category.

- The costs of expanding the retail infrastructure for E-85 distribution are also quite high, especially for the volumes achieved. In our study we assume E-85 sales volume, at retail, are comparable to midgrade, i.e., 12,000 to 15,000 gallons per unit month. Obviously, if higher volumes are achieved, this would reduce the cost per gallon of new volume. However, given the size and distribution of the flexible fuel fleet, and simply the fact that these vehicles can also use gasoline, higher estimated volumes may be overly optimistic. With costs estimated to exceed $60,000 per system, it is difficult to find retail facility operators willing to invest such resources to dispense a fuel with future volume and profit margins, that cannot be accurately predicted based on historic trends. Consequently, anything that can be done to lower the expense of a retail E-85 installation would aid in more rapid expansion for this fuel.

It is recommended that the possibility of some type of modular, relocatable system, be explored. Systems being installed typically consist of an 8,000 to 10,000 gallon underground tank and a dispenser, usually located on an island separate from the gasoline dispensers, at an existing retail outlet. Perhaps a system with a 3,000 to 4,000 gallon skid mounted, above ground tank, could be designed. This would result in the installation of the underground piping being the only "below grade" work. The piping and the dispenser would be permanent. When volumes increase to a significant level, underground tanks could be installed and the skid mounted tank relocated to another start up facility. This would contribute to more rapid industry expansion and, in the mind of the retailer, lower the potential for a stranded investment for an underground tank.

The primary obstacle is likely to be local permitting, especially obtaining approval from fire prevention officials. Consequently, any system development should be closely coordinated with the National Fire Prevention Association (NFPA).

- A large portion of the ethanol transported in an expanded ethanol market would move in river barges on the inland waterway system. For Case B1 such shipments amount to only 0.58% of current tonnage moved on the inland waterway system, and only 0.98% in Case C, While this is a relatively modest volume increase, it would occur at a time when traffic is already projected to rise 1.3% yearly. Perhaps more importantly, the origination of these shipments will occur on portions of the system known to already be plagued by delays at some locks. In the case of shipments to the Gulf Coast (to stage product for loading onto ships), shippers may also experience delays at their unloading destination at certain times of the year.

  Also, in the case of dry mills, coproducts such as Distillers Dried Grains & Solubles (DDGS) may result in increased shipments on the inland waterway system.

  Based on the above, it is recommended that this issue be studied more closely. Specifically, a study should be undertaken to determine what impact the increased ethanol and coproduct shipments of an expanded industry would have on the inland waterway system's operability. Such a study could be done by a private firm or perhaps the Army Corps of Engineers. Regardless of who might do the study, it is recommended that the Army Corps of Engineers be kept in the information loop on any industry expansion so that they can contribute to various ethanol related assessments, and also to ensure they are apprised of any significant industry expansions that might impact their area of responsibility.

- One of the most difficult areas to assess in detail is the increased demand that ethanol shipments would place on Jones Act Vessels that are OPA90 compliant. As noted in the report, this is an area of some debate and difference of opinion. Recent studies show an increasing shortage of Jones Act/OPA90 compliant vessels. A number of smaller clean product vessels have recently been retired and several more will be retired between now and 2014. At the same time, the American Waterways Operators has said adequate shipping capacity exists for an anticipated 0.6 bgy to be shipped to California. Further complicating the assessment is the variety of projections used to estimate gasoline demand increases and by what mode of transport any increased gasoline volumes would be shipped, especially going out as far as the time line envisioned for Study Case C (i.e., more than 10 years out).

  In Study Case B1 a total of 0.855 bgy of ethanol is shipped to the East and West Coasts by ship. This equates to 2.81 million short tons. In Case C, 1.145 bgy is exported to the coasts equating to 3.77 million short tons. However, in each case we have estimated that 0.252 bgy of ethanol would be shipped undenatured. These shipments would require a Jones Act vessel, but not an OPA 90 compliant vessel. This would reduce OPA90 vessel requirement use by 0.83 short tons in each Study Case. The result would be a requirement for 1.98 million short tons per year to move in OPA90 compliant vessels in Study Case B1 and 2.94 million short tons per year for Study Case C.

  While ethanol shipments in OPA90 complaint Jones Act vessels may represent as little as 3% of total petroleum products shipped, it is not possible to assess the impact this has on the total demand picture for OPA90 vessels. This would require a detailed assessment not only of ethanol shipments but also of all clean products moving between U.S. ports. Such an assessment is beyond the scope of this study. If the availability of Jones Act/OPA90 compliant vessels becomes constrained, this could result in price spikes for chartering such vessels. These freight increases could result in a preference for rail shipments and a greater number of terminals would then need to add rail spurs.

It is recommended that a detailed assessment of Jones Act/OPA90 compliant vessels be undertaken. This should include OPA90 vessels in service and retiring, along with confirmed and projected ship orders. This, combined with projected "clean product" shipments, including ethanol, would yield a more accurate picture of demand for these vessels. Simply put, the demand for OPA90 compliant Jones Act vessels, created by ethanol shipments between U.S. ports, cannot be assessed singularly. It must be assessed in the context of all vessels and all clean products shipments.

A second recommendation is to explore an expansion of the shipment of ethanol in non-OPA90 vessels. This could be done by shipping more ethanol as pure spirits (i.e., undenatured) to properly permitted terminals on the East and West Coasts. Another option is to examine potential denaturants that, while meeting industry standards and Bureau of Alcohol Tobacco and Firearm (BATF) requirements, would not be listed as a cargo requiring OPA90 vessels.

# Appendix A
# Population Figures
# Cities and Metropolitan Statistical Areas (MSAs)

Source: US Census Bureau Estimated 1999 Statistics

## Cities over 100,000/under 250,000 - PADDS I & II

| PADD I<br>City (MSA) | Population | PADD II<br>City (MSA) | Population |
|---|---|---|---|
| Albany GA | 117,421 | Benton Harbor MI | 159,709 |
| Altoona PA | 129,937 | Bloomington IN | 116,923 |
| Ashville NC | 215,180 | Bloomington/Normal IL | 145,477 |
| Athens GA | 140,372 | Cedar Rapids IA | 184,891 |
| Barnstable/Yarmouth MA | 153,750 | Champaign.Urbana IL | 170,272 |
| Binghampton NY | 247,462 | Clarksville/Hopkinsville TN/KY | 201,352 |
| Burlington VT | 165,917 | Columbia MO | 130,179 |
| Charlottesville VA | 151,267 | Decatur IL | 113,219 |
| Danville VA | 107,555 | Duluth/Superior MN/WI | 236,400 |
| Dover DE | 126,048 | Eau Claire WI | 144,463 |
| Florence SC | 125,229 | Elkhart/Goschen IN | 174,680 |
| Fort Walton Beach FL | 170,049 | Fargo/Moorehead ND/MN | 170,122 |
| Gainesville FL | 198,484 | Greenbay WI | 216,522 |
| Glens Falls NY | 121,582 | Iowa City IA | 103,813 |
| Goldsboro NC | 111,711 | Jackson MI | 157,271 |
| Greenville NC | 127,960 | Jackson TN | 101,611 |
| Jacksonville NC | 142,480 | Janesville/Beloit WI | 151,121 |
| Jamestown NY | 137,431 | Joplin MO | 149,981 |
| Johnstown PA | 233,794 | Kokomo IN | 100,377 |
| Lynchburb VA | 208,835 | LaCrosse WI | 121,927 |
| Myrtle Beach SC | 178,550 | Lafayette IN | 175,439 |
| Naples FL | 207,029 | Lawton OK | 106,621 |
| Ocala FL | 245,975 | Lima OH | 154,065 |
| Panama City FL | 147,958 | Lincoln NE | 237,657 |
| Parkersburg/Marietta WV/OH | 149,366 | Mansfield OH | 176,617 |
| Portland ME | 234,814 | Muncie IN | 115,472 |
| Punta Gorda FL | 136,992 | Rochester MN | 119,077 |
| Roanoke VA | 227,741 | St. Cloud MN | 164,913 |
| Rocky Mount NC | 147,028 | Sheboygan WI | 110,136 |
| Sharon PA | 121,458 | Sioux City IA/NE | 120,577 |
| State College PA | 132,190 | Sioux Falls SD | 164,481 |
| Sumter SC | 112,412 | Springfield IL | 204,030 |
| Wheeling WV/OH | 153,946 | Stuebenville/Weirton OH/WV | 133,292 |
| Williamsport PA | 116,709 | Terre Haute IN | 148,206 |
| Willington NC | 222,109 | Topeka KS | 170,773 |
| | | Waterloo/Cedar Falls IA | 119,959 |
| | | Wausau WI | 123,584 |
| TOTAL | 5,666,741 | TOTAL | 5,595,209 |

*US Census Bureau estimated 1999 statistics*

## Cities over 100,000/under 250,000 - PADDS III & IV

| PADD III City (MSA) | Population | PADD IV City (MSA) | Population |
|---|---|---|---|
| Abilene TX | 122,478 | Billings MT | 127,258 |
| Alexandria LA | 126,775 | Fort Collins/Loveland CO | 236,849 |
| Amarillo TX | 208,691 | Grand Junction CO | 115,147 |
| Anniston AL | 116,541 | Pueblo CO | 136,987 |
| Auburn/Opelika AL | 102,164 | | |
| Bryan/College Station | 134,213 | TOTAL | 616,241 |
| Decatur AL | 143,460 | | |
| Dothan AL | 135,243 | | |
| Florence AL | 136,879 | | |
| Fort Smith AR | 195,547 | | |
| Gadsdden AL | 103,472 | | |
| Hattiesburg MS | 113,054 | | |
| Houma LA | 194,591 | | |
| Lake Charles LA | 180,607 | | |
| Laredo TX | 193,180 | | |
| Las Cruces NM | 170,361 | | |
| Longview/Marshall TX | 209,493 | | |
| Lubbock TX | 227,890 | | |
| Monroe LA | 146,672 | | |
| Odessa/Midland TX | 242,238 | | |
| San Angelo TX | 102,300 | | |
| Santa Fe NM | 142,509 | | |
| Sherman/Denison TX | 103,728 | | |
| Texarkana TX/AR | 122,886 | | |
| Tuscaloosa AL | 161,435 | | |
| Tyler TX | 169,693 | | |
| Waco TX | 204,244 | | |
| Wichita Falls TX | 136,493 | | |
| TOTAL | 4,346,837 | | |

*US Census Bureau estimated 1999 statistics*

## Cities over 100,000/under 250,000 - PADD V

| PADD V<br>City (MSA) | Population |
|---|---|
| Bellingham WA | 160,310 |
| Chico/Paradise CA | 195,220 |
| Flagstaff AZ | 120,652 |
| Medford/Ashland OR | 175,822 |
| Merced CA | 200,746 |
| Redding CA | 164,530 |
| Richland/Kennewick/Pasco WA | 184,626 |
| San Luis Obispo/Atascadero/Paso Rob | 236,953 |
| Yakima WA | 220,785 |
| Yuba City CA | 138,030 |
| Yuma AZ | 135,614 |
| TOTAL | 1,933,288 |

*US Census Bureau estimated 1999 statistics*

# Cities over 250,000 - PADDS I & II

| PADD I<br>City (MSA) | Population | PADD II<br>City (MSA) | Population |
|---|---|---|---|
| | | Appleton/Oshkosh/Neehah WI | 348,100 |
| Albany/Schenectady/Troy NY | 869,474 | Canton/Massillon OH | 402,460 |
| Allentown/Bethlehem/Easton PA | 618,350 | Chattanooga TN | 452,034 |
| Atlanta GA | 3,857,097 | Chicago/Gary/Kenosha IL/IN/WI | 8,885,919 |
| Augusta/Aiken GA | 460,826 | Cincinnati-Hamilton OH/KY/IN | 1,960,995 |
| Boston/Worcester/Lawrence MA | 5,667,225 | Cleveland/Akron OH | 2,910,616 |
| Buffalo/Niagra Fallsa NY | 1,142,121 | Columbus OH | 1,489,487 |
| Charleston/North Charleston SC | 552,803 | Davenport/Moline/Rock Island IA/IL | 358,842 |
| Charleston WV | 251,199 | Dayton/Springfield OH | 958,698 |
| Charlotte/Gastonia/Rock Hill NC/SC | 1,417,217 | Des Moines IA | 443,496 |
| Columbia SC | 516,251 | Detroit/Ann Arbor/Flint MI | 5,469,312 |
| Columbus GA | 271,417 | Evansville/Henderson IN/KY | 291,181 |
| Daytona Beach FL | 474,711 | | |
| Erie PA | 276,993 | Fort Wayne IN | 484,320 |
| Fayetteville NC | 283,650 | Grand Rapids/Muskegon/Holland MI | 1,052,092 |
| Fort Myers/Cape Coral FL | 400,542 | Huntington/Ashland KY | 312,447 |
| Fort Pierce/Port St. Lucie FL | 299,967 | Indianapolis IN | 1,536,665 |
| Greensboro/Winston Salem/High Point | 1,179,384 | Johnson City/Kingsport/Bristol TN/VA | 462,769 |
| Greenville/Spartanburg/Anderson SC | 929,565 | Kalamazoo/Battle Creek MI | 447,164 |
| Harrisburg/Lebanon/Carisle PA | 618,375 | Kansas City MO/KS | 1,755,899 |
| Hartford CT | 1,147,504 | Knoxville TN | 672,087 |
| Hickory/Morganton/Lenoir NC | 325,821 | Lansing/East Lansing MI | 450,789 |
| Jacksonville FL | 1,056,332 | Lexington KY | 455,617 |
| Lakeland/Winter Haven FL | 457,347 | Louisville KY | 1,005,849 |
| Lancaster PA | 460,035 | Madison WI | 428,563 |
| Macon GA | 321,586 | Memphis TN/AR/MS | 1,105,058 |
| Melbourne/Titusville/Palm Bay FL | 470,365 | Milwaukee/Racine | 1,648,199 |
| Miami/Fort Lauderdale | 3,711,102 | Minneapolis/St. Paul MN | 2,872,109 |
| New London/Norwich CT | 284,087 | Nashville TN | 1,171,755 |
| New York/Long Island/et.al. NY/NJ/ | 20,196,649 | Oklahoma City OK | 1,046,283 |
| Norfolk/Virginia Beach/Newport New | 1,562,635 | Omaha NE/IA | 698,875 |
| Orlando FL | 1,535,004 | Peoria/Pekin IL | 346,480 |
| Pensacola FL | 403,384 | Rockford IL | 358,640 |
| Philadelphia/Wilmington/Atlantic Cit | 5,999,034 | Saginaw/Bay City/Midland | 400,753 |
| Pittsburgh PA | 2,331,336 | St. Louis MO/IL | 2,569,029 |
| Providence/Fall River/Warwick RI/M | 1,125,639 | South Bend IN | 258,537 |
| Raleigh-Durham/Chapel Hill NC | 1,105,535 | Springfield MO | 308,332 |
| Reading PA | 358,211 | Toledo OH | 608,976 |
| Richmond/Petersburg VA | 961,416 | Tulsa OK | 786,117 |
| Rochester NY | 1,079,073 | Wichita KS | 548,714 |
| Sarasota/Bradenton FL | 550,077 | Youngstown/Warren OH | 589,236 |
| Savannah GA | 288,426 | | |
| Scranton/Wilkes-Barre/Hazelton PA | 611,492 | TOTAL | 48,352,494 |
| Springfield MA | 573,940 | | |
| Syracuse NY | 732,920 | | |
| Tallahassee FL | 260,003 | | |
| Tampa/St. Petersburg/Clearwater FL | 2,278,169 | | |
| Utica/Rome NY | 293,068 | | |
| Washington/Baltimore DC/MD/VA/W | 7,359,044 | | |
| West Palm Beach/Boca Raton FL | 1,049,420 | | |
| York PA | 376,586 | | |
| TOTAL | 79,352,407 | | |

*US Census Bureau estimated 1999 statistics*

## Cities over 250,000 - PADDS III & IV

| PADD III City (MSA) | Population | PADD IV City (MSA) | Population |
|---|---|---|---|
| Albuquerque NM | 678,820 | Boise City ID | 407,844 |
| Austin/San Marcos TX | 1,146,050 | Colorado Springs CO | 499,994 |
| Baton Rouge LA | 578,946 | Denver/Boulder/Greeley CO | 2,417,908 |
| Beaumont/Port Arthur TX | 376,256 | Provo/Orem UT | 346,997 |
| Biloxi/Gulfport/Pascagoula MS | 353,205 | Salt Lake City/Ogden | 1,275,076 |
| Birmingham Al | 915,077 | | |
| Brownsville/Harlingen/San Benito TX | 329,131 | TOTAL | 4,947,819 |
| Corpus Cristi TX | 387,105 | | |
| Dallas/Fort Worth TX | 4,909,523 | | |
| El Paso TX | 701,908 | | |
| Fayetteville/Springdale/Rogers AR | 285,017 | | |
| Houston/Galveston/Brazoria TX | 4,493,741 | | |
| Huntsville AL | 343,418 | | |
| Jackson MS | 432,647 | | |
| Killeen/Temple TX | 296,316 | | |
| Lafayette LA | 377,238 | | |
| Little Rock/North Little Rock AR | 559,074 | | |
| McAllen/Edinburg/Mission TX | 534,907 | | |
| Mobile AL | 535,472 | | |
| Montgomery AL | 322,441 | | |
| New Orleans LA | 1,305,479 | | |
| San Antonio TX | 1,564,949 | | |
| Shreveport/Bossier City LA | 377,673 | | |
| TOTAL | 21,804,393 | | |

*US Census Bureau estimated 1999 statistics*

## Cities over 250,000 - PADD V

| PADD V<br>City (MSA) | Population |
|---|---|
| Anchorage AK | 257,808 |
| Bakersfield CA | 642,495 |
| Eugene OR | 314,901 |
| Fresno CA | 879,829 |
| Honolulu HI | 864,571 |
| Las Vegas NV/AZ | 1,381,086 |
| Los Angeles/Riverside/Orange Cty, C | 16,036,587 |
| Modesto CA | 436,790 |
| Phoenix/Mesa AZ | 3,013,696 |
| Portland/Salem OR/WA | 2,180,996 |
| Reno NV | 319,816 |
| Sacramento/Yolo CA | 1,741,002 |
| Salinas | 371,756 |
| San Diego CA | 2,820,844 |
| San Francisco/Iakland/San Jose CA | 6,873,645 |
| Santa Barbara/Santa Maria/Lompoc C | 391,071 |
| Seattle/Tacoma/Bremerton WA | 3,465,760 |
| Spokane WA | 409,736 |
| Stockton-Lodi CA | 563,183 |
| Tucson AZ | 803,618 |
| Visalia/Tulare/Pottersville CA | 358,470 |
| TOTAL | 44,127,660 |

*US Census Bureau estimated 1999 statistics*

# Appendix B
# Total Population of PADDs

Source: Population Estimate, Population Division U.S. Census

# Total Population Of PADDs

| | State | Population (1999 estimate) |
|---|---|---|
| PADD I | Connecticut | 3,282,031 |
| | Delaware | 753,538 |
| | Florida | 15,111,244 |
| | Georgia | 7,788,240 |
| | Maine | 1,253,040 |
| | Maryland | 5,171,634 |
| | Massachusetts | 6,175,169 |
| | New Hampshire | 1,201,134 |
| | New Jersey | 8,143,412 |
| | New York | 18,196,601 |
| | North Carolina | 7,650,789 |
| | Pennsylvania | 11,994,016 |
| | Rhode Island | 990,819 |
| | South Carolina | 3,885,736 |
| | Vermont | 593,740 |
| | Virginia | 6,872,912 |
| | West Virginia | 1,806,928 |
| | District of Columbia | 519,000 |
| | TOTAL PADD I | 101,389,983 |
| PADD II | Illinois | 12,128,370 |
| | Indiana | 5,942,901 |
| | Iowa | 2,869,413 |
| | Kansas | 2,654,052 |
| | Kentucky | 3,960,825 |
| | Michigan | 9,863,775 |
| | Minnesota | 4,775,508 |
| | Missouri | 5,468,338 |
| | Nebraska | 1,666,028 |
| | North Dakota | 633,666 |
| | Ohio | 11,256,654 |
| | Oklahoma | 3,358,044 |
| | South Dakota | 733,133 |
| | Tennessee | 5,483,535 |
| | Wisconsin | 5,250,446 |
| | TOTAL PADD II | 76,044,688 |

| | State | Population (1999 estimate) |
|---|---|---|
| PADD III | Alabama | 4,369,862 |
| | Arkansas | 2,551,373 |
| | Louisiana | 4,372,035 |
| | Mississippi | 2,768,619 |
| | New Mexico | 1,739,844 |
| | Texas | 20,044,141 |
| | TOTAL PADD III | 35,845,874 |
| PADD IV | Colorado | 4,056,133 |
| | Idaho | 1,251,700 |
| | Montana | 882,779 |
| | Utah | 2,129,836 |
| | Wyoming | 479,602 |
| | TOTAL PADD IV | 8,800,050 |
| PADD V | Alaska | 619,500 |
| | Arizona | 4,778,332 |
| | California | 33,145,121 |
| | Hawaii | 1,185,497 |
| | Nevada | 1,809,253 |
| | Oregon | 3,316,154 |
| | Washington | 5,756,361 |
| | TOTAL PADD V | 50,610,218 |

Source: Population Estimates Program, Population Division, US Census Bureau

# Appendix C
# Gasoline Sales by State within PADD and Demand Factor Calculations

## TABLE C-1: Gasoline Sales by State within PADD and Demand Factor Calculations

Annual Gallons

| Area | Gasoline Demand | Ethanol Demand by PADD Case B1 | Ethanol Demand Factor Case B 1 | Ethanol Demand by PADD Case C | Ethanol Demand Factor Case C |
|---|---|---|---|---|---|
| **PADD I** | **45,786,939,655** | **1,300,000,000**<br>**84.8 mbcd** | **2.84%** | **2,700,000,000** | **5.90%** |
| Connecticut | 1,426,074,821 | | | | |
| Delaware | 387,492,744 | | | | |
| Florida | 7,187,601,483 | | | | |
| Georgia | 4,532,682,908 | | | | |
| Maine | 653,167,415 | | | | |
| Maryland | 2,321,538,348 | | | | |
| Massachusetts | 2,683,400,671 | | | | |
| New Hampshire | 643,975,605 | | | | |
| New Jersey | 3,891,748,359 | | | | |
| New York | 5,628,304,831 | | | | |
| North Carolina | 4,035,811,151 | | | | |
| Pennsylvania | 4,990,001,213 | | | | |
| Rhode Island | 402,470,112 | | | | |
| South Carolina | 2,172,260,949 | | | | |
| Vermont | 321,941,190 | | | | |
| Virginia | 3,490,605,909 | | | | |
| West Virginia | 841,968,285 | | | | |
| District of Columbia | 175,893,661 | | | | |
| **PADD II** | **37,776,647,222** | **2,200,000,000**<br>**143.5 mbcd** | **5.82%** | **3,700,000,000** | **9.79%** |
| Illinois | 4,872,641,412 | | | | |
| Indiana | 3,177,177,487 | | | | |
| Iowa | 1,569,523,087 | | | | |
| Kansas | 1,382,778,992 | | | | |
| Kentucky | 2,151,682,740 | | | | |
| Michigan | 4,875,185,258 | | | | |
| Minnesota | 2,490,450,057 | | | | |
| Missouri | 3,073,277,791 | | | | |
| Nebraska | 863,557,532 | | | | |
| North Dakota | 372,049,260 | | | | |
| Ohio | 5,225,944,737 | | | | |
| Oklahoma | 1,842,590,357 | | | | |
| South Dakota | 448,530,497 | | | | |
| Tennessee | 2,895,461,610 | | | | |
| Wisconsin | 2,535,796,405 | | | | |
| **PADD III** | **19,035,571,897** | **700,000,000**<br>**45.7 mbcd** | **3.68%** | **1,800,000,000** | **9.46%** |
| Alabama | 2,439,536,662 | | | | |
| Arkansas | 1,430,857,250 | | | | |
| Louisiana | 2,142,363,018 | | | | |
| Mississippi | 1,559,629,241 | | | | |
| New Mexico | 1,017,555,760 | | | | |
| Texas | 10,445,629,966 | | | | |

Annual Gallons

| Area | Gasoline Demand | Ethanol Demand by PADD Case B1 | Ethanol Demand Factor Case B 1 | Ethanol Demand by PADD Case C | Ethanol Demand Factor Case C |
|---|---|---|---|---|---|
| **PADD IV** | **4,415,963,142** | **100,000,000**<br>**6.5 mbcd** | **2.26%** | **400,000,000** | **9.06%** |
| Colorado | 1,931,759,627 | | | | |
| Idaho | 656,956,847 | | | | |
| Montana | 496,231,553 | | | | |
| Utah | 989,417,187 | | | | |
| Wyoming | 341,597,928 | | | | |
| **PADD V** | **22,120,932,954** | **800,000,000**<br>**52.2 mbcd** | **3.62%** | **1,400,000,000** | **6.33%** |
| Alaska | 292,952,455 | | | | |
| Arizona | 2,239,870,388 | | | | |
| California | 14,003,803,000 | | | | |
| Hawaii | 405,952,828 | | | | |
| Nevada | 880,928,779 | | | | |
| Oregon | 1,647,446,411 | | | | |
| Washington | 2,649,979,093 | | | | |

*Monthly gasoline reported by state 1998 From Monthly Motor Fuel Reported by State, December 1999, Federal Highway Administration*

# Appendix D
# Gasoline Sales by City/MSA
# and Applied Ethanol Demand Factor

| PADD I TOTALS | Population | | Gasoline Sold | Case B-1 Factor | Case C Factor |
|---|---|---|---|---|---|
| | 100,870,983 | | 45,786,939,655 | 2.84% | 5.90% |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Albany/Schenectady/Troy NY | 869,474 | 0.86% | 394,668,044 | 11,204,626 | 23,273,575 |
| Allentown/Bethlehem/Easton PA | 618,350 | 0.61% | 280,678,876 | 7,968,473 | 16,551,633 |
| Atlanta GA | 3,857,097 | 3.82% | 1,750,797,527 | 49,705,142 | 103,244,530 |
| Augusta/Aiken GA | 460,826 | 0.46% | 209,176,233 | 5,938,513 | 12,335,122 |
| Boston/Worcester/Lawrence MA | 5,667,225 | 5.62% | 2,572,443,347 | 73,031,667 | 151,696,984 |
| Buffalo/Niagra Fallsa NY | 1,142,121 | 1.13% | 518,426,843 | 14,718,138 | 30,571,631 |
| Charleston/North Charleston SC | 552,803 | 0.55% | 250,926,053 | 7,123,791 | 14,797,109 |
| Charleston WV | 251,199 | 0.25% | 114,023,212 | 3,237,119 | 6,723,949 |
| Charlotte/Gastonia/Rock Hill NC/SC | 1,417,217 | 1.40% | 643,297,283 | 18,263,210 | 37,935,241 |
| Columbia SC | 516,251 | 0.51% | 234,334,520 | 6,652,757 | 13,818,707 |
| Columbus GA | 271,417 | 0.27% | 123,200,483 | 3,497,662 | 7,265,132 |
| Daytona Beach | 474,711 | 0.47% | 215,478,855 | 6,117,445 | 12,706,788 |
| Erie PA | 276,993 | 0.27% | 125,731,518 | 3,569,518 | 7,414,388 |
| Fayetteville NC | 283,650 | 0.28% | 128,753,236 | 3,655,304 | 7,592,578 |
| Fort Myers/Cape Coral FL | 400,542 | 0.40% | 181,812,369 | 5,161,653 | 10,721,475 |
| Fort Pierce/Port St. Lucie FL | 299,967 | 0.30% | 136,159,781 | 3,865,576 | 8,029,342 |
| Greensboro/Winston Salem/High Point NC | 1,179,384 | 1.17% | 535,341,110 | 15,198,334 | 31,569,065 |
| Greenville/Spartanburg/Anderson SC | 929,565 | 0.92% | 421,944,303 | 11,978,999 | 24,882,056 |
| Harrisburg/Lebanon/Carisle PA | 618,375 | 0.61% | 280,690,224 | 7,968,795 | 16,552,303 |
| Hartford CT | 1,147,504 | 1.14% | 520,870,273 | 14,787,507 | 30,715,720 |
| Hickory/Morganton/Lenoir NC | 325,821 | 0.32% | 147,895,322 | 4,198,748 | 8,721,387 |
| Jacksonville FL | 1,056,332 | 1.05% | 479,485,855 | 13,612,603 | 28,275,281 |
| Lakeland/Winter Haven FL | 457,347 | 0.45% | 207,597,060 | 5,893,681 | 12,241,999 |
| Lancaster PA | 460,035 | 0.46% | 208,817,186 | 5,928,320 | 12,313,949 |
| Macon GA | 321,586 | 0.32% | 145,972,988 | 4,144,173 | 8,608,027 |
| Melbourne/Titusville/Palm Bay FL | 470,365 | 0.47% | 213,506,137 | 6,061,439 | 12,590,457 |
| Miami/Fort Lauderdale | 3,711,102 | 3.68% | 1,684,528,080 | 47,823,752 | 99,336,621 |
| New London/Norwich CT | 284,087 | 0.28% | 128,951,597 | 3,660,936 | 7,604,276 |
| New York/Long Island/et.al. NY/NJ/CT/PA | 20,196,649 | 20.02% | 9,167,579,432 | 260,267,580 | 540,612,159 |
| Norfolk/Virginia Beach/Newport News VA/NC | 1,562,635 | 1.55% | 709,304,820 | 20,137,164 | 41,827,705 |
| Orlando FL | 1,535,004 | 1.52% | 696,762,671 | 19,781,092 | 41,088,095 |
| Pensacola FL | 403,384 | 0.40% | 183,102,398 | 5,198,277 | 10,797,548 |
| Philadelphia/Wilmington/Atlantic City PA/NJ/DE/MD | 5,999,034 | 5.95% | 2,723,056,716 | 77,307,580 | 160,578,655 |
| Pittsburgh PA | 2,331,336 | 2.31% | 1,058,230,401 | 30,043,161 | 62,403,847 |
| Providence/Fall River/Warwick RI/MA | 1,125,639 | 1.12% | 510,945,402 | 14,505,740 | 30,130,450 |
| Raleigh-Durham/Chapel Hill NC | 1,105,535 | 1.10% | 501,819,878 | 14,246,666 | 29,592,318 |
| Reading PA | 358,211 | 0.36% | 162,597,657 | 4,616,147 | 9,588,384 |
| Richmond/Petersburg VA | 961,416 | 0.95% | 436,401,977 | 12,389,452 | 25,734,625 |
| Rochester NY | 1,079,073 | 1.07% | 489,808,356 | 13,905,659 | 28,883,999 |
| Sarasota/Bradenton FL | 550,077 | 0.55% | 249,688,678 | 7,088,662 | 14,724,141 |
| Savannah GA | 288,426 | 0.29% | 130,921,138 | 3,716,851 | 7,720,419 |
| Scranton/Wilkes-Barre/Hazelton PA | 611,492 | 0.61% | 277,565,921 | 7,880,096 | 16,368,062 |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Springfield MA | 573,940 | 0.57% | 260,520,472 | 7,396,176 | 15,362,892 |
| Syracuse NY | 732,920 | 0.73% | 332,684,017 | 9,444,899 | 19,618,376 |
| Tallahassee FL | 260,003 | 0.26% | 118,019,487 | 3,350,573 | 6,959,609 |
| Tampa/St. Petersburg/Clearwater FL | 2,278,169 | 2.26% | 1,034,097,056 | 29,358,015 | 60,980,703 |
| Utica/Rome NY | 293,068 | 0.29% | 133,028,215 | 3,776,671 | 7,844,674 |
| Washington/Baltimore DC/MD/VA/WV/ | 7,359,044 | 7.30% | 3,340,386,834 | 94,833,582 | 196,982,612 |
| West Palm Beach/Boca Raton FL | 1,049,420 | 1.04% | 476,348,389 | 13,523,531 | 28,090,264 |
| York PA | 376,586 | 0.37% | 170,938,361 | 4,852,940 | 10,080,235 |
| Total | 79,352,407 | | | | |

| PADDI<br>Cities over 100000/ under 250000 | Population | % of PADD Population | Gasoline Demand | At 10% blend Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Albany GA | 117,421 | 0.12% | 53,299,255 | 1,513,166 | 3,143,057 |
| Altoona PA | 129,937 | 0.13% | 58,980,466 | 1,674,455 | 3,478,078 |
| Ashville NC | 215,180 | 0.21% | 97,673,616 | 2,772,954 | 5,759,813 |
| Athens GA | 140,372 | 0.14% | 63,717,078 | 1,808,928 | 3,757,396 |
| Barnstable/Yarmouth MA | 153,750 | 0.15% | 69,789,564 | 1,981,326 | 4,115,491 |
| Binghampton NY | 247,462 | 0.25% | 112,326,928 | 3,188,961 | 6,623,919 |
| Burlington VT | 165,917 | 0.16% | 75,312,359 | 2,138,118 | 4,441,170 |
| Charlottesville VA | 151,267 | 0.15% | 68,662,491 | 1,949,328 | 4,049,027 |
| Danville VA | 107,555 | 0.11% | 48,820,921 | 1,386,026 | 2,878,970 |
| Dover DE | 126,048 | 0.12% | 57,215,187 | 1,624,339 | 3,373,980 |
| Florence SC | 125,229 | 0.12% | 56,843,430 | 1,613,785 | 3,352,057 |
| Fort Walton Beach FL | 170,049 | 0.17% | 77,187,939 | 2,191,366 | 4,551,773 |
| Gainesville FL | 198,484 | 0.20% | 90,095,037 | 2,557,798 | 5,312,904 |
| Glens Falls NY | 121,582 | 0.12% | 55,187,999 | 1,566,787 | 3,254,436 |
| Goldsboro NC | 111,711 | 0.11% | 50,707,395 | 1,439,583 | 2,990,215 |
| Greenville NC | 127,960 | 0.13% | 58,083,074 | 1,648,978 | 3,425,159 |
| Jacksonville NC | 142,480 | 0.14% | 64,673,933 | 1,836,093 | 3,813,822 |
| Jamestown NY | 137,431 | 0.14% | 62,382,111 | 1,771,028 | 3,678,673 |
| Johnstown PA | 233,794 | 0.23% | 106,122,806 | 3,012,826 | 6,258,062 |
| Lynchburg VA | 208,835 | 0.21% | 94,793,520 | 2,691,188 | 5,589,974 |
| Myrtle Beach SC | 178,550 | 0.18% | 81,046,678 | 2,300,915 | 4,779,323 |
| Naples FL | 207,029 | 0.21% | 93,973,748 | 2,667,915 | 5,541,632 |
| Ocala FL | 245,975 | 0.24% | 111,651,955 | 3,169,799 | 6,584,116 |
| Panama City FL | 147,958 | 0.15% | 67,160,484 | 1,906,686 | 3,960,454 |
| Parkersburg/Marietta WV/OH | 149,366 | 0.15% | 67,799,597 | 1,924,831 | 3,998,142 |
| Portland ME | 234,814 | 0.23% | 106,585,800 | 3,025,971 | 6,285,365 |
| Punta Gorda FL | 136,992 | 0.14% | 62,182,842 | 1,765,371 | 3,666,922 |
| Roanoke VA | 227,741 | 0.23% | 103,375,253 | 2,934,823 | 6,096,039 |
| Rocky Mount NC | 147,028 | 0.15% | 66,738,342 | 1,894,702 | 3,935,560 |
| Sharon PA | 121,458 | 0.12% | 55,131,713 | 1,565,189 | 3,251,117 |
| State College PA | 132,190 | 0.13% | 60,003,138 | 1,703,489 | 3,538,385 |
| Sumter SC | 112,412 | 0.11% | 51,025,590 | 1,448,617 | 3,008,979 |
| Wheeling WV/OH | 153,946 | 0.15% | 69,878,532 | 1,983,852 | 4,120,737 |
| Williamsport PA | 116,709 | 0.12% | 52,976,067 | 1,503,991 | 3,123,999 |
| Willington NC | 222,109 | 0.22% | 100,818,799 | 2,862,246 | 5,945,285 |
| Total | 5,666,741 | | | | |

| PADD II TOTALS | Population | | Gasoline Sold | Case B-1 Factor | Case C Factor |
|---|---|---|---|---|---|
| | 76,044,688 | | 37,776,647,222 | 5.82% | 9.79% |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Appleton/Oshkosh/Neehah WI | 348,100 | 0.46% | 172,925,305 | 10,071,170 | 16,936,304 |
| Canton/Massillon OH | 402,460 | 0.53% | 199,929,671 | 11,643,904 | 19,581,112 |
| Chattanooga TN | 452,034 | 0.59% | 224,556,500 | 13,078,171 | 21,993,064 |
| Chicago/Gary/Kenosha IL/IN/WI | 8,885,919 | 11.69% | 4,414,249,517 | 257,085,892 | 432,331,598 |
| Cincinnati-Hamilton OH/KY/IN | 1,960,995 | 2.58% | 974,161,618 | 56,735,173 | 95,409,389 |
| Cleveland/Akron OH | 2,910,616 | 3.83% | 1,445,903,938 | 84,209,445 | 141,611,832 |
| Columbus OH | 1,489,487 | 1.96% | 739,931,038 | 43,093,584 | 72,468,846 |
| Davenport/Moline/Rock Island IA/IL | 358,842 | 0.47% | 178,261,599 | 10,381,955 | 17,458,941 |
| Dayton/Springfield OH | 958,698 | 1.26% | 476,251,492 | 27,736,887 | 46,644,071 |
| Des Moines IA | 443,496 | 0.58% | 220,315,085 | 12,831,151 | 21,577,659 |
| Detroit/Ann Arbor/Flint MI | 5,469,312 | 7.19% | 2,716,984,913 | 158,237,201 | 266,101,502 |
| Evansville/Henderson IN/KY | 291,181 | 0.38% | 144,649,708 | 8,424,399 | 14,166,992 |
| Fort Wayne IN | 484,320 | 0.64% | 240,595,185 | 14,012,264 | 23,563,892 |
| Grand Rapids/Muskegon/Holland MI | 1,052,092 | 1.38% | 522,646,741 | 30,438,946 | 51,188,022 |
| Huntington/Ashland KY | 312,447 | 0.41% | 155,213,999 | 9,039,663 | 15,201,659 |
| Indianapolis IN | 1,536,665 | 2.02% | 763,367,608 | 44,458,530 | 74,764,224 |
| Johnson City/Kingsport/Bristol TN/VA | 462,769 | 0.61% | 229,889,315 | 13,388,754 | 22,515,360 |
| Kalamazoo/Battle Creek MI | 447,164 | 0.59% | 222,137,234 | 12,937,273 | 21,756,121 |
| Kansas City MO/KS | 1,755,899 | 2.31% | 872,276,274 | 50,801,370 | 85,430,738 |
| Knoxville TN | 672,087 | 0.88% | 333,872,019 | 19,444,706 | 32,699,426 |
| Lansing/East Lansing MI | 450,789 | 0.59% | 223,938,022 | 13,042,150 | 21,932,490 |
| Lexington KY | 455,617 | 0.60% | 226,336,423 | 13,181,833 | 22,167,389 |
| Louisville KY | 1,005,849 | 1.32% | 499,674,650 | 29,101,052 | 48,938,135 |
| Madison WI | 428,563 | 0.56% | 212,896,833 | 12,399,112 | 20,851,116 |
| Memphis TN/AR/MS | 1,105,058 | 1.45% | 548,958,610 | 31,971,349 | 53,765,006 |
| Milwaukee/Racine | 1,648,199 | 2.17% | 818,774,247 | 47,685,412 | 80,190,750 |
| Minneapolis/St. Paul MN | 2,872,109 | 3.78% | 1,426,774,852 | 83,095,367 | 139,738,329 |
| Nashville TN | 1,171,755 | 1.54% | 582,091,615 | 33,901,016 | 57,010,053 |
| Oklahoma City OK | 1,046,283 | 1.38% | 519,761,009 | 30,270,881 | 50,905,393 |
| Omaha NE/IA | 698,875 | 0.92% | 347,179,468 | 20,219,732 | 34,002,757 |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Peoria/Pekin IL | 346,480 | 0.46% | 172,120,540 | 10,024,300 | 16,857,486 |
| Rockford IL | 358,640 | 0.47% | 178,161,251 | 10,376,111 | 17,449,113 |
| Saginaw/Bay City/Midland | 400,753 | 0.53% | 199,081,686 | 11,594,517 | 19,498,060 |
| St. Louis MO/IL | 2,569,029 | 3.38% | 1,276,214,089 | 74,326,709 | 124,992,408 |
| South Bend IN | 258,537 | 0.34% | 128,433,179 | 7,479,948 | 12,578,746 |
| Springfield MO | 308,332 | 0.41% | 153,169,794 | 8,920,609 | 15,001,450 |
| Toledo OH | 608,976 | 0.80% | 302,520,427 | 17,618,790 | 29,628,851 |
| Tulsa OK | 786,117 | 1.03% | 390,518,593 | 22,743,803 | 38,247,391 |
| Wichita KS | 548,714 | 0.72% | 272,584,131 | 15,875,300 | 26,696,890 |
| Youngstown/Warren OH | 589,236 | 0.77% | 292,714,206 | 17,047,675 | 28,668,429 |
| | | | | | |
| TOTAL | 48352494 | | | | |

| PADD II Cities over 100,000/under 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case C | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Benton Harbor MI | 159,709 | 0.21% | 79,338,488 | 4,620,674 | 7,770,411 |
| Bloomington IN | 116,923 | 0.15% | 58,083,727 | 3,382,796 | 5,688,720 |
| Bloomington/Normal IL | 145,477 | 0.19% | 72,268,471 | 4,208,916 | 7,077,974 |
| Cedar Rapids IA | 184,891 | 0.24% | 91,848,126 | 5,349,235 | 8,995,605 |
| Champaign.Urbana IL | 170,272 | 0.22% | 84,585,859 | 4,926,280 | 8,284,339 |
| Clarksville/Hopkinsville TN/KY | 201,352 | 0.26% | 100,025,441 | 5,825,482 | 9,796,492 |
| Columbia MO | 130,179 | 0.17% | 64,668,898 | 3,766,317 | 6,333,672 |
| Decatur IL | 113,219 | 0.15% | 56,243,695 | 3,275,633 | 5,508,507 |
| Duluth/Superior MN/WI | 236,400 | 0.31% | 117,436,203 | 6,839,484 | 11,501,702 |
| Eau Claire WI | 144,463 | 0.19% | 71,764,747 | 4,179,579 | 7,028,639 |
| Elkhart/Goschen IN | 174,680 | 0.23% | 86,775,617 | 5,053,812 | 8,498,804 |
| Fargo/Moorehead ND/MN | 170,122 | 0.22% | 84,511,344 | 4,921,941 | 8,277,041 |
| Green Bay WI | 216,522 | 0.28% | 107,576,331 | 6,265,246 | 10,536,026 |
| Iowa City IA | 103,813 | 0.14% | 51,571,085 | 3,003,500 | 5,050,872 |
| Jackson MI | 157,271 | 0.21% | 78,127,365 | 4,550,138 | 7,651,794 |
| Jackson TN | 101,611 | 0.13% | 50,477,200 | 2,939,792 | 4,943,737 |
| Janesville/Beloit WI | 151,121 | 0.20% | 75,072,235 | 4,372,207 | 7,352,575 |
| Joplin MO | 149,981 | 0.20% | 74,505,919 | 4,339,225 | 7,297,110 |
| Kokomo IN | 100,377 | 0.13% | 49,864,187 | 2,904,090 | 4,883,698 |
| LaCrosse WI | 121,927 | 0.16% | 60,569,560 | 3,527,571 | 5,932,183 |
| Lafayette IN | 175,439 | 0.23% | 87,152,665 | 5,075,771 | 8,535,732 |
| Lawton OK | 106,621 | 0.14% | 52,966,013 | 3,084,741 | 51,87,491 |
| Lima OH | 154,065 | 0.20% | 76,534,723 | 4,457,382 | 7,495,811 |
| Lincoln NE | 237,657 | 0.31% | 118,060,642 | 6,875,852 | 11,562,859 |
| Mansfield OH | 176,617 | 0.23% | 87,737,859 | 5,109,853 | 8,593,046 |
| Muncie IN | 115,472 | 0.15% | 57,362,915 | 3,340,816 | 5,618,124 |
| Rochester MN | 119,077 | 0.16% | 59,153,768 | 3,445,115 | 5,793,520 |
| St. Cloud MN | 164,913 | 0.22% | 81,923,674 | 4,771,235 | 8,023,605 |
| Sheboygan WI | 110,136 | 0.14% | 54,712,156 | 3,186,436 | 5,358,509 |
| Sioux City IA/NE | 120,577 | 0.16% | 59,898,921 | 3,488,513 | 5,866,500 |
| Sioux Falls SD | 164,481 | 0.22% | 81,709,070 | 4,758,736 | 8,002,586 |
| Springfield IL | 204,030 | 0.27% | 101,355,789 | 5,902,961 | 9,926,786 |
| Stuebenville/Weirton OH/WV | 133,292 | 0.18% | 66,215,340 | 3,856,381 | 6,485,130 |
| Terre Haute IN | 148,206 | 0.19% | 73,624,153 | 4,287,871 | 7,210,750 |
| Topeka KS | 170,773 | 0.22% | 84,834,741 | 4,940,775 | 8,308,714 |
| Waterloo/Cedar Falls IA | 119,959 | 0.16% | 59,591,918 | 3,470,633 | 5,836,432 |
| Wausau WI | 123,584 | 0.16% | 61,392,706 | 3,575,511 | 6,012,802 |
| TOTALS | 5,595,209 | | | | |

| PADD III TOTALS | Population | | Gasoline Sold | Case B-1 Factor | Case C Factor |
|---|---|---|---|---|---|
| | 35,845,874 | | 19,035,571,897 | 3.68% | 9.46% |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Albuquerque NM | 678,820 | 1.89% | 360,480,175 | 13,254,856 | 34,087,005 |
| Austin/San Marcos TX | 1,146,050 | 3.20% | 608,597,720 | 22,378,138 | 57,549,000 |
| Baton Rouge LA | 578,946 | 1.62% | 307,443,144 | 11,304,684 | 29,071,824 |
| Beaumont/Port Arthur TX | 376,256 | 1.05% | 199,806,765 | 7,346,895 | 18,893,728 |
| Biloxi/Gulfport/Pascagoula MS | 353,205 | 0.99% | 187,565,776 | 6,896,794 | 17,736,220 |
| Birmingham Al | 915,077 | 2.55% | 485,941,953 | 17,868,086 | 45,950,671 |
| Brownsville/Harlingen/San Benito TX | 329,131 | 0.92% | 174,781,533 | 6,426,717 | 16,527,342 |
| Corpus Cristi TX | 387,105 | 1.08% | 205,568,012 | 7,558,736 | 19,438,511 |
| Dallas/Fort Worth TX | 4,909,523 | 13.70% | 2,607,150,213 | 95,864,913 | 246,532,124 |
| El Paso TX | 701,908 | 1.96% | 372,740,812 | 13,705,680 | 35,246,371 |
| Fayetteville/Springdale/Rogers AR | 285,017 | 0.80% | 151,355,260 | 5,565,333 | 14,312,153 |
| Houston/Galveston/Brazoria TX | 4,493,741 | 12.54% | 2,386,353,584 | 87,746,221 | 225,653,595 |
| Huntsville AL | 343,418 | 0.96% | 182,368,493 | 6,705,689 | 17,244,765 |
| Jackson MS | 432,647 | 1.21% | 229,752,609 | 8,448,003 | 21,725,407 |
| Killeen/Temple TX | 296,316 | 0.83% | 157,355,475 | 5,785,961 | 14,879,534 |
| Lafayette LA | 377,238 | 1.05% | 200,328,246 | 7,366,070 | 18,943,039 |
| Little Rock/North Little Rock AR | 559,074 | 1.56% | 296,890,329 | 10,916,657 | 28,073,950 |
| McAllen/Edinburg/Mission TX | 534,907 | 1.49% | 284,056,699 | 10,444,765 | 26,860,401 |
| Mobile AL | 535,472 | 1.49% | 284,356,737 | 10,455,797 | 26,888,773 |
| Montgomery AL | 322,441 | 0.90% | 171,228,879 | 6,296,086 | 16,191,403 |
| New Orleans LA | 1,305,479 | 3.64% | 693,260,802 | 25,491,200 | 65,554,741 |
| San Antonio TX | 1,564,949 | 4.37% | 831,049,599 | 30,557,694 | 78,584,050 |
| Shreveport/Bossier City LA | 377,673 | 1.05% | 200,559,248 | 7,374,564 | 18,964,883 |
| TOTAL | 21,804,393 | | | | |

| PADD III<br>Cities over100,000/under 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Abilene TX | 122,478 | 0.34% | 65,040,645 | 2,391,545 | 6,150,243 |
| Alexandria LA | 126,775 | 0.35% | 67,322,522 | 2,475,449 | 6,366,018 |
| Amarillo TX | 208,691 | 0.58% | 110,823,146 | 4,074,967 | 10,479,437 |
| Anniston AL | 116,541 | 0.33% | 61,887,864 | 2,275,617 | 5,852,116 |
| Auburn/Opelika AL | 102,164 | 0.29% | 54,253,111 | 1,994,887 | 5,130,174 |
| Bryan/College Station | 134,213 | 0.37% | 71,272,393 | 2,620,686 | 6,739,517 |
| Decatur AL | 143,460 | 0.40% | 76,182,914 | 2,801,246 | 7,203,856 |
| Dothan AL | 135,243 | 0.38% | 71,819,363 | 2,640,798 | 6,791,239 |
| Florence AL | 136,879 | 0.38% | 72,688,144 | 2,672,743 | 6,873,391 |
| Fort Smith AR | 195,547 | 0.55% | 103,843,164 | 3,818,313 | 9,819,410 |
| Gadsden AL | 103,472 | 0.29% | 54,947,710 | 2,020,427 | 5,195,855 |
| Hattiesburg MS | 113,054 | 0.32% | 60,036,130 | 2,207,528 | 5,677,016 |
| Houma LA | 194,591 | 0.54% | 103,335,490 | 3,799,646 | 9,771,404 |
| Lake Charles LA | 180,607 | 0.50% | 95,909,435 | 3,526,590 | 9,069,196 |
| Laredo TX | 193,180 | 0.54% | 102,586,194 | 3,772,094 | 9,700,550 |
| Las Cruces NM | 170,361 | 0.48% | 90,468,405 | 3,326,523 | 8,554,692 |
| Longview/Marshall TX | 209,493 | 0.58% | 111,249,040 | 4,090,627 | 10,519,709 |
| Lubbock TX | 227,890 | 0.64% | 121,018,572 | 4,449,853 | 11,443,516 |
| Monroe LA | 146,672 | 0.41% | 77,888,613 | 2,863,964 | 7,365,147 |
| Odessa/Midland TX | 242,238 | 0.68% | 128,637,925 | 4,730,017 | 12,164,002 |
| San Angelo TX | 102,300 | 0.29% | 54,325,332 | 1,997,542 | 5,137,003 |
| Santa Fe NM | 142,509 | 0.40% | 75,677,896 | 2,782,676 | 7,156,102 |
| Sherman/Denison TX | 103,728 | 0.29% | 55,083,656 | 2,025,426 | 5,208,711 |
| Texarkana TX/AR | 122,886 | 0.34% | 65,257,309 | 2,399,511 | 6,170,731 |
| Tuscaloosa AL | 161,435 | 0.45% | 85,728,348 | 3,152,231 | 8,106,473 |
| Tyler TX | 169,693 | 0.47% | 90,113,671 | 3,313,480 | 8,521,149 |
| Waco TX | 204,244 | 0.57% | 108,461,614 | 3,988,134 | 10,256,130 |
| Wichita Falls TX | 136,493 | 0.38% | 72,483,163 | 2,665,206 | 6,854,008 |
| TOTALS | 4,346,837 | | | | |

| | Population | Gasoline Sold | Case B-1 Factor | Case C Factor |
|---|---|---|---|---|
| PADD IV TOTALS | 8,800,050 | 4,415,963,142 | 2.26% | 9.06% |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Boise City ID | 407,844 | 4.63% | 204,660,664 | 4,633,517 | 18,538,163 |
| Colorado Springs CO | 499,994 | 5.68% | 250,902,560 | 5,680,434 | 22,726,754 |
| Denver/Boulder/Greeley CO | 2,417,908 | 27.48% | 1,213,333,175 | 27,469,863 | 109,903,719 |
| Provo/Orem UT | 346,997 | 3.94% | 174,126,961 | 3,942,234 | 15,772,420 |
| Salt Lake City/Ogden | 1,275,076 | 14.49% | 639,847,344 | 14,486,144 | 57,957,372 |
| TOTALS | 4,947,819 | | | | |
| **Cities over 100,000/under 250,000** | | | | | |
| Billings MT | 127,258 | 1.45% | 63,859,482 | 1,445,779 | 5,784,392 |
| Fort Collins/Loveland CO | 236,849 | 2.69% | 118,853,467 | 290,843 | 10,765,747 |
| Grand Junction CO | 115,147 | 1.31% | 57,782,048 | 1,308,186 | 5,233,898 |
| Pueblo CO | 136,987 | 1.56% | 68,741,603 | 1,556,310 | 6,226,614 |
| TOTALS | 616,241 | | | | |

| PADD V TOTALS | Population | | Gasoline Sold | Case B-1 Factor | Case C Factor |
|---|---|---|---|---|---|
| | 50,610,218 | | 22,120,932,954 | 3.62% | 6,3.3% |

| Cities over 250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Anchorage AK | 257,808 | 0.51% | 112,683,836 | 4,074,647 | 7,131,760 |
| Bakersfield CA | 642,495 | 1.27% | 280,824,493 | 10,154,614 | 17,773,382 |
| Eugene OR | 314,901 | 0.62% | 137,638,291 | 4,977,001 | 8,711,127 |
| Fresno CA | 879,829 | 1.74% | 384,559,464 | 13,905,670 | 24,338,768 |
| Honolulu HI | 864,571 | 1.71% | 377,890,432 | 13,664,518 | 23,916,685 |
| Las Vegas NV/AZ | 1,381,086 | 2.73% | 603,651,042 | 21,828,022 | 38,205,074 |
| Los Angeles/Riverside/Orange Cty, CA | 16,036,587 | 31.69% | 7,009,340,798 | 253,457,763 | 443,621,179 |
| Modesto CA | 436,790 | 0.86% | 190,914,062 | 6,903,452 | 12,082,951 |
| Phoenix/Mesa AZ | 3,013,696 | 5.95% | 1,317,239,281 | 47,631,372 | 83,368,074 |
| Portland/Salem OR/WA | 2,180,996 | 4.31% | 953,279,164 | 34,470,575 | 60,333,038 |
| Reno NV | 319,816 | 0.63% | 139,786,560 | 5,054,682 | 8,847,091 |
| Sacramento/Yolo CA | 1,741,002 | 3.44% | 760,964,683 | 27,516,483 | 48,161,455 |
| Salinas | 371,756 | 0.73% | 162,488,720 | 5,875,592 | 10,283,911 |
| San Diego CA | 2,820,844 | 5.57% | 1,232,946,695 | 44,583,352 | 78,033,196 |
| San Francisco/Lakland/San Jose CA | 6,873,645 | 13.58% | 3,004,362,483 | 108,637,747 | 190,146,102 |
| Santa Barbara/Santa Maria/Lompoc CA | 391,071 | 0.77% | 170,931,004 | 6,180,865 | 10,818,223 |
| Seattle/Tacoma/Bremerton WA | 3,465,760 | 6.85% | 1,514,829,369 | 54,776,230 | 95,873,551 |
| Spokane WA | 409,736 | 0.81% | 179,089,183 | 6,475,865 | 11,334,554 |
| Stockton-Lodi CA | 563,183 | 1.11% | 246,158,461 | 8,901,090 | 15,579,369 |
| Tucson AZ | 803,618 | 1.59% | 351,248,831 | 12,701,158 | 22,230,539 |
| Visalia/Tulare/Pottersville CA | 358,470 | 0.71% | 156,681,618 | 5,665,607 | 9,916,380 |
| TOTAL | 44,127,660 | | | | |

| PADD V Cities over 100,000/under250,000 | Population | % of PADD Population | Gasoline Demand | Ethanol Demand Case B-1 | Ethanol Demand Case C |
|---|---|---|---|---|---|
| Bellingham WA | 160,310 | 0.32% | 70,068,988 | 2,533,695 | 160,358 |
| Chico/Paradise CA | 195,220 | 0.39% | 85,327,602 | 3,085,446 | 5,400,384 |
| Flagstaff AZ | 120,652 | 0.24% | 52,735,098 | 1,906,901 | 3,337,604 |
| Medford/Ashland OR | 175,822 | 0.35% | 76,849,040 | 2,778,861 | 4,863,776 |
| Merced CA | 200,746 | 0.40% | 87,742,930 | 3,172,784 | 5,553,250 |
| Redding CA | 164,530 | 0.33% | 71,913,484 | 2,600,392 | 4,551,404 |
| Richland/Kennewick/Pasco WA | 184,626 | 0.36% | 80,697,131 | 2,918,008 | 5,107,321 |
| San Luis Obispo/Atascadero/Paso Robles CA | 236,953 | 0.47% | 103,568,442 | 3,745,035 | 6,554,847 |
| Yakima WA | 220,785 | 0.44% | 96,501,663 | 3,489,500 | 607,590 |
| Yuba City CA | 138,030 | 0.27% | 60,330,749 | 2,181,560 | 3,818,333 |
| Yuma AZ | 135,614 | 0.27% | 59,274,754 | 2,143,375 | 3,751,499 |
| TOTALS | 1,933,288 | | | | |

# Appendix E
# Estimated Terminal Equipment Costs
# Estimated Retail Unit Conversion Costs
# Estimated Transportation Equipment Costs
# Amortization Calculation Information

## E.0 Introduction

This appendix contains information on the various cost estimates for the equipment that would be required at finished product terminals, the cost of converting retail service stations to E-10, and the cost of transportation equipment that would be required. Equipment cost estimates were based on industry estimates and purchases in calendar year 2000. A discussion on the method used to calculate amortization is also provided.

## E.1 Estimated Terminal Equipment Costs

### New Tankage

Tankage estimates vary widely depending on tank size, permitting problems, attendant piping runs, and other site specific information.

NPC(1) estimates that a 25 mbbl tank costs $450,000 ($18 per barrel). In our project colloquies (2) (see Appendix F) project participants put new tank costs in a range of $10 to $15 per steel barrel. Here we are using the high end of that range, i.e. $15.00 for any tanks under 25 mbbl due to their small size/higher cost per barrel. Tanks from 25 mbbl to 45 mbbl are assumed to cost $12 per barrel. Anything larger than 50 mbbl is assumed to be $10 per barrel. Larger tanks would usually be utilized for “hub terminal” operations.

Day tanks (i.e. those in size ranges below 5,000 barrels) are assumed to cost $20 per barrel.

### Tank Conversions

In many cases, existing tankage is idle or can be assigned to ethanol storage. Often the tank configuration is suitable for ethanol storage. In other cases modifications may be necessary to prevent intrusion of moisture into the tank or to pipe the tank to the truck rack. Examples would include adding a fixed roof or a floating internal cover, reconfiguration of piping, and different pressure vacuum vents. Such expenses will be very incident specific. Based on private conversations with industry personnel we are using 20% of the cost of new tankage for those tanks estimated to require conversion.

### Ethanol Receipt/Miscellaneous Contingency

The tankage at many terminals is not set up for receipt of product by rail or transport truck. The NPC(1) has estimated that modifying such terminals could cost as much as $300,000 per terminal, but this also included the installation of rail spurs which in our study is broken out separately. Here we are only talking about piping changes and an unloading station for transport trucks. Terminals already accepting product by water should be able to use the same system for barge delivery of ethanol.

These miscellaneous costs are covered by adding $20,000 (for all terminals estimated to require tank conversions or new tanks) per terminal for a miscellaneous contingency.

### Blending Systems

The NPC study (1) put the estimate for blending systems at $400,000 per terminal. Our industry contacts indicate this estimate may be high because of the variety of equipment and methods to accomplish the installation of a blending system. Skid mounted units are available with relatively short lead time. Systems can also be designed with preset proportioning pumps.

Based on the above, we are using a lower estimate of $300,000 per terminal for blending equipment installation. This assumes an average of two blending units per terminal.

### Rail Receipt Capabilities

The cost of rail spurs to service terminals can vary dramatically. In our project colloquies railroad personnel indicated that spurs typically run $75 to $95 per track foot (2). Accordingly we have used $85 per foot and assumed that those terminals requiring new rail spurs would require a spur averaging 4000 ft (i.e. 3/4 mile) for a total of $340,000. We have added an additional $15,000 to each such installation for piping costs and miscellaneous expense associated with connecting the spur to tankage.

## E.2 Estimated Retail Unit Conversion Costs

The cost estimates for conversion of retail facilities vary widely depending on the assumptions made about preparatory steps taken. Some observers have included such items as repairs to manhole covers and seals on fill caps to prevent entry of water into the system. We believe repairs to ensure a tight system would be, or should be, made in any case. Our assumptions of cost are restricted to those that are specifically necessary for a first time conversion to ethanol blends. This would include removing all water bottoms from retail tanks, (when necessary) cleaning older tanks, re-decaling pumps, repainting fill covers to the approved API color code and in some cases, pumping out water/sludge after the initial delivery. A certain amount of time may be needed for accounting changes, orientation meetings for transport drivers and store personnel, and field management, as well as assuring compliance with state and federal regulations. Estimates for converting a retail facility with three underground tanks range from $300 to $700 and are highly dependent on whether tanks need cleaning and if in-house personnel or subcontractors do the work. Construction of our estimate is broken down in Table E-1.

**Table E-1 Study Case B1 - Station Cost Estimate - E-10/E-5.7 Conversion**
**Average cost per unit - 3 tank conversion**

| | | |
|---|---|---|
| Water removed &/or tank cleaning | $400 | (1) |
| Re-decaling pumps/remarking | $50 | |
| Administrative time per unit | $100 | |
| After conversion water bottoms removal | $40 | (2) |
| Total | $590 | |

(1) Assumes water removal at 20% of stations at $400 per facility and tank cleaning at 40% of stations at $800 per facility. Remaining 40% converted without these steps yields an average of $400 per unit.
(2) Assumed necessary in 10% of units @ $400 per unit for an average of $40

## E.3 Transportation Equipment

Transport truck/trailer rigs: Ethanol industry transportation personnel and transport truck sales/leasing firms were contacted to obtain estimates of the cost of tractor/transport rigs suitable for hauling ethanol. Estimates ranged from a low of $105,000 per rig (assuming multiple rig purchases) to a high of $125,000 per rig for single rig purchase. A cost of $115,000 per rig is used in this study. Equipment life is assumed to be ten years. Although there is some salvage value at life cycle end, the amounts are relatively small and were not used in estimating total rig costs.

Rail Tank Cars: In estimating the cost of T108 rail tank cars both the railroad industry and tank car leasing companies were contacted. Estimates ranged from a low of $52,000 per car to a high of $65,000. A cost of $60,000 per tank car is used in the study. Equipment life cycle is assumed to be fifteen years. Again, there is some salvage value at the end of the life cycle but these small amounts are not included in determining total equipment costs.

River Barges: The marine transportation companies we contacted indicated that, in an expanded ethanol industry scenario, it is likely that new barges purchased would be of 30 mbbl capacity (as opposed to the 10 mbbl size currently used). Cost estimates for barges of this size were at an average of $1.6 million per unit and that is the cost used in the study. Life cycle is assumed to be fifteen years. Salvage value at the end on the life cycle was not used in determining total equipment cost.

## E.4 Amortization Calculations

In order to provide a reasonable comparison of program costs, it is necessary to amortize costs for investments over the projected lifetime of the equipment or program.

We have chosen to present costs on an amortized cents per gallon of new ethanol volume basis. The equipment life cycles used are as follows:

- Terminal Equipment - Tanks, blending systems, rail spurs, and miscellaneous terminal equipment is assumed to have a life cycle of 20 years.

- Transportation equipment - Barges and rail cars are assumed to have a life cycle of 15 years. Transport trucks and trailers are assumed to have a life cycle of 10 years.

To develop a reasonable amortization factor we reviewed different sources. As an example, past work by Turner, Mason and Company for the National Petroleum Council utilized a capital recovery factor (CRF) of 0.171 actual for 20 years.

We also consulted with Technology and Management Services Inc. (TMS). TMS has a spreadsheet which calculates capital recovery factors (CRF) for various assumptions. Assumptions employed in developing the factors we considered are as follows:

- Tax rate 34%
- Capital replacement increment of 1.6% (of initial capital cost)
- Return on Investment (ROI) - 10%

The above assumptions result in the following amortization factors for the three time frames.

| | |
|---|---|
| 10 years | 0.200 |
| 15 years | 0.170 |
| 20 years | 0.156 |

Of the options reviewed we have selected the TMS spreadsheet factors in part because we believe the 10% ROI is more representative of both long term petroleum industry performance and future performance that could be expected. Also, the TMS factors use a CRF that is an after-tax ROI and is for analysis of constant dollar costs.

To arrive at an amortized cents per gallon of new ethanol volume, the program cost being amortized is divided by the applicable new annual ethanol volume and then multiplied times the above factors for the equivalent life cycles.

**References**
**for Appendix E**
**Estimated Terminal Equipment Costs**
**Estimated Retail Unit Conversion Costs**
**Estimated Transportation Equipment Costs**
**Amortization Calculation Information**

**Specific References**

(1) U.S. Petroleum Refining-Assuring the Adequacy and Affordability of Clean Fuel, National Petroleum Council, June 2000

(2) Ethanol Logistics Colloquies Overview and Observations, Downstream Alternatives Inc. and Chief Executive Assistance, June 1, 2001

**General References**

The Current Fuel Ethanol Industry Transportation, Marketing, Distribution, and Technical Considerations, Downstream Alternatives Inc., May 15, 2000

Private conversations with transportation industry personnel

Correspondence with G. Hadder on amortization factors, Oak Ridge National Laboratory, November 6, 2001

Correspondence with Roger Legasse on amortization rate, Technology and Management Services Inc., November 6, 2001

# Appendix F
# Colloquy Report

# Ethanol Logistics Colloquies
# Overview and Observations

**June 1, 2001**

**Phase II - Oak Ridge National Laboratory**
**Ethanol Project**

**Subcontract No. 4500010570**

**Distribution: Jerry Hadder**
**Colloquy Participants/Attendees**

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**Background & Introduction**

The U.S. Department of Energy's (DOE) Office of Transportation Technologies (OTT), through its Office of Fuels Development (OFD), is responsible for major planning and analysis to ensure consistency of various program objectives with the Energy Policy Act (EPACT). Oak Ridge National Laboratory (ORNL) is supporting OFD in its analysis of current and future ethanol demand for the transportation fuels market.

Downstream Alternatives Inc. (DAI) was retained to provide technical expertise specifically related to ethanol transportation, distribution, and marketing issues. The work was divided into two phases. The first phase included three major tasks. The first task was a literature search and document review to identify documents and reports that could be used for other Phase I tasks. The literature search and document review was completed in December 1999. Phase I Task 2 required preparation of a report detailing current industry practices. This report entitled "The Current Fuel Ethanol Industry - Transportation, Marketing, Distribution, And Technical Considerations" was competed in May 2000. This comprehensive report is available for review via the internet. It is document #4788 in the Biofuels Information Center Database and can be accessed at www.ott.doe.gov/biofuels/database.html.

Phase I Task 3 required preparation of a set of recommendations for how best to analyze the transportation, marketing, and distribution issues and costs associated with a dramatic expansion of the ethanol industry. These recommendations were submitted in August 2000.

The project has now moved into Phase II which essentially implements the recommendations of Phase I Task 3, i.e. to analyze the transportation, marketing, and distribution issues and costs of a greatly expanded ethanol industry.

One aspect of Downstream Alternatives Inc.'s work is to assess the logistic challenges associated with such an expansion. Two cases are currently being studied. Case B1 is based on total annual ethanol production of 5.1 billion gallons. Case C is based on 10.0 billion gallons of annual ethanol production. Case B1 represents a 3.3 billion gallon increase in annual ethanol production and use while Case C represents an 8.2 billion gallon annual increase in production and use. Due to ethanol's blending characteristics and properties, ethanol is blended into gasoline at the finished product distribution terminal. Ethanol industry expansion such as the two cases being studied will clearly require the use of additional tanks at product distribution terminals and increased transportation requirements.

As one element of this study, DAI has contacted numerous transportation and storage industry personnel to discuss the various challenges and obstacles that might be encountered as the ethanol industry is expanded. Industry representatives contacted include those from pipeline operations, barge/ship lines, railroad operators, rail car leasing companies, and trucking companies.

While a number of representatives contacted provided varying levels of useful information, these one-on-one contacts are usually short in duration and do not always identify all areas of consideration. Additionally one-on-one contacts do not facilitate an understanding of the sometimes interrelated issues between various transportation modes.

In order to identify any potential information voids, enhance information gathered through one-on-one contacts, and to foster an environment of open discussion among various transportation and storage companies, it was decided to sponsor two project colloquies.

These colloquies on ethanol logistics were set up and coordinated by James Hettenhaus, Chief Executive Assistance, Inc. (cea) with support from Robert Reynolds of Downstream Alternatives Inc. Each meeting was designed to be five hours long, starting with lunch at noon and concluding by 5:00 PM to allow participants to travel in and out on the same day. The meetings were held in Chicago at the O’Hare Hilton, also to facilitate convenient in and out same day travel.

While the primary intent of the colloquies was to obtain logistic information for future use in the case studies, this report was prepared to provide a summary record for colloquy participants and sponsors.

## Colloquy Structure

Two colloquies were conducted, the first on March 29, 2001 and the second on April 3, 2001. For each colloquy, we attempted to have a balance of participants that could address the various logistic issues being studied. This included representatives of barge/ship, rail, pipeline, and terminal operations as well as ethanol producers and users. In addition several government representatives attended as observers. A list of participants/attendees for each colloquy is included as Attachment A. Robert E. Reynolds (DAI) and James Hettenhaus (cea) served as meeting facilitators. The meeting was opened with a brief description of why the colloquy was being conducted and what we hoped to accomplish. After introductions, we noted that a final report would be prepared and distributed to participants. We also advised that should DOE release our Phase II report the participants would be provided information on how to obtain copies. In order to encourage frank and open discussion we advised participants that while items discussed may be included in this or other reports, no statements would be quoted or attributed to specific participants.

Prior to starting the open discussion we covered the general details of the two study cases we were working with. They are listed below.

Case B1 5.1 billion gallons annual ethanol production

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 0.2 | 0.2 | | 1.1 | 1.3 |
| 2 | 4.0 | 0.5 | 4.5 | 2.3 | | 2.2 |
| 3 | | 0.2 | 0.2 | | 0.5 | 0.7 |
| 4 | | | 0.0 | | 0.1 | 0.1 |
| 5 | | 0.2 | 0.2 | | 0.6 | 0.8 |
| | 4.0 | 1.1 | 5.1 | 2.3 | 2.3 | 5.1 |

Case C 10.0 billion gallons annual ethanol production

| | | | Produced | | | |
|---|---|---|---|---|---|---|
| PADD | Grain | Cellulosic | Total | Exported | Imported | Used |
| 1 | | 1.4 | 1.4 | | 1.3 | 2.7 |
| 2 | 4.5 | 2.1 | 6.6 | 2.9 | | 3.7 |
| 3 | | 1.1 | 1.1 | | 0.7 | 1.8 |
| 4 | | 0.4 | 0.4 | | | 0.4 |
| 5 | | 0.5 | 0.5 | | 0.9 | 1.4 |
| | 4.5 | 5.5 | 10.0 | 2.9 | 2.9 | 10.0 |

We also used a handout and related board drawings to graphically depict the supply inflow/ outflow geography (see Attachment #2)

We then covered topics in the following general topic order:

Ethanol Producer Issues

Terminal Issues

Water Transport Issues

Rail Transport Issues

Pipeline Issues

Other Issues

**Primary Observations**

For the purposes of this report, primary observations for the two separate colloquies have been combined. Where opinions or information differ between the two colloquies or between participants, a discussion of the differences is included. The open and informal nature of the meeting causes some drifting back and forth between topics. For improvement of report structure and convenience of the reader, observations are segmented by topic category to the extent possible.

Primary observations are covered in the following sections.

**Ethanol Producer Issues**

1. **Plant Placement:** Most ethanol production is currently located in the Midwest. In both Case B1 and Case C, this trend continues with only PADD II being an ethanol exporter to other PADDS. Growth markets are on the coast so plant placement for new plants to facilitate rail and water shipments will be very important.

2. **Plant Size Versus Shipping Capabilities:** It will likely be impractical for smaller plants to ship by barge or unit train without pooling their production with others. As an example, a 15 million gallon annual capacity ethanol plant (360,000 BBL annual) produces at a rate of ~ 42,000 gallons per day. For these plants it would take ten days to fill a barge or 69 days to fill a unit train. This would not only be operationally impractical but would also be financially impractical due to demurrage on barges, idle time for rail cars, and the cost of tieing up inventories for long periods of time. Smaller plants are therefore likely to be limited to truck shipments and small rail car movements (e.g. one to ten cars). Smaller plants must therefore make a decision to either market in a smaller nearby geographic area, pool their resources (i.e. some type of consortium) to address some of the shortcomings of smaller production levels, or work with a larger producer via exchange or marketing agreements to avail themselves of the presumably higher valued coastal markets.

Larger plants can ship by any mode that is available to them. However in their case the receipt capabilities of the receiving terminal(s) will be the deciding factor. Larger plants will use a combination of truck, rail, and barge depending on the market area and terminal receipt capabilities. These plants will also use transhipment to service coastal markets. This would entail barge shipments (and could include some rail) to the Gulf Coast (probably New Orleans) for accumulation of ship quantities.

The product would then be loaded onto ships for delivery to the East Coast and California/West Coast markets. Producers also note that the limitation on Jones Act vessels may result in more need to move product by rail than originally anticipated (see Water Transport Issues section).

Larger producers also noted that they were adding capacity through a variety of projects and capacity was therefore increasing at a fairly steady rate. Farmer based co-ops are interested in several more new projects and possibly expanding existing plants. Many of their plants though rated in the ~ 30 million gallon annual range were designed to be expanded as market conditions and finances warrant.

It was also noted that while our project focuses on ethanol logistics there would be an increase in demand for transporting coproducts in the case of grain based plants.

**3. Product Exchanges:** Product exchange is simply a swap between producers of product that usually reduce shipping and terminaling costs. Product exchanges are routine in the petroleum industry. They have not been widely used by the ethanol industry. This has been due to the fact that in the past the largest markets were in the Midwest where plants are based. Exchanges will become much more important now that markets are more geographically dispersed. The most likely scenario will be for large producers to ship product to coastal markets and exchange product there to smaller producers, taking back product at the smaller producer’s Midwest plants. This enables the small producers some level of involvement in the higher valued RFG markets. It also enables the larger plants to maximize their water and unit train capability by directing their product to these shipment modes and receiving truck loads from small producers to serve their Midwest market areas.

**4. Marketing Agreements:** There is growing interest in methods to pool the small plants together into some type of consortium. For instance, the Broin Companies have existing positions in, and are actually involved in the management of, many of the smaller plants they have built. This model might provide the foundation for pooling resources although there are obviously some antitrust issues that would need to be addressed.

Another avenue is for the smaller producers to enter into some type of marketing agreement with a larger producer and several have already done so. For the smaller producer this eliminates the need for marketing and transportation personnel, transportation equipment or leases, and greatly reduces the need for accounting staff.

**5. Small Plants:** There was some concern expressed about small plants and if they were really the way to proceed. One issue raised was ethanol supply from these plants that do not have economies of scale if corn prices increase. However it was noted that many of these smaller plants are co-op structures and have some ability to reduce feedstock cost volatility. Producers, both large and small, are also becoming more sophisticated in hedging their positions (intermarket spreads) through the use of the commodities market (e.g. corn and petroleum futures). More detailed descriptions of intermarket spreads and hedging are provided by http://www.fiafii.org/tutorial/hedging5.htm.

Another concern was if bank financing would be available for smaller plants. It was noted that while each case may be different, several positive factors make it easier to secure commitments from the financial community today than in the past. For example, not only are market conditions better now, but plants are far less costly to build. Moreover, many plants are able to secure more up front equity. These factors combine to lower fixed operating costs (debt service).

Some ethanol users also indicated that it is absolutely imperative that smaller producers understand they must honor their contracts. Force Majeure is acceptable only in the most extreme cases. Producers are expected to cover their short positions through purchases or other market mechanisms. Small producers (and in some cases, larger producers) have not always met their commitments due to weather (e.g. frozen rivers, blizzards that caused barge and rail delays). In some instances, the customer was forced to use their trucks to take delivery from the supplier or alternate sources.

**6. Product Quality/Specifications:** There was also some general discussion about product quality. This included such issues as meeting ASTM Standards, California and Federal Sulfur requirements, and the use of corrosion inhibitors. These factors also impact the selection of denaturants and the level used.

All producers are aware of these issues and also routinely provide Certificates Of Analysis (C of As) on their product.

**7. Feasibility of Biomass:** Although not within the scope of the logistic work, there were some concerns expressed about the feasibility of biomass production, competitive costs, and timing. Such production is generally viewed to be three to five years or more into the future.

**8. Market Uncertainties:** It was also noted that market uncertainties were causing delays in decisions, not only with plant expansion but also transportation capabilities. The primary concern here was the California request for an oxygen waiver and its ramification for other areas ,if granted. Also, if granted, would it be replaced by a Renewable Fuels Standard? Again, these are somewhat beyond the scope of the meeting although anything that delays expansion of the transportation industry could, in fact, impact the timely and operationally trouble-free shipment of ethanol. Producers indicated it was unlikely that most producers would engage in major expansions until these uncertainties are resolved. They will not expand before the demand is there. Rail companies indicate they faced similar issues due to these uncertainties. There were however some differences of opinion with some participants being more upbeat about expansion, believing there would be demand increases for ethanol regardless of the outcome of some of these uncertainties.

**Terminal Issues**

**1. Terminal Issues Impact Transportation Modes:** One of the reasons terminals were covered second was because their product receipt capabilities and storage capabilities determine the shipment mode the producer/shipper must use. For instance, if a distant terminal cannot accept product by water or rail, it is necessary to ship to a redistribution or “hub terminal” and truck from there to the final destination. Likewise, if a terminal cannot spot more than a certain number of rail cars, large unit train shipments may not be an operationally attractive option. At the same time, producers will want to use barge and rail to take advantage of freight savings and this will necessitate hub terminal operation systems.

**2. Supply/Delivery Reliability:** Supply reliability will be a major determinant in the amount of inventory maintained, i.e. the amount of ethanol storage required. How much risk is prudent? As an example, if California product is being shipped via the Panama Canal transit time may be more than a month and a unanticipated delay of 5 to 10 days is not unheard of. In this scenario the terminal may need more storage to accommodate enough back up inventory as a contingency to such delays. Most felt that a minimum two week supply was required for worst case scenarios in coastal markets. Terminal operators/ethanol users noted that a history of reliable deliveries would enable them to maintain lower inventory levels. They also noted that they would like to receive rateable deliveries, i.e. specified and consistent amounts spread over a given time frame. The availability of product from other local terminals owned by others is a factor in managing risk. Short term borrowing from another's inventory in the event of a delayed shipment is a common practice. If none is stored nearby, the minimum inventory level is increased accordingly.

Concerns were also expressed that if only one plant was supplying an area, a plant failure would be a major issue. This too would necessitate a higher than normal working inventory as a contingency. However, most thought that more than one plant would supply an area especially in the case of smaller plants or newer plants with less operational history. This may result in a preference of large users preferring to deal with larger multiple plant type producers.

**3. Hub Terminal Operations:** Not all terminals can take rail or barge shipments. They may not have the necessary receipt facilities or may not have large enough tanks to accept these larger shipment. Ethanol producers will however desire to ship by rail or water transport to save on freight costs. In this case product is sent via ship, barge, or rail to a major terminal in the geographic area. Large working inventories could be maintained at this facility. Product would be delivered to other distribution terminals via truck from this facility. Terminal operators indicated that rail delivery was preferred over truck delivery. Lower truck traffic and less labor requirements per volume of product result . This is the case even in the Midwest. In larger markets, hub terminals would ideally be capable of receiving and storing barges and/or unit trains. However hub terminals in some markets can be smaller accepting small numbers of rail cars or single barges and redistributing by truck.

**4. Transshipment Terminals:** To move product to coastal markets via waterborne cargoes it is necessary to barge (or rail) product to the Gulf Coast area (currently New Orleans) to accumulate sufficient product for transport by ship. All participants felt there is adequate tank capacity suitable for ethanol in the Gulf Coast area to accommodate such transshipment.

**5. Distribution Terminals:** Most distribution terminals (finished product terminals) are set up to receive product by pipeline and in many cases by barge. Few are set up to handle receipt of rail cars. Even in the case of large petrochemical terminals that can receive rail cars, they may not be capable of spotting more than a few rail cars at a time. Some finished product terminals will likely install rail spurs but not all will be able to do so. For instance, in California product will likely be marined in and trucked to outlying terminals in many cases. It is not anticipated that terminals will normally receive ethanol by pipeline (see Pipeline Issues section) although some ethanol will move over short controlled segments of private pipeline.

**6. Product Ownership at Terminals:** There were mixed opinions as to at what point in the system terminal operators/blenders would or should take ownership of the product. Some felt that in the case of coastal bound transshipments buyers would want to take possession at the Gulf Coast transshipment facility (this would be more feasible for someone in control of, or contracted with, Jones Act vessels). Others felt they would prefer to take possession of product at the "hub terminal" and then transport the product to their terminal. Still others preferred to buy product on a "delivered to their terminal" basis. The varying opinions are a result of numerous financial and operational considerations including terminal location and receipt capabilities, available storage, interest on working capital for inventories, ownership of transportation equipment, etc.

**7. Tankage Availability:** This is one area where there seems to be disagreement. In one colloquy it was noted that the industry was "over-tanked". While in the other colloquy it was felt that the availability of tankage was limited. This may be due in part to the geographic areas of the participants.

Our best assessment is that tankage in PADD V in general, and California in particular, is constrained and the addition of ethanol would require either building new tanks or reassigning product and modifying existing tanks. This will already be done in most California areas due to existing federal oxygen requirements.

In the other PADDS more tankage is available and the necessity of product reassignment is lessened but some modification to tanks may be necessary.

Another distinction was made between distribution terminals and hub terminals. Larger terminals that would serve as hub terminals are likely to already have sufficient tankage while distribution terminals are more likely to be utilizing all available tankage.

8. **Product Exchange/Product Commingling:** Terminals operators also felt that further development of product exchanges was imperative to achieve maximum utilization of terminals. It was further noted that such exchanges may not necessarily be just between ethanol producers, but between ethanol producers and petroleum companies or in some cases simply between petroleum companies. It was also noted that given tankage limitations at terminals, ethanol producers/marketers would need to be more receptive to commingling arrangements. Some producers have been reluctant to commingle product in the past due to liability concerns and the unknown quality of ethanol other than there own. However with all ethanol now routinely meeting ASTM standards, there should be less concern.

9. **Increased Terminal Traffic:** There were some questions about whether ethanol deliveries via truck transport would create traffic problems or congestion within the terminals. The general consensus was that compared to outbound shipments of gasoline, diesel, and kerosene, that incoming ethanol shipments would equate to no more than 5% to 10% of total traffic. Additionally if the off-loading facilities were positioned in the right place, there should be no major congestion problems for the majority of terminals.

There was some question about the availability of transport trucks but is was felt that transport trailers could easily be built within a short time frame and that in many cases ethanol shipments would be handled with existing equipment. The issue of increased emissions from ethanol transport deliveries was brought up but this issue is beyond the scope of both the colloquies and the Phase II project. In this context the question was asked if backhauls could help offset this impact. There was some difference of opinion on the feasibility of backhauls. As an example, if a terminal had 780,000 gallons of outbound deliveries to retail, it would require 100 transport truck loads. If all were 10% ethanol blends, the inbound ethanol requirement is 78,000 gallons or 10 transport truck loads. So it would only be necessary to arrange backhauls on what is comparatively a small portion of outbound trucks. Still, some companies felt that timing, delivery locations, and ethanol pickup points could preclude backhauls in many instances.

Some, especially those using common carriers or with underutilized transports believe it is feasible to pick up ethanol at a hub terminal, deliver it to a destination terminal, and pick up gasoline at the destination terminal for delivery to retail.

Conversely, some companies (using their own trucks and strained capabilities) indicate that it would be too troublesome to take a truck out of general service (to retail) in order to pick up ethanol. These companies would prefer to have a common carrier, or the supplier, deliver the ethanol and keep their trucks on their normal schedule.

The above makes it difficult to quantify the extent to which backhauls may occur but it is a common practice in the more established Midwestern markets.

**10. Equipment Addition/Modification:** The type of terminal modifications that would typically be needed at distribution terminals was also discussed as a separate topic. Depending upon current terminal operations, terminals would need some, or all, of the following:

- Modification or installation of equipment for product receipt (e.g. rail spur, transport unloading site) and attendant piping changes.
- Modification to existing tanks, (typically installation of fixed roof and/or floating internal cover) or installation of new tankage and attendant piping changes. Cost estimates for new tanks are in the $10 to $15 per “steel barrel” range.

- Installation of blending systems, and attendant piping changes. Systems could be custom designed, but are also available for purchase as a prefabricated skid mounted unit.

**11. Distilled Spirits Permits (DSPs):** Although also discussed under other topic areas, participants noted that it might be advantageous for "hub terminals" to have distilled spirits permits (DSP). This would permit the shipment of undenatured ethanol "in bond" and the terminal operator would then denature the product and file the necessary reports with the BATF. Product from Caribbean plants (who ship product tariff-free under the Caribbean Basin Initiative) utilize this approach. In order to avoid applying tariffs, CBI product must meet certain indigenous value added requirements. However some product is subject to less strict standards. This grandfathered product cannot exceed 7 volume % of U.S. ethanol utilization. Other imports are not a major consideration. Occasional shipments from Canada are small while South American (Brazilian) ethanol is subject to significant tariffs.

**12. Suboctane Gasolines:** There was also discussion about the use of suboctane gasoline to maximize ethanol's value. These programs have expanded somewhat in the Midwest. However in many areas tankage limitations preclude such programs unless the terminal is set up to store a suboctane grade and blend it with premium to make a hydrocarbon unleaded regular for customers who prefer non-ethanol product.

**13. Tanks-Stress Cracking:** There were questions about whether corrosion and stress cracking of tanks could be an issue. It was noted that one terminal operator had a tank in ethanol service that stress cracked, although the failure could not be attributed specifically to ethanol. It was further noted that some Midwestern terminals have stored ethanol for 10-15 or more years without evidence of corrosion problems or stress cracking.

**14. Terminals are Key:** Finally, it seemed all participants were in agreement that the terminals were key in solving logistic issues. Terminal storage and receipt capabilities would play a big role in transportation demands.

**Waterborne Cargo Issues**

**1. Barge/Tow Availability:** Participants felt that the supply/demand picture for barges was relatively balanced. They noted that increased ethanol delivery by barge would require that additional barges be built but that adequate capability to increase the barge fleet exists given sufficient lead time. Although new barges would be required, the general consensus was that the tow fleet is probably sufficient to handle the volumes for Study Case B1. Some modest increase in tow capacity may be needed for Study Case C (i.e. 10 billion gallon annual ethanol production).

It was noted that unit build rates allow for replacement of about 1/10 of the barge fleet per year. In addition it was noted that two major ethanol producers (ADM and Cargill) are major owners of barge fleets now. Also there are independents such as ACBL that could supplement the fleet.

**2. Inland Waterways/Typical Shipments:** Ethanol shipments could originate on the Missouri, Illinois, and Ohio Rivers all of which connect with the Mississippi and in turn the Gulf Coast.

Current barges are typically 10,000-12,000 barrels capacity with a 9 foot draft. Some new barges can haul 30,000 barrels while still maintaining a 9 foot draft. Barges are typically combined into “tows” ranging from 6 to 15 barges depending on the navigable waterways traversed and associated locks. Above St. Louis the locks are only 600 feet long. Below St. Louis locks are 1200 feet long. A 15 barge tow can go through a 1200 foot lock as one unit. For a 600 foot lock the shipment would need to be separated into two tows to clear the lock. This is a troublesome and time consuming exercise. One barge equates to ~ 10,000 barrels (420,000 gallons). A 15 barge tow equates to ~ 150,000 barrels (6,300,000 gallons). Capacity on some waterways such as the Missouri and Ohio Rivers is often limited due to circumstances such as water levels. This can limit tow size to as few as six barges. Areas north of St. Louis may have limited winter shipment capabilities due to the river freezing. The Missouri and upper Mississippi rivers are typically closed from December through February.

Present travel above St. Louis can be difficult to accurately schedule due to lock delays. Increased movements on the inland waterways may eventually require, or at least would be better facilitated by, upgrading of certain locks. However there are also environmental considerations and some environmental groups might oppose such expansion. Funding for maintenance and infrastructure improvements for the inland waterways system and associated locks comes from the Inland Waterway Trust (50%) and the federal government (50%). Certain maintenance projects are budgeted while funding for improvements would require enabling legislation.

**3. Safety Precautions:** One shipper noted that when possible they put non-ethanol/non-liquid barges around their ethanol barges to protect them in the event of collision thereby minimizing the likelihood of a spill.

**4. Refinery Considerations:** One refiner noted that certain refinery related issues could impact barge availability, traffic patterns, etc. Two examples were cited. Refinery closings could have an impact on transportation demands/patterns and it is anticipated that additional closings may result from Tier II Sulfur Rules etc. Some felt such closings may be more prevalent in PADD II due to a general perception of less sophisticated refineries in these locales.

A second issue was that expanded ethanol use in RFG would create more demand for alkylate which may also move by barge in some cases.

**5. DSPs/Movement in Bond:** Some participants asked about the possibility of shipping undenatured ethanol noting less volume shipped/freight savings. Of course since the denaturant is lower priced than the ethanol the entity receiving the product would also be able to lower costs unless the producer adjusts prices accordingly.

Such product movements would require shipment “in bond”, necessitating the receiving entity to acquire a distilled spirits plant permit (DSP) and completing onerous paperwork to comply with BATF regulations. Still this may be an attractive option for some large volume users or for “hub terminal” operators.

**6. Back Hauls:** The potential for "backhauls" was also discussed. This would be especially attractive in the case of ethanol shipments to the Gulf Coast. Barges delivering ethanol to the Gulf Coast could haul gasoline back up river to the Midwest. This would provide for greater utilization of barges. It was thought that gasoline moving up-river was a much greater volume than the ethanol that would move down-river.

There would likely be no special cleaning requirement for "gasoline to ethanol" or "ethanol to gasoline" switches between the barges. There was some concern expressed about the need to meet the low sulfur requirements for California Clean Burning Gasoline Phase III (CBG3) product (i.e. the need to avoid contaminants that would result in sulfur levels above 10 ppm in CBG3 ethanol).

Of course, gasoline backhauls from the Gulf Coast to the Midwest would also be competing with pipelines that carry product from/to these same areas.

**7. Jones Act Vessel Constraints:** The requirement for the use of Jones Act Vessels to ship ethanol may prove more problematic than originally thought. The Jones Act (Merchant Marine Act of 1922) requires that products shipped between U.S. ports must be transported in ships that were built in the U.S., that are U.S. flagged, and manned with U.S. personnel. The Oil Pollution Action of 1990 (OPA90) required that many of these vessels in petroleum product service be retired at certain ages. As a result a number of vessels were retired in the late 1990s with no replacements being built. Consequently there is a growing shortage of Jones Act Vessels especially those in "clean product" service.

Ethanol shipments from the U.S. Gulf Coast to other U.S. ports would require Jones Act Vessels. The shortage of these vessels and the high costs of using them may lead to a growing preference for rail shipments as ethanol capacity is increased. This issue needs to be studied in greater detail.

**Rail Transport Issues**

**1. Typical Movements:** Typical rail movements in today's market consist of shipments as small as one rail car up to unit train size. A typical rail car holds ~ 29,000 - 30,000 gallons although some "jumbo" rail cars of 34,000 gallons capacity are in use. A unit train is typically either 100 cars @ 29,000 gallons each equating to 2.9 million gallons or up to 85 jumbo cars @ 34,000 gallons equating to 2.9 million gallons. Unit trains are pulled with dedicated power and result in freight savings compared to smaller shipments.

**2. Infrastructure:** Railroad representatives indicated the infrastructure is adequate to handle the anticipated demand increase for both study cases. Industry invests ~ 5.0 billion dollars annually on infrastructure maintenance and improvement. No one felt there would be any constraints resulting from track or equipment. Locomotives are adequate and additional rail cars can be built on fairly short lead times.

Any real bottlenecks will be in yard space, switch capacity, and at the terminals themselves. In some cases yard space is limited so additional traffic could increase congestion to unacceptable levels. Units would therefore need to be moved out to final destinations quickly. Participants indicated that yard space was extremely limited in California. While switching capacity is generally perceived as adequate, some concerns were expressed about being able to properly time the switch, terminal receipt (space), and availability of power (locomotives to move cars). No one felt this was an insurmountable problem but rather an area needing special attention as the market develops. It was noted that the "last five miles" can often be the problem area due to the interrelated timing of all items involved.

The greatest concern expressed was the fact that those terminals that are capable of receiving rail are limited in the number of cars they can spot. Some terminals can spot only 3-5 cars. Even larger terminals cannot routinely spot more than 15-20 cars. Consequently a unit train would need to be broken up into segments.

Most felt that while other terminals will add rail spurs, space limitation would result in similarly restrained rail car spotting in improvements at terminal facilities.

Adding rail spurs is not enormously expensive and participants provided estimates of $75 to $95 per track foot. This would equate to $200,000-$250,000 for a half mile spur. The terminal operators would typically be responsible for, and incur the cost of, the rail spur installation. By comparison switch track runs $35 to $45 per foot while main line track can run as much as $200-$300 per foot, i.e.

1.0 million-1.5 million dollars per mile. The higher cost of main line track is, in part, due to right of way issues, permitting, environmental assessments and concerns, relationship to residential areas, traffic concerns, and a host of other such issues.

**3. Turn Around Times:** Turn around times vary depending on whether the cars are a small shipment or a unit train. Single cars or groups of a few cars are moved less consistently and therefore take as much as twice the amount of time to reach their destination compared to unit trains. As an example, single car movements or movements of a few cars from Illinois to Phoenix can result in a total of 25 days consisting of 10 days out, 2 days in the yard, 3 days to switch, unload, and prep for return, and 10 days return. Unit trains could probably be done in 7 days out, 7 days back, plus unloading time for a best turn around time of 15-16 days. Under current shipment scenarios participants seemed to agree that for shipments to the east and west coasts, a likely turn per car is 25-30 days.

Some of the big issues for turn around time are related to switching and the number of cars that can be unloaded at one spotting. Power to move and spot cars can be made available only at certain times and for certain durations of time. Typically, a switch engine and crew can be made available for 12-15 hours or so and if not utilized will be pulled to other assignments. Therefor it is imperative that terminals plan to fully utilize available switch engines/crews.

Another major factor in turn around time is the type of rail cars. Regular rail cars are unloaded one car at a time per header so if only one header is available the cars need to be spotted at the header one after another. In the case of GATX, they use a patented system they call “pipeline on wheels” which can unload 17-18 cars that are connected in tandem and all unloaded through one car at one header. Several participants noted that having a greater number of headers (to enable simultaneous unloading of several cars) would speed up the process.

**4. Inventory levels:** There was some discussion as to how much inventory would be needed at terminals serviced by rail to provide a comfort range should cars be delayed. The general consensus was that 10 days inventory should be sufficient. Again, a risk assessment that takes into consideration local ethanol availability from other sources may alter the minimum inventory requirement.

**5. Backhauls:** Participants did not feel that backhauls would be feasible due to the need for rail cars to be unloaded and returned as rapidly as possible.

**6. Terminal Upgrades:** Some participants noted that some terminal operators have indicted a willingness to upgrade their terminals to facilitate rail receipt or increased rail receipt (e.g. GATX terminal in Philadelphia is currently adding rail receipt capability). This trend is more prevalent for independent terminal operators, i.e. those that provide storage but do not take ownership of product.

**7. Competition with Waterborne Cargoes:** Some participants noted that the Jones Act requirements could result in waterborne shipments to coastal markets costing up to 3 times as much as if non-Jones Act Vessels could be used. This is forcing producers to rethink their railroad shipment strategy and will likely result in more ethanol moving by rail than originally thought. This would be especially true in the case of an expanded ethanol market. Many felt a 50/50 split between rail/water deliveries to coastal markets was a realistic estimate.

It was noted that some ethanol could simply replace MTBE in Jones Act Vessel movements. While this is true, a large portion of current MTBE used is imported and therefore not subject to the Jones Act. However on an oxygen basis it would only be necessary to ship about one half the amount of ethanol compared to MTBE.

**8. Other Transportation Factors:** Participants noted than an expanded ethanol market would create other circumstances that would require increased use of transportation. In the case of grain plants, more grain feedstock would be moved. Also the removal of butanes/pentanes could result in the need to move these products out while perhaps bringing other products such as alkylates in. Also increased grain based production, whether wet or dry mill, will result in increased coproducts. These products would also need to be moved to market. For example, 18.5 lbs. of Distillers Dried Grain and Solubles (DDGS) are produced for each dry milled bushel. A five billion gallon grain ethanol production increase would increase production of DDGS by 17 million tons.

While participants realized that some of these topics are beyond the scope of the current study, they felt they should at least be mentioned and identified as an area requiring further analysis.

9. **Class I Railroads vs Regional Concerns:** Most participants felt that product will move to "hub terminals" (redistribution terminals) almost exclusively on Class I railroads, i.e. major railroads. Shipments on regional lines would result in more cost due to switching fees/higher rates, could result in more delays, and add to logistic complexity.

**Pipeline Issues**

1. **Technical Issues/Business Issues:** It is well known that ethanol picks up water and this is a concern for pipeline shipment. Other technical issues include the potential for increased corrosion of the system and elastomer compatibility. Based on actual test shipments in the U.S. and considerable experience in Brazil, no one felt either would be a major concern. Also there are issues such as how ethanol shipments would affect downgrading product interfaces, transmix, and things of this nature. The technical issues could be addressed by drying out the system, avoiding breakout tankage where "draw dry" tanks are not in service (or having dedicated break out tankage for ethanol), sequencing of product, use of pigs (or instrumented pigs in the case of monitoring for corrosion), and other operational practices. Williams Pipeline and others have conducted tests shipping ethanol over short distances of controlled segments of their systems with favorable results.

While technical issues can be addressed, no one felt the volume being discussed, i.e. 5-10 billion gallons would be enough to warrant major pipeline shipments. Most felt that even on a small diameter line (participants thought that shipments on anything bigger than a 10" to 12" line was totally unfeasible because of the tender size and product interface issues - i.e. 500 BBL interface on a 10" line), ethanol shipment would need to exceed 20% of pipeline shipment volume before the additional handling cost and special handling issues could be justified. When one considers the combined pipeline volume of gasoline, diesel, kerosene/jet, etc. it is not likely that ethanol will reach these volume levels anytime in the near future and certainly not with the volumes being analyzed in Study Cases B1 and C.

It was also noted that if sufficiently high volumes were ever reached, there would also be special requirements for any potential shippers. These would include larger tender size (i.e. 50M BBL or more input) and meeting specifications for a fungible grade, especially on common carrier pipelines.

**2. Special Scenarios:** Participants did note that there will be special scenarios where ethanol or possibly even gasoline ethanol blends may be moved by pipeline for very short distances under controlled circumstances. These would all be movements within the same PADD. Examples cited included a short 17 mile segment of the Buckeye Pipeline where gasoline ethanol blends may be moved. Also neat ethanol will be shipped on short private pipelines in California that connect marine receipt terminals to nearby terminals.

Another possibility would be use of pipelines solely for dedicated ethanol shipment. Most participants felt this would involve perhaps the recommissioning of privately owned idle lines and would generally be over short distances. The construction of new pipelines might also be possible in very specific situations. Examples given were short segments (1-10 miles) to connect an ethanol plant with a major distribution terminal or to gain access to water transport.

Estimates on constructing new pipelines for dedicated ethanol shipments were put at $250,000 per mile at the low end (small diameter line/middle of desert/no environmental or right of way and permitting problems) to as much as $1,000,000 per mile in more complicated situations. A reasonable estimate for a 10” pipeline was placed at $500,000 per mile. Participants noted that in addition to permits etc. for the pipeline, it would also be necessary to get real estate and permits for necessary tankage/terminals.

**3. Study case B1 and C/PADD II Exports:** One important observation is that in Study Cases B1 and C all exports to other PADDS are from PADD II. There are no pipelines running from PADD II to the other PADDS.

**Important Observations**

While all information gathered in the colloquies is important and useful, a few major items come to the forefront as key items to be considered in the Study cases. These are as follows:

1. The Jones Act and the Oil Pollution Act of 1990 (OPA90) has created a shortage of "Clean Product" Jones Act Vessels. This will result in more ethanol being shipped by rail than originally thought. This will be especially true as the ethanol market increases.

2. The need to ship more product by rail will require more "hub terminals" to be upgraded to handle rail receipt (i.e. installation of rail spurs). Moreover, limitations on spotting cars may result in less unit train movements than originally thought. Smaller producers (especially those not near navigable waters) will need to pool resources to meet unit train requirements as the coastal markets develop.

3. More attention will need to be given to the constraints of the Inland Waterway System when assessing barge movements.

4. Pipeline shipments are simply not viewed as feasible under any predicted volumes being considered and will be limited largely to very specific short distance movements on private pipelines. These will all be movements within individual PADDS.

5. In Study Case B1 and C all ethanol movement to other PADDS originate in PADD II. There are no pipelines originating in PADD II servicing other PADDS so there will be no movement of ethanol by pipeline in the study cases except for the special cases cited in item #4 above.

6. The colloquies resulted in a few changes in the assumptions in the current Phase II Study. Rail shipments will play a greater role than originally anticipated. This in turn necessitates more terminal modifications for rail receipt capabilities. Accordingly, the ongoing analysis of transportation and terminal receipt capabilities will need to give greater consideration to these factors.

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**March 29 Colloquy**

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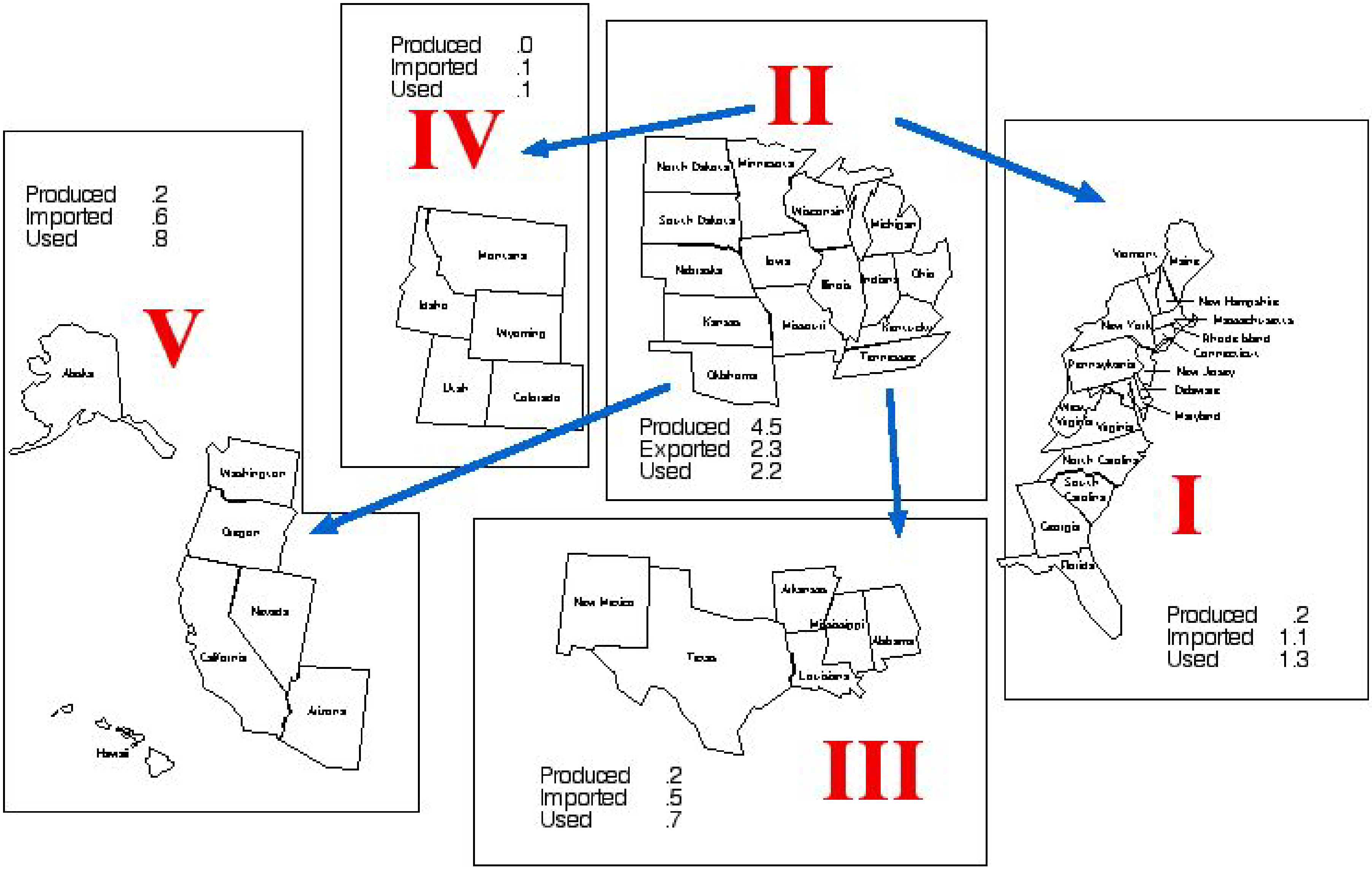
# CASE B1



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Imported .1
Used .1
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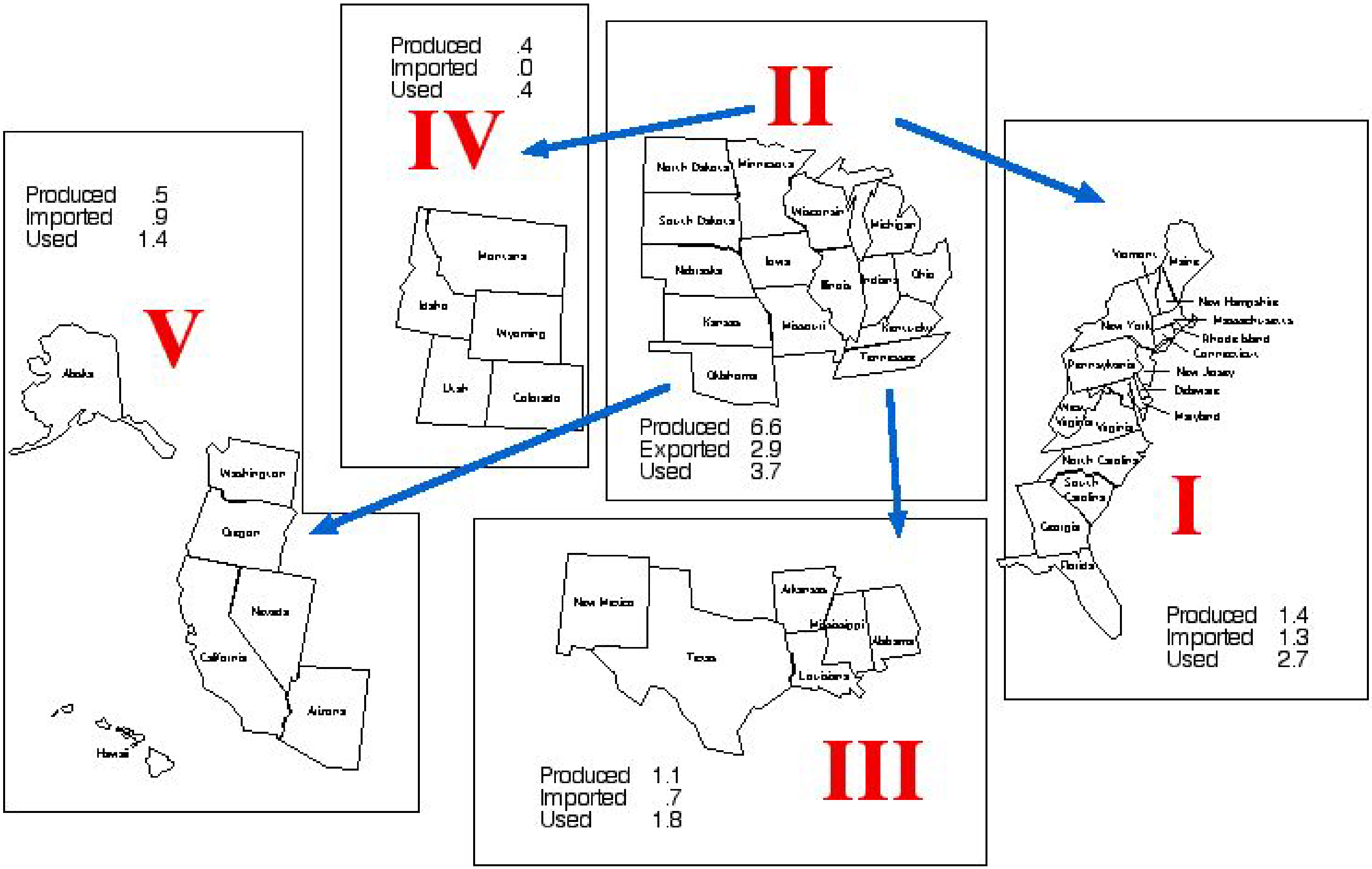
Idaho
Wyoming
Utah
Colorado
II
North Dakota
Minnesota
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Indiana
Ohio
Kansas
Missouri
Kentucky
Tennessee
Oklahoma
Produced 4.5
Exported 2.3
Used 2.2
I
Vermont
Maine
New Hampshire
Massachusetts
Rhode Island
Connecticut
New York
Pennsylvania
New Jersey
Delaware
Maryland
West Virginia
Virginia
North Carolina
South Carolina
Georgia
Florida
Produced .2
Imported 1.1
Used 1.3
V
Produced .2
Imported .6
Used .8
Alaska
Washington
Oregon
Nevada
California
Arizona
Hawaii
III
New Mexico
Texas
Arkansas
Mississippi
Alabama
Louisiana
Produced .2
Imported .5
Used .7

# CASE C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Imported .0
Used .4
IV
Montana
Idaho
Wyoming
Utah
Colorado
II
North Dakota
Minnesota
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Indiana
Ohio
Kansas
Missouri
Kentucky
Tennessee
Oklahoma
Produced 6.6
Exported 2.9
Used 3.7
Produced .5
Imported .9
Used 1.4
V
Alaska
Washington
Oregon
California
Nevada
Arizona
Hawaii
Vermont
Maine
New Hampshire
Massachusetts
Rhode Island
Connecticut
New York
Pennsylvania
New Jersey
Delaware
Maryland
West Virginia
Virginia
North Carolina
South Carolina
Georgia
Florida
I
Produced 1.4
Imported 1.3
Used 2.7
New Mexico
Texas
Arkansas
Mississippi
Alabama
Louisiana
III
Produced 1.1
Imported .7
Used 1.8

# Appendix G
# TEA-21 Fact Sheet

TEA-21 - Transportation Equity Act for the 21st Century
Moving Americans into the 21st Century

## Fact Sheet

TEA-21 Home | DOT Home | Fact Sheet Index

### TRUST FUNDS AND TAXES

**Extension of Highway-user Taxes**

Extends the imposition of highway-user taxes through September 30, 2005. These taxes consist of gallonage taxes on highway motor fuel and truck related taxes, including an annual tax on heavy vehicle use, a weight-based tax on heavy truck tires and a retail sales tax on truck and trailer sales. Each of these taxes, with the exception of 4.3 cents per gallon of the motor fuel taxes would have expired after September 30, 1999. [9002(a)]

With the exception of alcohol fuels, all tax rates and related exemption and refund provisions are extended at the rates in effect prior to TEA-21 enactment. [9002(a)&(b)]

The partial fuel tax exemption for gasohol and other alcohol fuels is extended through September 30, 2007 with a slight phase down of the exemption beginning January 1, 2001. [9003]

**Transfer of Highway-user Taxes to the Highway Trust Fund**

Generally, the deposit of amounts equivalent to the proceeds of the highway-user taxes in the Highway Trust Fund is extended through September 30, 2005. [9002(c)]

The Leaking Underground Storage Tank Trust Fund continues to receive 0.1 cent per gallon of the motor fuel tax through March 30, 2005 at which time the 0.1 cent levy terminates. [26 USC 4081(a)(2)(B) & (d)(3)]

The Mass Transit Account of the Highway Trust Fund receives an increased share of the motor fuel taxes—2.86 cents per gallon. The Transit Account receives smaller amounts on certain fuels which are taxed at reduced rates, including liquefied petroleum gases, liquefied natural gas, and methanol from natural gas. Both changes take effect retroactively to October 1, 1997, correcting and clarifying provisions of the Taxpayer Relief Act of 1997. [9002(e)]

The General Fund of the Treasury continues to receive 2.5 cents per gallon on gasohol and other alcohol fuels where the alcohol source is not natural gas or a petroleum product. The General Fund also receives 0.6 cent per gallon on 10-percent gasohol and other higher-ethanol blends where the ethanol source is not natural gas or a petroleum product. [26 USC 9503(b)(4)(E) & (b)(5)]

The Highway Account of the Highway Trust Fund receives the remaining proceeds of the motor fuel taxes and all of the proceeds from the truck related taxes.

## Expenditures from the Highway Trust Fund

Authority to expend Highway Trust Fund monies for authorized purposes is extended through September 30, 2003. After that date, expenditures from the Trust Fund are authorized only to liquidate obligations made before that date. Any other expenditure will cause the cessation of deposits of highway-user taxes to the Trust Fund. [9002(d)]

## Highway Trust Fund Operation

Cash balances in the Highway Trust Fund not needed for immediate expenditure will continue to be invested in securities of the U.S. Government, but effective October 1, 1998, interest earnings on such investments will no longer be credited to the Trust Fund. [9004(a)]

A one-time adjustment to the cash balance of the Highway Account of the Trust Fund will be made on October 1, 1998. The Account balance will be reduced to $8 billion with the remainder of the former balance being credited to the General Fund of the Treasury. No adjustment will be made to the Mass Transit Account balance. [9004(a)]

The Mass Transit Account will be subject to the same anti-deficiency test (the Byrd Test) as the Highway Account. [9004(d)]

**Federal Highway User Taxes**

| Fuel Type | Effective Date | Tax Rate (cents per gallon) | Distribution of Tax: Highway Trust Fund: Highway Account | Distribution of Tax: Highway Trust Fund: Mass Transit Account | Distribution of Tax: Leaking Underground Storage Tank Trust Fund | Distribution of Tax: General Fund |
|---|---|---|---|---|---|---|
| Gasoline | 10/01/1997 | 18.4 | 15.44 | 2.86 | 0.1 | - |
| Diesel | 10/01/1997 | 24.4 | 21.44 | 2.86 | 0.1 | - |
| Gasohol (10% ethanol) | 10/01/1997 | 13 | 6.94 | 2.86 | 0.1 | 3.1 |
| | 01/01/2001 | 13.1 | 7.04 | 2.86 | 0.1 | 3.1 |
| | 01/01/2003 | 13.2 | 7.14 | 2.86 | 0.1 | 3.1 |
| | 01/01/2005 | 13.3 | 7.24 | 2.86 | 0.1 | 3.1 |
| Special Fuels: | | | | | | |
| General Rate | 10/01/1997 | 18.4 | 15.44 | 2.86 | 0.1 | - |
| Liquified petroleum gas | 10/01/1997 | 13.6 | 11.47 | 2.13 | - | - |
| Liquefied natural gas | 10/01/1997 | 11.9 | 10.04 | 1.86 | - | - |
| M85 (from natural gas) | 10/01/1997 | 9.25 | 7.72 | 1.43 | 0.1 | - |
| Compressed natural gas (cents per thousand cu. ft.) | 10/01/1997 | 48.54 | 38.83 | 9.70 | - | - |

| Truck Related Taxes — All proceeds to Highway Account | |
|---|---|
| Tire Tax | 0-40 pounds, no tax<br>Over 40 pounds - 70 pounds, 15¢ per pound in excess of 40<br>Over 70 pounds - 90 pounds, $4.50 plus 30¢ per pound in excess of 70<br>Over 90 pounds, $10.50 plus 50¢ per pound in excess of 90 |
| Truck and Trailer Sales Tax | 12 percent of retailer's sales price for tractors and trucks over 33,000 pounds GVW and trailers over 26,000 pounds GVW |
| Heavy Vehicle Use Tax | Annual tax:<br>Trucks 55,000 pounds and over GVW, $100 plus $22 for each 1,000 pounds (or fraction thereof) in excess of 55,000 pounds (maximum tax of $550) |

## Aquatic Resources Trust Fund

The transfer of motorboat gasoline and special fuel taxes and small engine gasoline taxes from the Highway Trust Fund to the Aquatic Resources Trust Fund is extended through September 30, 2005. [9002(c)]

The portion of the motorboat and small engine fuel taxes deposited to the Highway Trust Fund and then transferred to the Aquatic Resources Trust Fund is modified as follows [9005(a)]:

* Before October 1, 2001, 11.5 cents per gallon is transferred.
* From October 1, 2001 through September 30, 2003, 13 cents per gallon is transferred.
* Effective October 1, 2003, 13.5 cents per gallon is transferred.

Authority to expend Aquatic Resources Trust Fund's Boat Safety Account monies for the Recreational Boating Safety program is extended through September 30, 2003. After that date, expenditures from the Trust Fund are authorized only to liquidate obligations made before that date. Any other expenditure will cause the cessation of deposits of highway-user taxes to the Trust Fund. [9005(b) & (d)]

**Taxes for Aquatic Resources Trust Fund**

| Fuel Type | Effective Date | Tax Rate (cents per gallon) | Distribution of Tax | | |
|---|---|---|---|---|---|
| | | | Aquatic Resources Trust Fund | Leaking Underground Storage Tank Trust Fund | General Fund |
| Motorboat and Small EngineFuel | 10/01/1997 | 18.4 | 11.5 | 0.1 | 6.8 |
| | 0/01/2001 | 18.4 | 13 | 0.1 | 5.3 |
| | 10/01/2003 | 18.4 | 13.5 | 0.1 | 4.8 |

**<u>Other Provisions</u>**

The National Recreational Trails Trust Fund is repealed. The Trails Fund has never been used; the Recreational Trails Program is funded from the Highway Trust Fund. [9011]

The 5.55 cents-per-gallon deficit reduction tax on rail diesel is reduced to 4.3 cents per gallon effective October 1, 1998. [9006]

September 14, 1998

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TEA-21 Home | DOT Home | Fact Sheet Index
United States Department of Transportation

# Appendix H
# Terminal Analysis Case B1 (Section H-1)
# Terminal Analysis Case C (Section H-2)

# Table H-1 A Case B1 - PADD 1 Terminal Analysis



**PADD I**

Ethanol imports ....... 1.1 billion gallons
Ethanol produced ...... .2 billion gallons
Total ethanol used .. 1.3 billion gallons

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| CT | Hartford | East Hartford | Motiva | P, S1 | 20 | 38.40% | 2 | 2 x10M |
| | | Rocky Hill | Citgo | P, S2 | | | | |
| | New London | Groton | Amarada Hess | W | 10 | 77.55% | 1 | 1 x 10M |
| FL | Ft. Meyers | See Tampa, See Miami | | | 5 | 27.50% | 0 | -- |
| | Jacksonville | Jacksonville | Amarada Hess | W | 15 | 31.28% | 8 | 2 x 5M |
| | | | Amoco | W, S3 | | | | |
| | | | BP | R, W, S3 | | | | |
| | | | Chevron | W, S3 | | | | |
| | | | Coastal Fuel Mkg | R, W, S3 | | | | |
| | | | Koch | W, S3 | | | | |
| | | | Pet Fuel & Term. Co. | W, S3, **(E)** | | | | |
| | | | ST Services | W, R, S3 | | | | |
| | Lakeland/Winter Haven | See Tampa | | | 5 | 24.09% | 0 | -- |
| | Miami/Ft Lauderdale | See Palm Beach | | | 50 | 29.68% | 11 | 5 x 10M |
| | | Ft Lauderdale | Amerada Hess | W | | | | |
| | | | Amoco | W, S3 | | | | |
| | | | Chevron | P, W, S3 | | | | |
| | | | Citgo | P, W, S3 | | | | |
| | | | GATX | P, W, R, S3 | | | | |
| | | | Louis Dryfus | W, S3 | | | | |
| | | | Marathon/Ashland | S3 | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | % of market | Blend # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | Mobil | P, W, S3 | | | | |
| | | Motiva | W, S3 | | | | |
| | | Motiva | W, S3 | | | | |
| | Homestead | ST Services | P, S2 | | | | |
| Orlando | See Tampa | | | 20 | 28.70% | 0 | -- |
| Palm Beach/Boca Ratan/West Palm Beach | Palm Beach | Port of Palm Beach | R, W, S3 | 15 | 31.49% | 1 | |
| | See Miami/Ft Lauderdale also | | | | | | 1 x 20M |
| Pennsacola | Pennsacola | Louis Dryfus | W, S2 | 5 | 27.31% | 5 | 1 x 5M |
| | | Mackenzie Srv Co. | W, S1 | | | | |
| | | Mocar Oil | W, S2 | | | | |
| | | Pennsacola Term. . | W, **(E)** | | | | |
| | Milton | Mackenzie Srv Co. | W, S1 | | | | |
| | See Mobile AL also | | | | | | |
| Sarasota/Bradenton | See Tampa/St Petersburg | | | 5 | 20.02% | 0 | -- |
| Tampa/St Petersburg | Tampa | Amarada Hess | W | 30 | 29.01% | 9 | |
| | | Amoco | W, S3 | | | | 3 x 10M |
| | | BP | W, S3 | | | | |
| | | Chevron | P, W, S3 | | | | |
| | | Citgo | P, W, S3 | | | | |
| | | Louis Dreyfus | W, P, S3 | | | | |
| | | Marathon/Ashland | S3 | | | | |
| | | Murphy Oil | W, S3 | | | | |
| | Port Tampa | Motiva | W | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| **GA** | Atlanta | Atlanta | BP | P, S2 | 20 | 11.42% | 19 | 2 x 10M |
| | | | Colonial Pipeline | P, S3 | | | | |
| | | | Fina | P, S2 | | | | |
| | | | Louis Dreyfus | P, S2 | | | | |
| | | | Whitaker Oil | R, S1 | | | | |
| | | Austel | Marathon Ashland | P, S2 | | | | |
| | | Doraville | Amarada Hess | P | | | | |
| | | | Amoco | P, S2 | | | | |
| | | | Amoco | R, S2 | | | | |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | | Chevron | P, S3 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Motiva | P | | | | |
| | | | Motiva | P, S3 | | | | |
| | | | Motiva | P | | | | |
| | | | Phillips | P, R, S2 | | | | |
| | | | Southern Facilities | P, S3, **(E)** | | | | |
| | | Rome | BP | P, S2 | | | | |
| | | | Louis Dreyfus | P, S2 | | | | |
| | Augusta/Aiken | North Augusta SC | Amoco | P, S1 | 10 | 47.81% | 5 | 1 x 10M |
| | | | BP | P, S2 | | | | |
| | | | Charter Terminals | P, S3 | | | | |
| | | | Phillips | P, S2 | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| **MA** | Boston | Beverly | Armory Term. Inc. | P, S2 | 100 | 38.87% | 8 | 4 x 20M |
| | | Revere | Coastal Oil | R,W,P,S2, **(E)** | | | | |
| | | | Global Petroleum | W, S3 | | | | |
| | | | Tosco | P, S3 | | | | |
| | | Everett | Exxon | W | | | | |
| | | Braintree | Citgo | W, S3 | | | | |
| | | Boston | Mobil | P, W, S3, **(E)** | | | | |
| | | Chelsea | Gulf Oil LP | W, S3 | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Springfield | Springfield | Gulf Oil LP (closed) | | 10 | 38.38% | 1 | 1 x 10M |
| | | | Mobil | P, S3 | | | | |
| MD/DC | Baltimore/Washington | Baltimore | Amerada Hess | P, W, | 160 | 47.90% | 11 | 7 x 25M |
| | | | Amoco | P, W, S3 | | | | |
| | | | Champion Rn.(closed) | | | | | |
| | | | Conoco | P, S3 | | | | |
| | | | Exxon (2-closed)] | | | | | |
| | | | Motiva | P | | | | |
| | | | Motiva | P, W, S3 | | | | |
| | | | Pet. Fuels & Term. | P, W, S3 | | | | |
| | | | Pet. Fuels & Term. | P, W, S3 | | | | |
| | | | Stratus Petroleum | P, W, S3 | | | | |
| | | | Sun R & M (closed) | | | | | |
| | | | Tosco | P, S3 | | | | |
| | | DC | ST Services | P, S2 | | | | |
| | | | ST Services | P, SW | | | | |
| **NC** | Charlotte | Charlotte | Exxon | P | 20 | 31.09% | 13 | 3 x 10M |
| | | | Motiva | P | | | | |
| | | Paw Creek | Amerada Hess | P | | | | |
| | | | Amoco | R, P. S3 | | | | |
| | | | BP | P, S3 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Crown Central | P, S2 | | | | |
| | | | Louis Dreyfuss | P, S3 | | | | |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | | Motiva | P, S2 | | | | |
| | | | Phillips | P, S2 | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| | | | Valero M & S | P | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Greensboro/Winston Salem/High Point | Greensboro | Amerada Hess | P | 20 | 37.36% | 12 | 2 x 10M |
| | | | Amoco | P, S2 | | | | |
| | | | Ashland | P, S2, **(E)** | | | | |
| | | | BP | P, S3 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Exxon | P | | | | |
| | | | Louis Dreyfuss | P, S3 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Motiva | P, S2 | | | | |
| | | | Pet. Fuels Terminal | P, S3 | | | | |
| | | | Southern Facilities | P,S3 | | | | |
| | | | Triad Terminal Co. | P, S3 | | | | |
| | Raleigh Durham/Chapel Hill | Apex | Motiva | P, S2 | 15 | 29.89% | 10 | 3 x 5M |
| | | Selma | Amerada Hess | P | | | | |
| | | | BP | P, S3 | | | | |
| | | | Citgo | P, S3 | | | | |
| | | | Crown Petroleum | P, S2 | | | | |
| | | | Exxon | P | | | | |
| | | | Phillips | P, S2 | | | | |
| | | | Southern Facilities | P, S3, **(E)** | | | | |
| | | | Triad Terminal Co. | P, S3 | | | | |
| | | | Valero | P | | | | |
| NY | Albany/Schenectady/Troy | Albany | Agway Petroleum | W, S3 | 10 | 25.34% | 10 | 1 x 10M |
| | | | Mobil | W, R, S3 | | | | |
| | | Rennselaer | Amerada Hess | W | | | | |
| | | | Bray Terminals | R, W, S3, **(E)** | | | | |
| | | | Getty | W, S3, **(E)** | | | | |
| | | | Pet. Fuel & Term. | W, S3 | | | | |
| | | | Sun R & M | W, S3 | | | | |
| | | Glenmont | Citgo | W, S3 | | | | |
| | | | Sears Oil | W, S3 | | | | |
| | | Selkirk | TEPPCO | P, R, S1 | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| Buffalo/Niagra Falls | Tonawanda | NOCO Energy | R, P, W, S3 | 20 | 38.58% | 4 | 2 x 10M |
| | | Sun R & M | P, S3 | | | | |
| | | United Refining | P, W, S3 | | | | |
| | Buffalo | Mobil Oil | P, S3 | | | | |
| New York City | Linden NJ | Citgo | P, W, S3 | 300 | 32.72% | 32 | 12 x 25M |
| | | Gulf Oil | P, S3 | | | | |
| | | Mobil | P, S3 | | | | |
| | | Tosco | P, W, S3 | | | | |
| | Carteret NJ | Amoco | P, S3 | | | | |
| | | GATX | P, R, W, S3 | | | | |
| | Bayonne NJ | Amerada Hess | P, W | | | | |
| | | IMTT | P, S3 | | | | |
| | Port Reading NJ | Amerada Hess | R, P, W, S3 | | | | |
| | Seraren NJ | Motiva | P, W | | | | |
| | Perth Amboy NJ | Amerada Hess | W | | | | |
| | | Chevron | W | | | | |
| | | Stolthaven | | | | | |
| | Milton | Agway | S2 | | | | |
| | New Burgh | Amerada Hess | W | | | | |
| | | Mobil Oil | R, W, S3 | | | | |
| | Riverhead | Tosco | W, S3 | | | | |
| | Glenwood Landing | Mobil Oil | W, S2 | | | | |
| | Oceanside | Gulf Oil (closed) | | | | | |
| | | RAD Energy | W, S2, **(E)** | | | | |
| | Lawrence | Carbo Energy | P, W, S3 | | | | |
| | Inwood | Mobil Oil | P, W, S2 | | | | |
| | | Motiva | P, S2 | | | | |
| | Brooklyn | Amerada Hess | W | | | | |
| | | Amoco | P, W, S2 | | | | |
| | | Metro Terminals | W, P, S2 | | | | |
| | | Metro Terminals | W, P, S2 | | | | |
| | | Motiva | P, W | | | | |
| | | Star Ent/Texaco | P, S2 | | | | |
| | Staten Island | Mobil Oil | S3 | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | Long Island City | Getty Oil | P, W, S1 | | | | |
| | | Bronx | Getty Oil | W, S1 | | | | |
| | | Mt. Vernon | Amoco | W, S2 | | | | |
| | | Stamford CT | Sprague Energy | W, S2 | | | | |
| | Rochester | Rochester | Agway Petroleum | P, S2 | 20 | 40.83% | 5 | 2 x 10M |
| | | | Amerada Hess | P | | | | |
| | | | Coastal Oil | P, S2 | | | | |
| | | | Gulf Oil (closed) | | | | | |
| | | | Mobil Oil | R, P, S3 | | | | |
| | | | Sun R & M | P, S2 | | | | |
| | Syracuse | Warners | Amerada Hess | P | 15 | 45.09% | 9 | 4 x 10M |
| | | Oswego | Sprague Energy | W, S3 | | | | |
| | | Brewerton | Agway Petroleum | P, S3 | | | | |
| | | Liverpool | Stratus Petroleum | P, S2 | | | | |
| | | Syracuse | Coastal Oil | P, S3 | | | | |
| | | | Mobil | P, S3 | | | | |
| | | | Mobil | P, S3 | | | | |
| | | | Sun R & M | P, S2 | | | | |
| | | | Sun R & M | P, S2 | | | | |
| | Utica/Rome | Rome | Sears Oil (?-closed) | P, W, S2 | 10 | 75.17% | 3 | 1 x 10M |
| | | Marcy | Agway Petroleum | W, S3 | | | | |
| | | | Amerada Hess | P | | | | |
| | | | Bray Terminals | P, W, S2 | | | | |
| PA | Bethleham/Allentown/Easton | Allentown | Mobil Oil | P, S2 | 10 | 35.63% | 2 | |
| | | Macungie | Agway Petroleum | P, S3 | | | | 1 x 10M |
| | Erie | Warren | United Refining | S2 | 5 | 39.77% | 1 | 1 x 5M |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| Harrisburg/Lebanon/Carisle | Harrisburg | Mobil | P, S2 | 10 | 35.63% | 5 | 2 x 5M |
| | Mechanicsburg | Amoco | P, S1 | | | | |
| | | Gulf Oil | P, S3 | | | | |
| | | Star Ent/Texaco | P, S2 | | | | |
| | | Sun R & M | P, S2 | | | | |
| Lancaster | Lancaster | Mobil | P, S2 | 10 | 47.89% | 1 | 1 x 10M |
| | See Richland also | | | | | | |
| Philadelphla | Hatboro | Sun R & M | W, P | 90 | 33.95% | 12 | 4 x 25M |
| | Philadelphia | Amerada Hess | W, P | | | | |
| | | Amoco | P, S3 | | | | |
| | | Exxon | P | | | | |
| | | Maritank Phil. | P, W, S3 | | | | |
| | | Sun R & M | S2 | | | | |
| | Bryn Mawr | Carlos Leffler | | | | | |
| | Malvern | Sun R & M | P, S2 | | | | |
| | Exton | Sun R & M | P, S2 | | | | |
| | Frazier Bogato | Mobil Oil | P, S2 | | | | |
| | Wilmington DE | Deleware Term. Co. | W, S3 | | | | |
| | Deleware City DE | Motiva | P | | | | |
| Pittsburgh | Corapolis | BP | P, S2 | 50 | 47.25% | 15 | 5 x 10M |
| | | Buckeye | P, W, S3 | | | | |
| | | Citgo | P, W, S3 | | | | |
| | | Motiva | P, W, S3 | | | | |
| | Pittsburgh | American Refining | P, S3 | | | | |
| | | Exxon | P. W | | | | |
| | | Gulf Oil | P, W, S3 | | | | |
| | | Sun R & M | P, S2 | | | | |
| | | Sun R & M | P, S3 | | | | |
| | Whitehall | Gulf Oil | P, S3 | | | | |
| | | Sun R & M | P, S2 | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | Floreffe | Ashland | W, S3 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | Belle Vernon | Gutman Oil | W, S2 | | | | |
| | | Dravosberg | Boswell Oil | W, S3 | | | | |
| | Reading | Sinking Springs | Sun R & M | P, S2 | 10 | 61.50% | 3 | 1 x 10M |
| | | Richland | Carlos Leffler | P, S2 | | | | |
| | | | Carlos Leffler | P, S2 | | | | |
| | Scranton | Avoca | Gulf Oil | P, S2 | 10 | 36.03% | 1 | 1 x 10M |
| | York | See Lancaster | | | 10 | 58.50% | 0 | == |
| | | See Harrisburg | | | | | | |
| RI | Providence | Providence | Citgo | W, S3 | 15 | 29.36% | 5 | 1 x 5M |
| | | | Motiva | W, S3 | | | | |
| | | | Sun R & M (closed) | | | | | |
| | | East Providence | Getty | R, W, S3, **(E)** | | | | |
| | | | Mobil | W, S3 | | | | |
| | | Fall River MA | Shell Oil | W, S3 | | | | |
| SC | Charleston | Charleston | Allied Terminals | P, W, S3 | 10 | 39.85% | 4 | 1 x 5M |
| | | North Charleston | Amerada Hess | W | | | | |
| | | | Koch Refining | W, S3 | | | | |
| | | | Marathon/Ashland | W, S3 | | | | |
| | Greenville/Spartanburg/Anderson | Spartanburg | Amerada Hess | P | 15 | 35.55% | 10 | 2 x 5M |
| | | | Amoco | P | | | | |
| | | | Ashland (closed) | | | | | |
| | | | BP | P, S3 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Crown Central | P, S2 | | | | |
| | | | Louis Dreyfuss | R, P, S3 | | | | |
| | | | Motiva | P | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | | Motiva | P, S2 | | | | |
| | | | Phillips | P, S2 | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| VA | Norfolk/VA Beach/Newport News | Newport News | Koch Fuels | R, W, S3 | 30 | 42.29% | 13 | 3 x 10M |
| | | Grafton | Amoco | | | | | |
| | | Virginia Beach | ST Services | P, W, S1 | | | | |
| | | Chesapeake | Amerada Hess | W | | | | |
| | | | Amoco | P, W, S3 | | | | |
| | | | Chesapeake Term. | R, P, S2 | | | | |
| | | | Citgo | P, W, S3 | | | | |
| | | | Conoco | P, S3 | | | | |
| | | | Crown Central Pet. | P, W, S2 | | | | |
| | | | Exxon | P, W | | | | |
| | | | Louis Dreyfuss | P, W, S3 | | | | |
| | | | Mobil | P, W, S3 | | | | |
| | | | Stratus Petroleum | P, W, S3 | | | | |
| | Richmond/Petersburg | Richmond | Amoco | P, S2 | 15 | 34.37% | 10 | 2 x 10M |
| | | | Chevron | P, S2 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Crown Central | P, S2 | | | | |
| | | | Exxon | P | | | | |
| | | | First Energy | P, S3 | | | | |
| | | | Louis Dreyfuss | P, S2 | | | | |
| | | | Motiva | P, S2 | | | | |
| | | | Primary Corp. | W, P, S2 | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| | **TOTAL** | | | | 1200 (not including ethanol in E85) | | | |

**PADD I Summary - Case B1**

| | |
|---|---|
| Total ethanol for blends | 1200 mmgy |
| Total ethanol for E-85 | 100 mmgy |

**PADD I Terminal Recap**

| | | | |
|---|---|---|---|
| Total # of operating terminals | 261 | Total listing ethanol | 11 |
| Total # with water capability | 116 | | |
| Total # with rail capability | 22 | | |
| Total S1 | 10 | **Total Preliminary** | **Estimated Tankage additions** |
| Total S2 | 86 | 5M - 13 | 20M - 5 |
| Total S3 | 116 | 10M - 44 | 25M - 23 |

# Table H-1 B Case B1 - PADD II Terminal Analysis



PADD II

Ethanol exports ............. (2.3) billion gallons
Ethanol produced ............ 4.5 billion gallons
Total ethanol used .......... 2.2 billion gallons

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| IA | Davenport/Moline/Rock Island | Bettendorf | Amoco | W, P, S3 | 15 | 84.15% | 4 | 2 x 5M |
| | | | Koch Refining | W, P, S2 | | | | |
| | | | Phillips | W, P, S3, **(E)** | | | | |
| | | Riverdale | Citgo | P, S2 | | | | |
| | Des Moines | Des Moines | Amoco | P, S3 | 15 | 68.08% | 2 | 1 x 5M |
| | | | Williams Pipeline | P, R, S3, **(E)** | | | | |
| | Cedar Rapids | See Sioux City | | | 7 | 76.21% | 0 | - |
| | Iowa City | North Liberty | Amoco | P | 5 | 96.95% | 2 | 1 x 2M |
| | | Coraville | Williams Pipeline | P, S3, **(E)** | | | | |
| IL | Chicago/Gary/Kenosha | Arlington Heights | Arco | P, S3 | 400 | 90.62% | 28 | - |
| | | | Citgo | P, S3 | | | | |
| | | | Equilon | P, S3 | | | | |
| | | | Mobil | P, | | | | |
| | | | Marathon/Ashland | P, S3 | | | | |
| | | Mt. Prospect | UNO-VEN | P, S2, **(E)** | | | | |
| | | Des Plaines | Amoco | P | | | | |
| | | Franklin Park | Williams Pipeline | P, S3, **(E)** | | | | |
| | | Forestview | Amoco | P, W, S3 | | | | |
| | | | Lake River | R, W, S3, **(E)** | | | | |
| | | Chicago | GATX | | | | | |

NOTE: Chicago MSA is nearly 100% ethanol use due to RFG program & sufficient tankage is already in service

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | Argo | Equilon | P, S3 | | | | |
| | | GATX | R, P, W, S3 | | | | |
| | Willow Springs | Marathon/Ashland | P, S3 | | | | |
| | Blue Island | Clark | P, S2, **(E)** | | | | |
| | | Clark | P, S2 | | | | |
| | | Martin Oil | W, P, S2, **(E)** | | | | |
| | | Martin Oil (closed) | | | | | |
| | | ST Services | P, W, S3, **(E)** | | | | |
| | Whiting IN | Amoco | P, W, S3, **(E)** | | | | |
| | Hammond IN | Clark | P, S3, **(E)** | | | | |
| | | Equilon | P, S3 | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| | | Mobil | P, S3 | | | | |
| | | Wolfelake Terminals | R, S3 | | | | |
| | Shererville | Transmontaigne | P, S3 | | | | |
| | East Chicago | Citgo | P, S3 | | | | |
| | | Phillips | R, P, S3 | | | | |
| | | Transmontaigne | P, S3 | | | | |
| Peoria/Pekin | Norris City | LaGloria | P, S2, **(E)** | 15 | 87.15% | 4 | 2 x 3M |
| | Chillicothe | ST Services | P, R, S2 | | | | |
| | Creve Couer | Amoco | | | | | |
| | North Pekin | Hicks Oil | W, S2 | | | | |
| Rockford | Rockford | Clark | P, S2, **(E)** | 15 | 84.19% | 3 | 1 x 2M |
| | | Clark | P, S2, **(E)** | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| Bloomington/Normal | Heyworth | Williams Pipeline | P, S3, **(E)** | 5 | 69.19% | 1 | - |
| | See Peoria/Pekin | | | | | | |
| Champaign/Urbana | Champaign | Marathon/Ashland | P, S3 | 5 | 59.11% | 1 | 1 x 3M |
| Decatur | Forsyth | Phillips Petroleum | P, S2, **(E)** | 5 | 88.90% | 2 | 1 x 2M |
| | Harristown | Shell Oil | P, S2 | | | | |
| Springfield | Petersburg | Williams Pipeline | P, S2, **(E)** | 5 | 49.33% | 1 | - |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| IN | Evansville/Henderson | Evansville | Ashland | W, S2 | 10 | 69.13% | 7 | 3 x 3M |
| | | | Marathon/Ashland | | | | | |
| | | | Transmontaigne | W, S2 | | | | |
| | | Mt. Vernon | CountryMark | W | | | | |
| | | | Marathon/Ashland | P, W, S3 | | | | |
| | | Henderson KY | Transmontaigne | W, S2 | | | | |
| | | Owensboro KY | Transmontaigne | W, S2 | | | | |
| | Fort Wayne | Huntington | Ashland | P, S2, **(E)** | 15 | 62.35% | 4 | 2 x 2M |
| | | | Citgo | P, S2 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Sun R & M | P, S2 | | | | |
| | Indianapolis | Indianapolis | Amoco | P, S3 | 60 | 78.60% | 10 | 1 x 5M |
| | | | Center Term.Co. | P, S2, **(E)** | | | | |
| | | | Clark | P, S2, **(E)** | | | | |
| | | | LaGloria | P, S3, **(E)** | | | | |
| | | | Marathon/Ashland | S3 | | | | |
| | | | Marathon/Ashland | P, S3 | | | | |
| | | | ST Services | P, S3, **(E)** | | | | |
| | | Claremont | Clark | P, S2, **(E)** | | | | |
| | | | Phillips | P, S3 | | | | |
| | | Zionsville | Equilon | P, S3 | | | | |
| | South Bend | Granger | Amoco | P, S2 | 10 | 77.86% | 6 | 2 x 2M |
| | | South Bend | Transmontaigne | P, S2, **(E)** | | | | |
| | | Niles MI | Citgo | P, S2 | | | | |
| | | | Equilon | P, S3 | | | | |
| | | | Marathon/Ashland | S3 | | | | |
| | | | Mobil | P, S2, **(E)** | | | | |
| | Terre Haute | See Indianapolis | | | 5 | 66.91% | | |
| | Bloomington | Seymour | LaGloria | P, S1, **(E)** | 5 | 86.08% | 1 | - |
| | | See Indianapolis also | | | | | | |
| | Elkhart/Goshen | See South Bend | | | 7 | 80.67% | 0 | - |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Kokomo | Brookston | Amoco | P, S2 | 3 | 60.16% | 1 | 1 x 2M |
| | | See Indianapolis also | | | | | | |
| | Lafayette | See Kokomo | | | 5 | 57.37% | 0 | - |
| | | See Indianapolis | | | | | | |
| | Muncie | Muncie | Equilon | P, S2 | 5 | 87.16% | 3 | 2 x 2M |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | Richmond | Marathon/Ashland | | | | | |
| | | See Indianapolis also | | | | | | |
| | | | - | | | - | | |
| | Topeka | Wakarusa | Williams Pipeline | | 5 | 58.94% | 1 | initial supply from KC |
| | | See Kansas City MO | | | | | | |
| | Wichita | Wichita | Coastal Derby | P, R | 15 | 55.03% | 7 | 3 x 5M |
| | | | Conoco | P | | | | |
| | | | Williams Pipeline | P, S2 | | | | |
| | | | Phillips | P, S2 | | | | |
| | | Eldorado | Equilon | P, **(E)** | | | | |
| | | Valley Center | Amoco | P, S2 | | | | |
| | | Hutchinson | Kaneb Pipeline | P | | | | |
| KY | Huntington/Ashland | Ashland | Ashland Petroleum (closed) | | 10 | 64.43% | 2 | 2 x 2M |
| | | | Ashland Petroleum (closed) | | | | | |
| | | Catlettsburg | Marathon/Ashland | | | | | |
| | | | Marathon/Ashland | | | | | |
| | Lexington | Lexington | Ashland Petroleum | P, S2 | 15 | 66.27% | 4 | 3 x 2M |
| | | | Chevron | P, S2 | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | | Marathon/Ashland | | | | | |
| | | | Marathon/Ashland | | | | | |
| | Louisville | Louisville | Ashland Petroleum | P, W, S3 | 40 | 80.05% | 12 | 5 x 3M |
| | | | BP | P, W, S2 | | | | |
| | | | Chevron | P, W, S3 | | | | |
| | | | Citgo | P, W, S3 | | | | |
| | | | Marathon/Ashland | W, S2 | | | | |
| | | | Marathon/Ashland | P, W, S3 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Sun | P, W, S2 | | | | |
| | | | Transmontaigne | W, R, P, S2 | | | | |
| | | Clarksville IN | Ashland Petroleum | W, S2, **(E)** | | | | |
| | | New Albany IN | Transmontaigne | W, S2, **(E)** | | | | |
| MI | Detroit/Ann Arbor/Flint | Detroit | Equilon | P, S3 | 200 | 73.61% | 17 | 10 x 3M |
| | | | Marathon/Ashland | | | | | |
| | | | Sun | P, S2 | | | | |
| | | River Rouge | Amoco | P, W, S3 | | | | |
| | | Taylor | Amoco | P, S2 | | | | |
| | | | Ashland Petroleum | P, S2, **(E)** | | | | |
| | | | BP | P, S3 | | | | |
| | | | Clark | P, S3 | | | | |
| | | | Clark | P, S3 | | | | |
| | | | Cousins Petroleum | P, S2, **(E)** | | | | |
| | | | Marathon/Ashland | | | | | |
| | | Woodhaven | Mobil | P, W, S3 | | | | |
| | | Romulus | Citgo | P, S3 | | | | |
| | | | Equilon | P | | | | |
| | | | Total | P | | | | |
| | | Flint | Mobil | P, S2 | | | | |
| | | Mt. Morris | Marathon/Ashland | P, S2 | | | | |
| | Grand Rapids/Muskegon/Holland | North Muskegon | Marathon/Asland | P, S3 | 40 | 76.53% | 3 | 2 x 2M |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | Ferrysburg | Citgo | P, S2 | | | | |
| | | | Equilon | P, S3 | | | | |
| | Kalamazoo/Batttle Creek | Marshall | Clark | P, S3 | 15 | 67.53 | 1 | 1 x 5M |
| | | See Grand Rapids also | | | | | | |
| | | See Jackson | | | | | | |
| | Lansing/East Lansing | Lansing | Total | P | 15 | 66.98% | 1 | 1 x 5M |
| | | See Jackson also | | | | | | |
| | Saginaw/Bay City/Midland | Bay City | Total | P, W | 15 | 75.35% | 3 | 1 x 2M |
| | | | UNO-VEN | P, S3, **(E)** | | | | |
| | | Owosso | Sun | P, S2 | | | | |
| | Benton Harbor/St. Joseph | See South Bend IN | | | 5 | 63.21% | 0 | - |
| | Jackson | Napoleon | Amoco | P | 5 | 64.00% | 4 | 2 x 2M |
| | | Jackson | Citgo | P, S2 | | | | |
| | | | Equilon | P, S2 | | | | |
| | | | Marathon/Ashland | P, S3 | | | | |
| MN | Minneapolis/St. Paul | Roseville | Amoco | | 135 | 94.62% | 5 | |
| | | St. Paul | Koch | S3 | | | | |
| | | | Williams Pipeline | P, R, **(E)** | | | | |
| | | St. Paul Park | Ashland | P | | | | |
| | | Pine Bend | Koch | S1 | | | | |
| | Duluth/Superior | Proctor | Murphy Oil | P, S2 | 10 | 85.15% | 5 | |
| | | Esko | Murphy Oil | P, S2 | | | | |
| | | Renshaw | Conoco | P, S3, **(E)** | | | | |
| | | Superior WI | Amoco | P | | | | |
| | | | Murphy Oil | P | | | | |

NOTE: All Minnesota terminals have ethanol capability

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Rochester | Winona | ST Services | P, W, S2 | 5 | 84.53% | 2 | |
| | | Eyota | Williams Pipeline | P, S2 | | | | |
| | St. Cloud | Sauk Center | Amoco | P | 5 | 61.03% | 1 | |
| | | See Minneapolis/St. Paul | | | | | | |
| MO | St. Louis | St. Louis | Clark | P,W,R,S3,**(E)** | 90 | 70.52% | 12 | 1 x 15M |
| | | | Clark | P, W, S3, **(E)** | | | | 3 x 3M |
| | | | Equilon | P, S1 | | | | |
| | | | JD Street | P, W, S3, **(E)** | | | | |
| | | St. Peter | Williams Pipeline | P, S1 | | | | |
| | | Wood River IL | Amoco | P | | | | |
| | | Hartford IL | Center Terminal Co. | W, P, S2 | | | | |
| | | | Clark | W, P, S3, **(E)** | | | | |
| | | | Clark | W, P, S3, **(E)** | | | | |
| | | | Conoco | P, S3 | | | | |
| | | | Hartf.Wood River Ter | P, W, S3 | | | | |
| | | Cohokia IL | Phillips | P, R, S3 | | | | |
| | Kansas City MO/KS | Kansas City KS | Phillips | | 60 | 68.79% | 6 | 2 x 20M |
| | | | Sinclair Pipweline | | | | | 2 x 5M |
| | | | Williams PL | R, P, S3, **(E)** | | | | |
| | | Riverside MO | Williams PL | | | | | |
| | | | Conoco | | | | | |
| | | Sugars Creek MO | Amoco | | | | | |
| | Springfield | Mt. Vernon | Conoco | P, S3 | 10 | 65.29% | 2 | 1 x 1M |
| | | Brookline Station | Williams Pipeline | P, S2 | | | | |
| | Columbia | Columbia | Williams Pipeline | P, S3 | 5 | 77.32% | 3 | 2 x 2M |
| | | Mexico | Sinclair Pipeline | P, S2 | | | | |
| | | Jefferson City | Phillips | P, S2 | | | | |
| | Joplin | Jasper | Williams Pipeline | P, S3 | 5 | 67.11% | 1 | 1 x 2M |
| | | See Springfield also | | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| ND | Fargo/Moorehead | Fargo | Williams Pipeline | P,R,S3,**(E)** | 5 | 59.16% | 2 | 1 x 2M |
| | | Moorehead MN | Amoco | P | | | | |
| NE | Omaha | Omaha | Williams Pipeline | P, S3. **(E)** | 25 | 72.01% | 3 | 2 x 3M |
| | | Council Bluffs IA | Amoco | P | | | | |
| | | | National Coop | S3 | | | | |
| | Lincoln | Roca | Conoco | P, S2, **(E)** | 10 | 84.70% | 2 | 1 x 1M |
| | | | Williams Pipeline | P, S2 | | | | |
| | | See Omaha also | | | | | | |
| OH | Canton/Massillon | Canton | Ashland Petroleum | P | 12 | 60.02% | 6 | 3 x 3M |
| | | | BP | P, S2 | | | | |
| | | East Canton | Marathon/Ashland | | | | | |
| | | Akron | Sun R & M | P, S2 | | | | |
| | | Mogadore | Equilon | P, S2 | | | | |
| | | Talmadge | UNO-VEN | P, S2 | | | | |
| | Cincinnati/Hamilton | North Bend | Marathon/Ashland | | 70 | 71.86% | 11 | 1 x 15M |
| | | Cincinnati | Ashland Petroleum | R, W, S3 | | | | 4 x 2M |
| | | | Boswell Oil | P, R, W, S2 | | | | 5 x 5 M |
| | | | BP | P, S2 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | Bromley KY | BP | W, P, S3 | | | | |
| | | Covington KY | Ashland Petroleum | W, S3 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Transmontaigne | P, W, S2 | | | | |
| | | Lebanon | Marathon/Ashland | P, S3 | | | | |
| | | | TEPPCO | P, S3 | | | | |
| | Cleveland/Akron | Cleveland | BP | P, S2 | 100 | 69.16% | 9 | 2 x 5M |
| | | | Equilon | P, S2 | | | | |
| | | | Sun R & M | P, S2 | | | | |
| | | | UNO-VEN | P, S2, **(E)** | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | Brecksville | Clark | P, S2, **(E)** | | | | |
| | | Clark Refining | P, S2, **(E)** | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| | Aurora | Amoco | P, S2 | | | | |
| | | Aurora Terminals | P, S2, **(E)** | | | | |
| | See Canton also | | | | | | |
| Columbus | Columbus | Ashland | P, S2, **(E)** | 50 | 67.57% | 7 | 1 x 5M |
| | | BP | P, S3 | | | | |
| | | Clark | P, S2, **(E)** | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| | | Midwest Terminals | P, S2, **(E)** | | | | |
| | | Sun R & M | P, S2 | | | | |
| | Amlin | UNO-VEN | P, S2 | | | | |
| Dayton/Springfield | Dayton | BP | P, S3 | 40 | 83.99% | 4 | 4 x 5M |
| | | Equilon | P, S2 | | | | |
| | | Sun R & M | P, S2 | | | | |
| | | UNO-VEN | P, S2 | | | | |
| | See Cincinnati also | | | | | | |
| Toledo | Toledo | BP | S2 | 20 | 66.11% | 6 | 3 x 3M |
| | | Clark | R, P, W, S2, **(E)** | | | | |
| | | Sun R & M | S2 | | | | |
| | | Transmontaigne | P, S3 | | | | |
| | Oregon | Citgo | P, S3 | | | | |
| | | Marathon/Ashland | P, S2 | | | | |
| Youngstown/Warren | Youngstown | Marathon/Ashland | P, S2 | 20 | 68.33% | 3 | 2 x 5M |
| | | Sun R & M | P, S1 | | | | |
| | Niles | BP | P, S2 | | | | |
| Lima | Lima | BP | S1 | 5 | 65.33% | 3 | 2 x 2M |
| | | Equilon | P | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| Mansfield | See Columbus | | | 5 | 87.16% | 0 | - |
| | See Akron | | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Stuebenville/Weirton WV | Stuebenville | Marathon/Asland | P, S2 | 5 | 75.51% | 5 | 2 x 1M |
| | | Wellsville | Marathon/Asland | | | | | |
| | | East Liverpool | Transmontaigne | W, S2, **(E)** | | | | |
| | | Newell WV | Quaker State | P, R, W, S3 | | | | |
| | | Weirton WV | Pet Fuel & Term | W, S3, **(E)** | | | | |
| OK | Oklahoma City | Oklahoma City | Conoco | P, S3 | 30 | 57.72% | 5 | 2 x 5M |
| | | | Williams Pipeline | P, S2 | | | | |
| | | | Williams Pipeline | P, S2 | | | | |
| | | Dell City | Texaco R & M | P, S2 | | | | |
| | | Shawnee | Sinclair | P, S2 | | | | |
| | Tulsa | Catoosa | Frontier Terminals | R, W, S3 | 25 | 64.02% | 6 | 2 x 5M |
| | | | Southern MO Oil | P, W, S2, **(E)** | | | | |
| | | Tulsa | Frontier Terminals | | | | | |
| | | | Sinclair Pipeline | P | | | | |
| | | | Sun R & M | P | | | | |
| | | | Williams Pipeline | P, S3 | | | | |
| | Lawton | See Oklahoma City | | | 3 | 56.64% | 0 | - |
| | | See Wichita Falls TX (PADD III) | | | | | | |
| SD | | | | | | | | |
| TN | Chattanooga | Chattanooga | Amoco | P, S2 | 16 | 71.25% | 7 | 3 x 5M |
| | | | BP | P, S2 | | | | |
| | | | Chevron | P, S2 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Louis Dreyfus | P, S2 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| | Johnson City/Kingsport/Bristol | See Knoxville | | | 15 | 65.25% | 0 | - |
| | Knoxville | Knoxville | Amoco | P, S2 | 25 | 74.88 % | 10 | 4 x 10M |
| | | | BP | P, S3 | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | | | Citgo | P, S2 | | | | |
| | | | Cummins Terminals | P, S3, **(E)** | | | | |
| | | | Cummins Terminals | P, S2 | | | | |
| | | | Exxon | P, R | | | | |
| | | | Louis Dreyfuss | P, S2 | | | | |
| | | | Marathon/Ashland | P, S3 | | | | |
| | | | Motiva | P | | | | |
| | | | Southern Facilities | P, S2 | | | | |
| | Memphis | Memphis | Exxon | W, | 40 | 72.87% | 7 | 5 x 5M |
| | | | Lion Oil | W, S2 | | | | |
| | | | Mapco | P, S3 | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Pet. Fuel & Term. | W, S2 | | | | |
| | | | Truman Arnold | R, W, S2 | | | | |
| | | West Memphis AR | Truman Arnold | R, W, P, S3 | | | | |
| | Nashville | Nashville | Amoco | R, S2 | 35 | 60.13% | 11 | 5 x 5M |
| | | | Ashland Petroleum | P, S2 | | | | |
| | | | BP | R, P, S2 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Cumberland Term. | P, S2 | | | | |
| | | | Exxon | P, W | | | | |
| | | | Lion Oil | P | | | | |
| | | | Marathon/Ashland | | | | | |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | | Motiva | P, S2 | | | | |
| | | | Southern Facilities | P, S2, **(E)** | | | | |
| | Clarksville/Hopkinsville | See Nashville | | | 7 | 69.98% | 0 | - |
| | Jackson | See Memphis | | | 3 | 59.43% | 0 | - |
| WI | Appleton/Oshkosh/Neehah | See Green Bay | | | 12 | 69.39% | 0 | |
| | Green Bay | Green Bay | Amoco | P, S3 | 5 | 46.48% | 8 | 4 x 2M |
| | | | Citgo | P, S3 | | | | |
| | | | Clark | P, S3 | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | Marathon/Ashland | P, S3 | | | | |
| | | Mobil | P, S3 | | | | |
| | | US Oil | P, S2 | | | | |
| | | US Oil | P, S3 | | | | |
| | | US Oil | P, S2 | | | | |
| Madison | Madison | Transmontaigne | P, S2 | 15 | 70.46% | 8 | 3 x 3M |
| | | US Oil | P, S3 | | | | |
| | McFarland | Cenex | P, S2, **(E)** | | | | |
| | | Center Terminal Co. | P, S2, **(E)** | | | | |
| | | Citgo | P, S2 | | | | |
| | | Koch | P, S3 | | | | |
| | | Mobil | P, S2 | | | | |
| | | US Oil | P, S2 | | | | |
| Milwaukee/Racine | Milwaukee | Amoco | P | 60 | 73.28% | 11 | |
| | | Citgo | P, S3 | | | | |
| | | Clark | P, S3, **(E)** | | | | |
| | | Equilon | P | | | | |
| | | Koch | P, S3 | | | | |
| | | Marathon/Ashland | P, S3 | | | | |
| | | PTW Inc. | R, P, W, S2 | | | | |
| | | ST Services | W, S3 | | | | |
| | | US Oil | P, S2 | | | | |
| | | US Oil | P, S2 | | | | |
| | | US Oil | P, S2 | | | | |
| Eau Claire | Eau Claire | Marathon/Ashland | | 5 | 69.67% | 3 | 2 x 2M |
| | Chippawa Falls | Cenex | P, S3, **(E)** | | | | |
| | | Transmontaigne | P, S2, **(E)** | | | | |
| Janesville/Beloit | See Rockford IL | | | 5 | 66.60% | 0 | - |
| Lacrosse | See Rochester MN | | | 3 | 49.53% | 0 | - |
| Sheboygan | See Milwaukee<br>See Appleton | | | 2 | 36.55% | 0 | - |

NOTE: Sufficient terminals for ethanol exist due to RFG program

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| Wausau | Junction City | Koch | P, S3 | 5 | 81.44% | 2 | 1 x 3M |
| | Musinee | Williams | P, S2 | | | | |
| TOTAL | | | | 2000 (not including ethanol in E85) | | | |

**PADD II Summary - Case B1**

| | |
|---|---|
| Total ethanol for blends | 2000 mmgy |
| Total ethanol for E-85 | 200 mmgy |

**PADD II Terminal Recap**

| | | | |
|---|---|---|---|
| Total # of operating terminals | 311 | Total listing ethanol | 61 |
| Total # with water capability | 56 | | |
| Total # with rail capability | 22 | | |
| Total S1 | 6 | **Total Estimated Tankage additions** | |
| Total S2 | 133 | 1M -4 | 5M - 42 |
| Total S3 | 108 | 2M - 36 | 10M - 4 |
| | | 3M - 36 | 15M - 2 |
| | | | 20M - 2 |

# Table H-1C Case B1 - PADD III Terminal Analysis

PADD III

| | |
|---|---|
| Ethanol imports | 0.5 billion gallons |
| Ethanol produced | 0.2 billion gallons |
| Total ethanol used | 0.7 billion gallons |

W = water (ship, barge)
R = rail
P = pipeline

E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | Servicing City/MSA | Terminal | Company | Demand Category | Ethanol % of mmgy | Blend # of market | Tankage Term. | Additional Required |
|---|---|---|---|---|---|---|---|---|
| AL | Birmingham | Birmingham | Allied Energy | P, S3, **(E)** | 25 | 51.45% | 11 | 3 x 5M |
| | | | Amoco | P | | | | |
| | | | Chevron | P, S2 | | | | |
| | | | Citgo | P, S2 | | | | |
| | | | Crown | P, S2 | | | | |
| | | | Louis Dreyfus | P, S3 | | | | |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | | Motiva | P | | | | |
| | | | Motiva | P, S2 | | | | |
| | | | Phillips | P, S2 | | | | |
| | | | Southern Facilities | P, S2, **(E)** | | | | |
| | Huntsville | See Birmingham | | | 7 | 38.38% | 0 | - |
| | | See Chatanooga TN | | | | | | |
| | Mobile | Mobile | Amoco | W, S2 | 15 | 52.75% | 8 | 5 x 3M |
| | | | BP | W, S2 | | | | |
| | | | BP | W, S2 | | | | |
| | | | Coastal Fuels | W, S3 | | | | |
| | | | Coastal Mobil Ref | R, W, S3 | | | | |
| | | | EOTT Energy | P, W, S3 | | | | |
| | | | Port of Mobile | W, R | | | | |
| | | | Shell | W, P, S2, **(E)** | | | | |
| | | See Pasagoula MS | | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Montgomery | Montgomery | Amoco | P | 10 | 58.40% | 7 | 3 x 3M |
| | | | BP | P, S2 | | | | |
| | | | Chevron | P, S2 | | | | |
| | | | Louis Dreyfus | P, S2 | | | | |
| | | | Marathon/Ashland | P, S2 | | | | |
| | | | Southern Facilities | P, S2, **(E)** | | | | |
| | | | ST Services | P, S2 | | | | |
| | Anniston | Anniston<br>See Birmingham | Murphy Oil | P, S2 | 3 | 48.47% | 1 | 1 x 1M |
| | Auburn/Opelika | See Columbus GA<br>See Montgomery | | | 2 | 36.86% | 0 | - |
| | Decatur | See Birmingham<br>See Chattanooga TN | | | 3 | 39.38% | 0 | - |
| | Dothan | Columbia<br>See Panama City FL | Stratus Petroleum | W, S2 | 3 | 41.77% | 1 | 1 x 2M |
| | Florence | Sheffield<br>See Birmingham | Murphy Oil | W, S2 | 3 | 41.27% | 1 | 1 x 2M |
| | Gadsdden | See Birmingham | | | 3 | 54.60% | 0 | - |
| | Tuscaloosa | See Birmingham | | | 4 | 46.66% | 0 | - |
| AR | Fayetteville/Springdale/Rogers | Rogers<br>See Fort Smith | Transmontaigne | P, S2 | 8 | 52.86% | 1 | 1 x 5M |
| | Little Rock/North Little Rock | North Little Rock | Exxon | P | 15 | 50.52% | 4 | 2 x 5M |
| | | | LaGloria | P, S2 | | | | |
| | | | Transmontaigne | P, S3 | | | | |
| | | | Truman Arnold | P, R, S3, **(E)** | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Fort Smith | Fort Smith | Williams Pipeline | P, S2 | 4 | 38.52% | 1 | 1 x 5M |
| | | See Fayetteville | | | | | | |
| LA | Baton Rogue | Baton Rogue | Exxon | | 15 | 48.79% | 5 | 3 x 5M |
| | | Port Allen | Int Terminals | R, W | | | | |
| | | | Pet Fuel & Term | R, W, S3 | | | | |
| | | | Placid Refining | P, W | | | | |
| | | Sunshine | Petro United | W, S3, **(E)** | | | | |
| | Lafayette | Lafayette | Public Terminals | P, S2 | 10 | 49.92% | 3 | 2 x 5M |
| | | Opeloosa | Chevron | P, S2 | | | | |
| | | Krotz Springs | Kinder Morgan | | | | | |
| | New Orleans | Garyville | Marathon/Ashland | S2 | 45 | 64.91% | 12 | 2 x 20M |
| | | | Pet Fuels & Term | W, S3 | | | | 5 x 2 M |
| | | Kenner | Motiva | P | | | | |
| | | St. Rose | Int Mtx Tank Term | R, W, S3 | | | | |
| | | Chalmette | Mobil | S2 | | | | |
| | | Meraux | Murphy Oil | P, S2 | | | | |
| | | Gretna | IMTT | | | | | |
| | | | John W. Stone | | | | | |
| | | Harvey | Delta Commodities | | | | | |
| | | | IMTT | W, R, S3 | | | | |
| | | Westwego | PakTank | R, W, S3 | | | | |
| | | | ST Services | | | | | |
| | Shreveport/Bossier City | Shreveport | Pennzoil | P, S2 | 10 | 49.86% | 4 | 2 x 5M |
| | | Waskom | Mobil | P, S2 | | | | |
| | | | Mobil | P, S2 | | | | |
| | | | Motiva | P, S2 | | | | |
| | Alexandria | See Lafayette/Opaloosa | | | 4 | 59.42% | 0 | - |
| | Houma | See New Orleans | | | 4 | 38.71% | 0 | - |
| | Lake Charles | Lake Charles | Citgo | S2 | 4 | 41.82% | 2 | 1 x 2M |
| | | Westlake | Conoco | **(E)** | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Monroe | Arcadia | Chevron<br>Exxon | P, S3<br>P | 3 | 38.52% | 2 | 1 x 3M |
| MS | Biloxi/Gulfport/Pascagoula | Biloxi<br>Pascagoula<br>See Mobile AL | Munro Petroleum<br>Chevron | W, S2 | 10 | 53.31% | 2 | 1 x 15M |
| | Jackson | Jackson<br>Vicksburg | Southland Oil<br>Citgo<br>Southland Oil | W<br>W, S2<br>W, S3 | 10 | 43.53% | 3 | 1 x 15M<br>2 x 2M |
| | Hattiesburg | Purvis | Amerada Hess | P, W | 3 | 49.97% | 1 | 1 x 3M |
| NM | Albuquerque | Albuquerque | Chevron<br>Conoco<br>Diamond Shamrock<br>Phillips | | 30 | 64.28% | 4 | 4 x 10M |
| | Las Cruces | See El Paso TX | | | 4 | 44.21% | 0 | - |
| | Santa Fe | See Albuquerque | | | 3 | 39.64% | 0 | - |
| TX | Austin/San Marcos | Austin<br>See San Antonio | Koch | P | 30 | 92.94% | 1 | 1 x 25M |
| | Beaumont/Port Arthur | Beaumont<br><br>Vidor<br>Nederland<br>Port Arthur | Clark<br>Mobil<br>TEPPCO<br>Unocal<br>Fina<br>Motiva | P, S2<br>P, S3<br>P, W<br><br>W. S3<br>P, W | 10 | 50.05% | 6 | 2 x 5M |
| | Brownsville/Harlingen | Brownsville | Citgo | W, S2 | 10 | 57.21% | 5 | 3 x 5M |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | Statia Terminals | R, W, S3 | | | | |
| | | Transmontaigne | W, S2 | | | | |
| | Harlingen | Diamond Shamrock | W, S2 | | | | |
| | McAllen | Coastal | P, S1 | | | | |
| Corpus Christi | Corpus Christi | Citgo | S1 | 10 | 48.65% | 6 | 3 x 5M |
| | | Citgo | P, S3 | | | | |
| | | Corpus Refining | W, P, S1 | | | | |
| | | Diamond Shamrock | P, W, S3 | | | | |
| | | Koch | | | | | |
| | | Port of Corpus Christi | | | | | |
| Dallas/Fort Worth | Dallas | Mobil | P, S2 | 140 | 53.70% | 16 | 7 x 10M |
| | | Motiva | P, S2 | | | | 3 x 25M |
| | | Citgo | P, S3 | | | | |
| | Grapevine | Citgo | P, S3 | | | | |
| | | Conoco | P, S2 | | | | |
| | | Diamond Shamrock | P, S3 | | | | |
| | Irving | Exxon | P | | | | |
| | Euless | Koch | P | | | | |
| | | Phillips | P, S2 | | | | |
| | Aledo | Pride Refining | R, S2 | | | | |
| | Fort Worth | Chevron | P, S3 | | | | |
| | | Citgo | P, S2 | | | | |
| | | Mobil | P, S2 | | | | |
| | | Motiva | P, S3 | | | | |
| | | Total Petroleum | P | | | | |
| | South Lake | Fina | P, S3 | | | | |
| El Paso | El Paso | Chevron | S1 | 20 | 53.66% | 4 | 2 x 10M |
| | | Diamond Shamrock | P, S3 | | | | |
| | | Equilon | P | | | | |
| | | Navajo | P, S2, **(E)** | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| Houston/Galveston/Brazoria | Houston | Citgo | P, S2 | 110 | 46.10% | 17 | 6 x 10M |
| | | Coastal | P, R, S1 | | | | 2 x 25M |
| | | Exxon | P | | | | |
| | | Exxon | P | | | | |
| | | Lyondell-Citgo | | | | | |
| | | Motiva | P, S2 | | | | |
| | | Oil Tank Houston | P, W, R, S3 | | | | |
| | | Valero | | | | | |
| | Pasadena | GATX | P, W, S3 | | | | |
| | Pasadena | Motiva | P | | | | |
| | | Phillips | P, R, S3 | | | | |
| | Texas City | Intercoastal Term | W, S2 | | | | |
| | | ST Services | P, W, S3 | | | | |
| | Seabrook | PetroUnited | R, P, W, S3, **(E)** | | | | |
| | Galena Park | Chevn/Warren Pet | W, P, R. S3 | | | | |
| | | Chevron | P, W, S3 | | | | |
| | | GATX | R, P, W, S3 | | | | |
| Killeen/Temple | See Austin | | | 7 | 44.49% | 0 | - |
| | See Dallas | | | | | | |
| McAllen/Edinburg/Mission | See Brownsville | | | 15 | 52.80% | 0 | - |
| San Antonio | San Antonio | Citgo | P, S2 | 40 | 48.13% | 7 | 3 x 15M |
| | | Coastal | P, S1 | | | | |
| | | Diamond Shamrock | P, S2 | | | | |
| | | Exxon | P | | | | |
| | | Koch | P | | | | |
| | | Motiva | P, S2 | | | | |
| | Elmendorf | ST Services | P, S2 | | | | |
| Abilene | See Dallas/Fort Worth | | | 4 | 61.50% | 0 | - |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| Amarillo | Amarillo | Diamond Shamrock | P, S2 | 6 | 54.14 | 4 | 2 x 3M |
| | Phillips | P, S2 | | | | | |
| | Borger | Phillips | R | | | | |
| | Sunray | Diamond Shamrock | S2 | | | | |
| Bryan/College Station | Bryan | Citgo | P, S2 | 3 | 42.09% | 3 | 2 x 3M |
| | Hearne | Mobil | P, S2 | | | | |
| | | Motiva | P | | | | |
| Larado | Larado | Diamond Shamrock | P, S2 | 4 | 38.99% | 2 | 1 x 5M |
| | Falfurrias | Coastal | P, S1 | | | | |
| Longview/Marshall | Mt. Pleasant | Conoco | P, S2 | 5 | 44.94% | 2 | 1 x 5M |
| | Big Sandy | Chevron | P, S2 | | | | |
| Lubbock | Lubbock | Phillips | P, S2 | 5 | 41.32% | 2 | 1 x 5M |
| | Abernathy | Diamond Shamrock | P, S2 | | | | |
| Midland/Odessa | Midland | Chevron | P, S2 | 5 | 38.87% | 3 | 2 x 3M |
| | Big Springs | Fina | S3 | | | | |
| | Odessa | Shell | | | | | |
| Sherman/Dennison | Ardmore | Total | | 2 | 36.31 | 1 | 1 x 2m |
| | See Dallas/Fort Worth | | | | | | |
| Texarkana TX/AR | See Longview/Marshall | | | 3 | 45.97% | 0 | - |
| Tyler | Tyler | LaGloria | W, S1, **(E)** | 4 | 44.39% | 1 | |
| Waco | Waco | Citgo | W, S1 | 4 | 36.88% | 3 | initially pulled from Dallas |
| | | Koch | P | | | | |
| | | Motiva | P, S2 | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | | | Ethanol | | | Additional |
| Wichita Falls | Wichita Falls | Conoco | P, S2 | 3 | 41.39% | 2 | 1 x 2M |
| | | Fina | P, S2 | | | | |
| **TOTAL** | | | | 700 | | | |

## PADD III Summary - Case B1

| | |
|---|---|
| Total ethanol for blends | 700 mmgy |
| Total ethanol for E-85 | 0 mmgy |

## PADD III Terminal Recap

| | | | |
|---|---|---|---|
| Total # of operating Terminals | 158 | Total listing ethanol | 10 |
| Total # with water capability | 42 | | |
| Total # with rail capability | 17 | | |

| | |
|---|---|
| Total S1 | 9 |
| Total S2 | 68 |
| Total S3 | 36 |

**Total Estimated Tankage additions**

| | |
|---|---|
| 1 M - 1 | 10M - 19 |
| 2M - 12 | 15M - 5 |
| 3M - 16 | 20M - 2 |
| 5M -25 | 25M - 6 |

# Table H-1D  Case B1 - PADD IV Terminal Analysis



PADD IV

Ethanol imports ............... 0.1 billion gallons
Ethanol produced ............ 0.0 billion gallons
Total ethanol used .......... 0.1 billion gallons

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| CO | Colorado Springs | Colorado Springs | Diamond Shamrock | P, S3 | 15 | 59.78% | 1 | 1 x 10M |
| | | See Denver | | | | | | |
| | Denver/Boulder/Greeley | Aurora | Chase Pipeline | P, S3, **(E)** | 55 | 45.33% | 8 | 4 x 10M |
| | | Commerce City | Colorado Refining | R, S2 | | | | |
| | | | Colorado Refining | R, P, S1 | | | | |
| | | | Conoco | | | | | |
| | | | Diamond Shamrock | P. S2 | | | | |
| | | | Phillips | P, S3 | | | | |
| | | Henderson | Sinclair Pipeline | P, S3, **(E)** | | | | |
| | | Dupont | Kaneb Pipeline | P | | | | |
| ID | Boise | Boise | Amoco | P, S3 | 10 | 48.86% | 4 | 2 x 5M |
| | | | Flying J | P, S2 | | | | |
| | | | Northwest Term | P, S3 | | | | |
| | | | Northwest Term | P, W, S3 | | | | |
| | | | Sinclair (closed) | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| MT | | | | | | | | |
| UT | Provo/Orem | See Salt Lake City | | | 5 | 28.71% | 0 | - |
| | Salt Lake City/Ogde | Salt Lake City | Amoco | S1 | 15 | 23.44% | 6 | 2 x 10M |
| | | | Chevron | S1 | | | | |
| | | North Salt Lake | Conoco | P, S3 | | | | |
| | | | Flying J | P, R, S3 | | | | |
| | | Woodcross | Inland Refining | P, R, S1 | | | | |
| | | | Phillips | | | | | |
| | **TOTAL** | | | | 100 | | 19 | |

**PADD IV Summary - Case B1**

| | |
|---|---|
| Total ethanol for blends | 100 mmgy |
| Total ethanol for E-85 | 0 mmgy |

**PADD IV Terminal Recap**

| | | | |
|---|---|---|---|
| Total # of operating terminals | 19 | | |
| Total # with water capability | 1 | | |
| Total # with rail capability | 4 | | |
| Total listing ethanol | 2 | **Total Estimated Tankage additions** | |
| Total S1 | 4 | 5M -2 | 10M - 7 |
| Total S2 | 3 | | |
| Total S3 | 9 | | |

## Table H-1E Case B1 - PADD V Terminal Analysis

PADD V

Ethanol imports ............... 0.6 billion gallons
Ethanol produced ............ 0.2 billion gallons
Total ethanol used .......... 0.8 billion gallons

W = water (ship, barge) S1 = under 100 m barrels
R = rail S2 = 100 m - 250 m barrels
P = pipeline S3 = over 250 m barrels
E = ethanol

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| AK | Achorage | Anchorage | Chevron | W,R, P, S3 | 5 | 44.37% | 4 | |
| | | | Equilon | W, S3 | | | | |
| | | | Mapco | W, P, R, S3 | | | | |
| | | | Port of Anchorage | W, P, R, S3 | | | | |
| CA | Bakersfield | Bakersfield | Coast Gas | R, S1 | 15 | 53.41% | 4 | 2 x 5M |
| | | | Equilon | P, S1 | | | | |
| | | | Gibson Env | S1 | | | | |
| | | | Kern Oil | S1 | | | | |
| | Fresno | Fresno | Kinder Morgan | P, S3 | 20 | 52.01% | 1 | 1 x 20M |
| | Los Angeles/Riverside/Orange Cty | Torrance | Mobil | P, R, S2 | 400 | 57.07% | 36 | |
| | | Terminal Island | GP Resources | W | | | | |
| | | Wilmington | Equilon | R, W, P, S1 | | | | |
| | | | GATX | P, W, S3 | | | | |
| | | | PAC Tank | P, W, R, S3 | | | | |
| | | | Wickland | P, W, S3 | | | | |
| | | Bloomington | Arco | P, S2 | | | | |
| | | | Equilon | P, S2 | | | | |
| | | | Kinder Morgan | P, S3 | | | | |
| | | | Tosco | P, S2 | | | | |
| | | Signal Hill | Arco | P, S3 | | | | |
| | | Long Beach | Arco | P, S3 | | | | |
| | | | Arco | P, W, S3 | | | | |

NOTE: Tankage in place due to existing Program

NOTE: All LA area terminals will undergo ethanol conversion before 2003

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | Equilon | P, S1 | | | | |
| | | GATX | W, P | | | | |
| | | Petro Diamond | P, W, R, S3 | | | | |
| | | Ultramar | P, S1 | | | | |
| | Ventura | Equilon | P, S1 | | | | |
| | Van Nuys | Chevron | P, S1 | | | | |
| | | Equilon | P, S1 | | | | |
| | Los Angeles | Equilon | P | | | | |
| | | Kinder Morgan | ? | | | | |
| | | Mobil | P, S2 | | | | |
| | | Mobil | P, S1 | | | | |
| | | Tosco | P, S1 | | | | |
| | | Tosco | P, S1 | | | | |
| | Southgate | Arco | P, S3 | | | | |
| | Montebello | Chevron | P, S2 | | | | |
| | Santa Fe Springs | Powerine Oil | P, S1 | | | | |
| | | Tosco | | | | | |
| | San Bernadino | CAL-NEV | P, S2 | | | | |
| | Rialto | Tosco | P, S1 | | | | |
| | Orange | Kinder Morgan | P, S2 | | | | |
| | Carson | Arco | P, S1 | | | | |
| | | Equilon | P, W, S3 | | | | |
| | Huntington Beach | Chevron | P, S1 | | | | |
| Modesto | See Stockton | | | 10 | 52.38% | 0 | - |
| Sacramento | West Sacramento | Arco | P, S2 | 45 | 59.14% | 6 | |
| | | Equilon | P | | | | |
| | | Tesoro | P, S2 | | | | |
| | Sacramento | Chevron | P, S2 | | | | |
| | | Tosco | P, S2 | | | | |
| | Rancho Cordova | Kinder Morgan | P, S3 | | | | |
| San Diego | San Diego | Arco | P, S2 | 70 | 56.77% | 8 | |
| | | Chevron | P, S2 | | | | |
| | | Equilon | P, S2 | | | | |
| | | Equilon | P, S2 | | | | |

NOTE: All Sacramento area terminals will undergo ethanol conversion before 2003

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|
| | | Kinder Morgan | P, S3 | | | | |
| | Imperial | Kinder Morgan | P, S3 | | | | |
| | | ST Services | P, S2 | | | | |
| | Nyland | Kinder Morgan | P, S1 | | | | |
| San Francisco/Oakland | Benicia | Exxon | | 160 | 53.26% | 19 | 8 x 20M |
| | Crocket | Wickland | P, R, W, S3 | | | | |
| | Brisbane | Kinder Morgan | P, S3 | | | | |
| | South San Francisco | Equilon | P | | | | |
| | Redwood City | Gibson Env | W | | | | |
| | San Jose | Equilon | P | | | | |
| | | Chevron | P, S2 | | | | |
| | Milipitas | Kinder Morgan | P, S3 | | | | |
| | Richmond | Arco | P, R, W, S3 | | | | |
| | | Chevron | P, W, S3 | | | | |
| | | GATX | W, R, S3 | | | | |
| | | Texaco | R, W, S3 | | | | |
| | | Time Oil | P, W, R, S3, **(E)** | | | | |
| | | Tosco | P, R, W, S3 | | | | |
| | Pittsburg | Diablo Services | W, S2 | | | | |
| | Martinez | Chevron | P, S2 | | | | |
| | | Equilon | P, W | | | | |
| | | Tosco | P, R, W, S2, **(E)** | | | | |
| | | Wickland | P, W, S3 | | | | |
| Stockton/Lodi | Stockton | Arco | P, S1 | 15 | 60.94% | 7 | 3 x 5M |
| | | Equilon | P | | | | |
| | | Kinder Morgan | P, S2 | | | | |
| | | ST Services | P, S3, **(E)** | | | | |
| | | Tesoro | P, S3 | | | | |
| | | Tosco | P, S1 | | | | |
| | Tracy | Chevron | P, S2 | | | | |

NOTE: All San Diego area terminals will undergo ethanol conversion before 2003

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required |
|---|---|---|---|---|---|---|---|---|
| | Visalia/Tulare/Pottersville | See Fresno | | | 10 | 63.82% | 0 | - |
| HI | Honolulu | | | | | | | |
| NV | Las Vegas | | | | | | | |
| OR | | | | | | | | |
| WA | Seattle/Tacoma/Bremerton | Richmond Beach | Chevron (closed) | | 50 | 33.01% | 10 | |
| | | Seattle | Arco | P, W, **(E)** | | | | |
| | | | Crowley Marine | W, S2 | | | | |
| | | | Equilon | P, W, S3 | | | | |
| | | | GATX | P, W, S3 | | | | |
| | | | Time Oil | W, S2, **(E)** | | | | |
| | | Renton | Tosco | P, S2 | | | | |
| | | Tacoma | Time Oil | P, R, W, S3, **(E)** | | | | |
| | | | Tosco | P, W, S3, **(E)** | | | | |
| | | | US Oil & Refining | S1 | | | | |
| | | Tumwater | Equilon | P, S1 | | | | |
| | **TOTAL** | | | | 800 | | | |

NOTE: Sufficient tankage already in place

**PADD V Summary - Case B1**

| | |
|---|---|
| Total ethanol for blends | 800 mmgy |
| Total ethanol for E-85 | 0 mmgy |

**PADD V Terminal Recap**

| | | | |
|---|---|---|---|
| Total # of operating terminals | 95 | Total listing ethanol | 7 |
| Total # with water capability | 32 | | |
| Total # with rail capability | 16 | | |

| | |
|---|---|
| Total S1 | 22 |
| Total S2 | 26 |
| Total S3 | 34 |

**Total Estimated Tankage additions**

| | |
|---|---|
| 5M -5 | 20M - 9 |

# Table H-2 A PADD I Terminal Analysis - Case C

Ethanol imports ....... 1.3 billion gallons
Ethanol produced .... 1.4 billion gallons
Total ethanol used .. 2.7 billion gallons

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

PADD I

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| CT | Hartford | East Hartford<br>Rocky Hill | Motiva<br>Citgo | P, S1<br>P, S2 | 35 | 67.20% | 2 | 2 x10M | 1 x 10M |
| | New London | Groton | Amarada Hess | W | 10 | 77.55% | 1 | 1 x 10M | |
| FL | Daytona Beach | See Jacksonville | | | 15 | 69.61% | 0 | | |
| | Ft. Meyers | See Tampa, See Miami | | | 10 | 55.00% | 0 | -- | |
| | Ft. Pierce/Port St. Lucie | See Palm Beach | | | 10 | 73.44% | 0 | | |
| | Jacksonville | Jacksonville | Amarada Hess<br>Amoco<br>BP<br>Chevron<br>Coastal Fuel Mkg<br>Koch<br>Pet Fuel & Term. Co.<br>ST Services | W<br>W, S3<br>R, W, S3<br>W, S3<br>R, W, S3<br>W, S3<br>W, S3, **(E)**<br>W, R, S3 | 30 | 62.57% | 8 | 2 x 5M | 3 x 5M<br>2 x 10M |
| | Lakeland/Winter Haven | See Tampa | | | 10 | 48.17% | 0 | -- | |
| | Melbourne/Titusville/P. Bay | Cape Canaveral | Coastal | W, S3 | 10 | 46.83 | 1 | | 1 x 5M |
| | Miami/Ft Lauderdale | See Palm Beach<br>Ft Lauderdale | <br>Amerada Hess<br>Amoco | <br>W<br>W, S3 | 100 | 59.36% | 11 | 5 x 10M | 1 x 25M<br>1 x 50M |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Chevron | P, W, S3 | | | | | |
| | | | Citgo | P, W, S3 | | | | | |
| | | | GATX | P, W, R, S3 | | | | | |
| | | | Louis Dryfus | W, S3 | | | | | |
| | | | Marathon/Ashland | S3 | | | | | |
| | | | Mobil | P, W, S3 | | | | | |
| | | | Motiva | W, S3 | | | | | |
| | | | Motiva | W, S3 | | | | | |
| | | Homestead | ST Services | P, S2 | | | | | |
| | Orlando | See Tampa | | | 40 | 57.41% | 0 | -- | |
| | Palm Bch/Boca Ratan/W. P. Beh | Palm Beach | Port of Palm Beach | R, W, S3 | 30 | 62.98% | 1 | | |
| | | See Miami/Ft Lauderdale also | | | | | | | 1 x 20M |
| | Pennsacola | Pennsacola | Louis Dryfus | W, S2 | 10 | 54.61% | 5 | 1 x 5M | 2 x 5M |
| | | | Mackenzie Srv Co. | W, S1 | | | | | |
| | | | Mocar Oil | W, S2 | | | | | |
| | | | Pennsacola Term. . | W, **(E)** | | | | | |
| | | Milton | Mackenzie Srv Co. | W, S1 | | | | | |
| | | See Mobile AL also | | | | | | | |
| | Sarasota/Bradenton | See Tampa/St Petersburg | | | 15 | 60.07% | 0 | -- | |
| | Tallahassee | St, Marks | Mackenzie Srvc. Co. | W, S3 | 5 | 42.37% | 7 | | 2 x 3M |
| | | | Murphy Oil | W, S2 | | | | | |
| | | | Stratus Petroleum | W, S2 | | | | | |
| | | Bainbridge GA | BP | P, S2 | | | | | |
| | | | Louis Dreyfus | P, S2 | | | | | |
| | | | Mackenzie Srvc. | S2 | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | Tampa/St Petersburg | Tampa | Amarada Hess | W | 60 | 58.02% | 9 | | |
| | | | Amoco | W, S3 | | | | 3 x 10M | 2 x 25M |
| | | | BP | W, S3 | | | | | |
| | | | Chevron | P, W, S3 | | | | | |
| | | | Citgo | P, W, S3 | | | | | |
| | | | Louis Dreyfus | W, P, S3 | | | | | |
| | | | Marathon/Ashland | S3 | | | | | |
| | | | Murphy Oil | W, S3 | | | | | |
| | | Port Tampa | Motiva | W | | | | | |
| **GA** | Atlanta | Atlanta | BP | P, S2 | 100 | 57.12% | 19 | 2 x 10M | 6 x 10M |
| | | | Colonial Pipeline | P, S3 | | | | | 2 x 20M |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | | Fina | P, S2 | | | | | |
| | | Louis Dreyfus | P, S2 | | | | | |
| | | Whitaker Oil | R, S1 | | | | | |
| | Austel | Marathon Ashland | P, S2 | | | | | |
| | Doraville | Amarada Hess | P | | | | | |
| | | Amoco | P, S2 | | | | | |
| | | Amoco | R, S2 | | | | | |
| | | Marathon/Ashland | P, S2 | | | | | |
| | | Chevron | P, S3 | | | | | |
| | | Citgo | P, S2 | | | | | |
| | | Motiva | P | | | | | |
| | | Motiva | P, S3 | | | | | |
| | | Motiva | P | | | | | |
| | | Phillips | P, R, S2 | | | | | |
| | | Southern Facilities | P, S3, **(E)** | | | | | |
| | Rome | BP | P, S2 | | | | | |
| | | Louis Dreyfus | P, S2 | | | | | |
| Augusta/Aiken | North Augusta SC | Amoco | P, S1 | 10 | 47.81% | 5 | 1 x 10M | |
| | | BP | P, S2 | | | | | |
| | | Charter Terminals | P, S3 | | | | | |
| | | Phillips | P, S2 | | | | | |
| | | Southern Facilities | P, S2 | | | | | |
| Columbus | Columbus | Chevron | P, S2 | 5 | 40.58% | 4 | | 3 x 2M |
| | | Crown | P, S1 | | | | | |
| | | Marathon Ashland | P, S2 | | | | | |
| | | TransMontaigne | P, S2 | | | | | |
| Macon | Macon | BP | P, S2 | 5 | 34.25% | 8 | | 3 x 2M |
| | | Chevron | P, S2 | | | | | |
| | | Louis Dreyfus | P, S2 | | | | | |
| | | Marathon Ashland | P, S2 | | | | | |
| | | Southern Facilities | P, S2 | | | | | |
| | | ST Services | P, S3 | | | | | |
| | Griffin | BP | P, S1 | | | | | |
| | | Louis Dreyfus | P, S2 | | | | | |
| Savannah | Savannah | Colonial Terminals | R, W, S3 | 5 | 38.19% | 3 | | 3 x 2M |
| | | PakTank | R, W, S3 | | | | | |
| | | ST Services | R, W, S3 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| MA | Boston | Beverly | Armory Term. Inc. | P, S2 | 165 | 64.14% | 8 | 4 x 20M | 1 x 25M<br>3 x 10M |
| | | Revere | Coastal Oil | R, W, P, S2, **(E)** | | | | | |
| | | | Global Petroleum | W, S3 | | | | | |
| | | | Tosco | P, S3 | | | | | |
| | | Everett | Exxon | W | | | | | |
| | | Braintree | Citgo | W, S3 | | | | | |
| | | Boston | Mobil | P, W, S3, **(E)** | | | | | |
| | | Chelsea | Gulf Oil LP | W, S3 | | | | | |
| | Springfield | Springfield | Gulf Oil LP (closed) | | 20 | 76.77% | 1 | 1 x 10M | |
| | | | Mobil | P, S3 | | | | | |
| MD/DC | Baltimore/Washington | Baltimore | Amerada Hess | P, W, | 230 | 68.85% | 11 | 7 x 25M | 7 x 20M |
| | | | Amoco | P, W, S3 | | | | | |
| | | | Champion Rn.(closed) | | | | | | |
| | | | Conoco | P, S3 | | | | | |
| | | | Exxon (2-closed)] | | | | | | |
| | | | Motiva | P | | | | | |
| | | | Motiva | P, W, S3 | | | | | |
| | | | Pet. Fuels & Term. | P, W, S3 | | | | | |
| | | | Pet. Fuels & Term. | P, W, S3 | | | | | |
| | | | Stratus Petroleum | P, W, S3 | | | | | |
| | | | Sun R & M (closed) | | | | | | |
| | | | Tosco | P, S3 | | | | | |
| | | DC | ST Services | P, S2 | | | | | |
| | | | ST Services | P, W | | | | | |
| NC | Charlotte | Charlotte | Exxon | P | 40 | 62.18% | 13 | 3 x 10M | 4 x 5M |
| | | | Motiva | P | | | | | |
| | | Paw Creek | Amerada Hess | P | | | | | |
| | | | Amoco | R, P. S3 | | | | | |
| | | | BP | P, S3 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Crown Central | P, S2 | | | | | |
| | | | Louis Dreyfuss | P, S3 | | | | | |
| | | | Marathon/Ashland | P, S2 | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | | Southern Facilities | P, S2 | | | | | |
| | | | Valero M & S | P | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | Fayetteville | Fayetteville | Motiva | P, S2 | 5 | 38.83% | 1 | | 1 x 5M |
| | | See Raleigh/Durham also | | | | | | | |
| | Greensboro/Winston Salem/High Point | Greensboro | Amerada Hess | P | 30 | 56.04% | 12 | 2 x 10M | 3 x 5M |
| | | | Amoco | P, S2 | | | | | |
| | | | Ashland | P, S2, **(E)** | | | | | |
| | | | BP | P, S3 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| | | | Louis Dreyfuss | P, S3 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Pet. Fuels Terminal | P, S3 | | | | | |
| | | | Southern Facilities | P,S3 | | | | | |
| | | | Triad Terminal Co. | P, S3 | | | | | |
| | Hickory/Lenoir/Morganton | See Greensboro & Charlotte | | | 10 | 67.62% | 0 | | |
| | Raleigh Durham/Chapel Hill | Apex | Motiva | P, S2 | 30 | 59.78% | 10 | 3 x 5M | 2 x 10M |
| | | Selma | Amerada Hess | P | | | | | |
| | | | BP | P, S3 | | | | | |
| | | | Citgo | P, S3 | | | | | |
| | | | Crown Petroleum | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | | Southern Facilities | P, S3, **(E)** | | | | | |
| | | | Triad Terminal Co. | P, S3 | | | | | |
| | | | Valero | P | | | | | |
| **NY** | Albany/Schenectady/Troy | Albany | Agway Petroleum | W, S3 | 30 | 76.01% | 10 | 1 x 10M | 2 x 5M |
| | | | Mobil | W, R, S3 | | | | | |
| | | Rennselaer | Amerada Hess | W | | | | | |
| | | | Bray Terminals | R, W, S3, **(E)** | | | | | |
| | | | Getty | W, S3, **(E)** | | | | | |
| | | | Pet. Fuel & Term. | W, S3 | | | | | |
| | | | Sun R & M | W, S3 | | | | | |
| | | Glenmont | Citgo | W, S3 | | | | | |
| | | | Sears Oil | W, S3 | | | | | |
| | | Selkirk | TEPPCO | P, R, S1 | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| Buffalo/Niagra Falls | Tonawanda | NOCO Energy | R, P, W, S3 | 40 | 77.16% | 4 | 2 x 10M | 2 x 10M |
| | | Sun R & M | P, S3 | | | | | |
| | | United Refining | P, W, S3 | | | | | |
| | Buffalo | Mobil Oil | P, S3 | | | | | |
| New York City | Linden NJ | Citgo | P, W, S3 | 700 | 76.36% | 32 | 12 x 25M | 2 x 50M |
| | | Gulf Oil | P, S3 | | | | | 10 x 25M |
| | | Mobil | P, S3 | | | | | 4 x 10M |
| | | Tosco | P, W, S3 | | | | | 2 x 5M |
| | Carteret NJ | Amoco | P, S3 | | | | | |
| | | GATX | P, R, W, S3 | | | | | |
| | Bayonne NJ | Amerada Hess | P, W | | | | | |
| | | IMTT | P, S3 | | | | | |
| | Port Reading NJ | Amerada Hess | R, P, W, S3 | | | | | |
| | Seraren NJ | Motiva | P, W | | | | | |
| | Perth Amboy NJ | Amerada Hess | W | | | | | |
| | | Chevron | W | | | | | |
| | | Stolthaven | | | | | | |
| | Milton | Agway | S2 | | | | | |
| | New Burgh | Amerada Hess | W | | | | | |
| | | Mobil Oil | R, W, S3 | | | | | |
| | Riverhead | Tosco | W, S3 | | | | | |
| | Glenwood Landing | Mobil Oil | W, S2 | | | | | |
| | Oceanside | Gulf Oil (closed) | | | | | | |
| | | RAD Energy | W, S2, **(E)** | | | | | |
| | Lawrence | Carbo Energy | P, W, S3 | | | | | |
| | Inwood | Mobil Oil | P, W, S2 | | | | | |
| | | Motiva | P, S2 | | | | | |
| | Brooklyn | Amerada Hess | W | | | | | |
| | | Amoco | P, W, S2 | | | | | |
| | | Metro Terminals | W, P, S2 | | | | | |
| | | Metro Terminals | W, P, S2 | | | | | |
| | | Motiva | P, W | | | | | |
| | | Star Ent/Texaco | P, S2 | | | | | |
| | Staten Island | Mobil Oil | S3 | | | | | |
| | Long Island City | Getty Oil | P, W, S1 | | | | | |
| | Bronx | Getty Oil | W, S1 | | | | | |
| | Mt. Vernon | Amoco | W, S2 | | | | | |
| | Stamford CT | Sprague Energy | W, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | Rochester | Rochester | Agway Petroleum | P, S2 | 35 | 71.46% | 5 | 2 x 10M | 2 x 10M |
| | | | Amerada Hess | P | | | | | |
| | | | Coastal Oil | P, S2 | | | | | |
| | | | Gulf Oil (closed) | | | | | | |
| | | | Mobil Oil | R, P, S3 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | Syracuse | Warners | Amerada Hess | P | 25 | 75.15% | 9 | 4 x 10M | 1 x 5M |
| | | Oswego | Sprague Energy | W, S3 | | | | | |
| | | Brewerton | Agway Petroleum | P, S3 | | | | | |
| | | Liverpool | Stratus Petroleum | P, S2 | | | | | |
| | | Syracuse | Coastal Oil | P, S3 | | | | | |
| | | | Mobil | P, S3 | | | | | |
| | | | Mobil | P, S3 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | Utica/Rome | Rome | Sears Oil (?-closed) | P, W, S2 | 10 | 75.17% | 3 | 1 x 10M | |
| | | Marcy | Agway Petroleum | W, S3 | | | | | |
| | | | Amerada Hess | P | | | | | |
| | | | Bray Terminals | P, W, S2 | | | | | |
| PA | Bethleham/Allentown/ | Allentown | Mobil Oil | P, S2 | 15 | 53.44% | 2 | | |
| | | Macungie | Agway Petroleum | P, S3 | | | | 1 x 10M | 1 x 5M |
| | Erie | Warren | United Refining | S2 | 10 | 79.53% | 1 | 1 x 5M | |
| | Harrisburg/Lebanon/Carisle | Harrisburg | Mobil | P, S2 | 20 | 71.25% | 5 | 2 x 5M | 2 x 5M |
| | | Mechanicsburg | Amoco | P, S1 | | | | | |
| | | | Gulf Oil | P, S3 | | | | | |
| | | | Star Ent/Texaco | P, S2 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | Lancaster | Lancaster | Mobil | P, S2 | 15 | 71.83% | 1 | 1 x 10M | |
| | | See Richland also | | | | | | | |
| | Philadelphla | Hatboro | Sun R & M | W, P | 180 | 66.10% | 12 | 4 x 25M | 4 x 25M |
| | | Philadelphia | Amerada Hess | W, P | | | | | |
| | | | Amoco | P, S3 | | | | | |
| | | | Exxon | P | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Maritank Phil. | P, W, S3 | | | | | |
| | | | Sun R & M | S2 | | | | | |
| | | Bryn Mawr | Carlos Leffler | | | | | | |
| | | Malvern | Sun R & M | P, S2 | | | | | |
| | | Exton | Sun R & M | P, S2 | | | | | |
| | | Frazier Bogato | Mobil Oil | P, S2 | | | | | |
| | | Wilmington DE | Deleware Term. Co. | W, S3 | | | | | |
| | | Deleware City DE | Motiva | P | | | | | |
| | Pittsburgh | Corapolis | BP | P, S2 | 70 | 66.15% | 15 | 5 x 10M | 2 x 10M |
| | | | Buckeye | P, W, S3 | | | | | |
| | | | Citgo | P, W, S3 | | | | | |
| | | | Motiva | P, W, S3 | | | | | |
| | | Pittsburgh | American Refining | P, S3 | | | | | |
| | | | Exxon | P. W | | | | | |
| | | | Gulf Oil | P, W, S3 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | | | Sun R & M | P, S3 | | | | | |
| | | Whitehall | Gulf Oil | P, S3 | | | | | |
| | | | Sun R & M | P, S2 | | | | | |
| | | Floreffe | Ashland | W, S3 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | Belle Vernon | Gutman Oil | W, S2 | | | | | |
| | | Dravosberg | Boswell Oil | W, S3 | | | | | |
| | Reading | Sinking Springs | Sun R & M | P, S2 | 10 | 61.50% | 3 | 1 x 10M | |
| | | Richland | Carlos Leffler | P, S2 | | | | | |
| | | | Carlos Leffler | P, S2 | | | | | |
| | Scranton | Avoca | Gulf Oil | P, S2 | 20 | 72.05% | 1 | 1 x 10M | |
| | York | See Lancaster | | | 10 | 58.50% | 0 | | |
| | | See Harrisburg | | | | | | | |
| **RI** | Providence | Providence | Citgo | W, S3 | 35 | 68.50% | 5 | 1 x 5M | 2 x 10M |
| | | | Motiva | W, S3 | | | | | |
| | | | Sun R & M (closed) | | | | | | |
| | | East Providence | Getty | R, W, S3, **(E)** | | | | | |
| | | | Mobil | W, S3 | | | | | |
| | | Fall River MA | Shell Oil | W, S3 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| SC | Charleston | Charleston | Allied Terminals | P, W, S3 | 15 | 59.78% | 4 | 1 x 5M | 2 x 5M |
| | | North Charleston | Amerada Hess | W | | | | | |
| | | | Koch Refining | W, S3 | | | | | |
| | | | Marathon/Ashland | W, S3 | | | | | |
| | Columbia | See Augusta GA | | | 15 | 64.01% | 0 | | |
| | | See Charlotte NC | | | | | | | |
| | Greenville/Spartanburg/ | Spartanburg | Amerada Hess | P | 25 | 59.25% | 10 | 2 x 5M | 4 x 5M |
| | | | Amoco | P | | | | | |
| | | | Ashland (closed) | | | | | | |
| | | | BP | P, S3 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Crown Central | P, S2 | | | | | |
| | | | Louis Dreyfuss | R, P, S3 | | | | | |
| | | | Motiva | P | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | | Southern Facilities | P, S2 | | | | | |
| VA | Norfolk/VA Bch/Newpt Nws | Newport News | Koch Fuels | R, W, S3 | 45 | 63.44% | 13 | 3 x 10M | 4 x 5M |
| | | Grafton | Amoco | | | | | | |
| | | Virginia Beach | ST Services | P, W, S1 | | | | | |
| | | Chesapeake | Amerada Hess | W | | | | | |
| | | | Amoco | P, W, S3 | | | | | |
| | | | Chesapeake Term. | R, P, S2 | | | | | |
| | | | Citgo | P, W, S3 | | | | | |
| | | | Conoco | P, S3 | | | | | |
| | | | Crown Central Pet. | P, W, S2 | | | | | |
| | | | Exxon | P, W | | | | | |
| | | | Louis Dreyfuss | P, W, S3 | | | | | |
| | | | Mobil | P, W, S3 | | | | | |
| | | | Stratus Petroleum | P, W, S3 | | | | | |
| | Richmond/Petersburg | Richmond | Amoco | P, S2 | 25 | 57.29% | 10 | 2 x 10M | 4 x 5M |
| | | | Chevron | P, S2 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Crown Central | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| | | | First Energy | P, S3 | | | | | |
| | | | Louis Dreyfuss | P, S2 | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Primary Corp. | W, P, S2 | | | | | |
| | | | Southern Facilities | P, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| WV | Charleston | Charleston | Exxon | W | 5 | 43.85 | 3 | | 1 x 5M |
| | | | Pennzoil | W, S2 | | | | | |
| | | St. Albans | Go Mart Inc. | W, S2 | | | | | |
| | TOTAL | | | | 2400 | | | | |

**PADD I Summary - Case C**

| | |
|---|---|
| Total ethanol for blends | 2400 mmgy |
| Total ethanol for E-85 | 300 mmgy |

**PADD II Terminal Recap**

| | |
|---|---|
| Total # of operating terminals | 288 |
| Total # with water capability | 126 |
| Total # with rail capability | 23 |
| Total listing ethanol | 11 |
| Total S1 | 12 |
| Total S2 | 104 |
| Total S3 | 123 |

**Total Preliminary Estimated Tankage additions**

| Size | Added for Case B1 | Added for Case C |
|---|---|---|
| 2M | -- | 9 |
| 3M | -- | 2 |
| 5M | 13 | 37 |
| 10M | 44 | 26 |
| 20M | 5 | 10 |
| 25M | 23 | 18 |
| 50M | -- | 3 |

# Table H-2B PADD II Terminal Analysis - Case C (part 1)

| | |
|---|---|
| Ethanol Exports ....... | 2.9 billion gallons |
| Ethanol produced .... | 6.6 billion gallons |
| Total ethanol used .. | 3.7 billion gallons |

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| IA | Davenport/Moline/Rock Is. | Bettendorf | Amoco | W, P, S3 | 18 | 100.98% | 4 | 2 x 5M | 1 x 5M |
| | | | Koch Refining | W, P, S2 | | | | | |
| | | | Phillips | W, P, S3, **(E)** | | | | | |
| | | Riverdale | Citgo | P, S2 | | | | | |
| | Des Moines | Des Moines | Amoco | P, S3 | 23 | 104.40% | 2 | 1 x 5M | 1 x 5M |
| | | | Williams Pipeline | P, R, S3, **(E)** | | | | | |
| | Cedar Rapids | See Sioux City | | | 10 | 108.88% | 0 | - | - |
| | Iowa City | North Liberty | Amoco | P | 6 | 116.34% | 2 | 1 x 2M | - |
| | | Coraville | Williams Pipeline | P, S3, **(E)** | | | | | |
| | Sioux City IA/NE | Sioux City | William Pipeline | P, S3, **(E)** | 6 | 109.66% | 1 | -- | |
| | Waterloo/Cedar Falls | Waterloo | Williams Pipeline | P, S3 | 6 | 100.68% | 1 | -- | 1 x 3M |
| IL | Chicago/Gary/Kenosha | Arlington Heights | Arco | P, S3 | 450 | 101.94% | 28 | - | 1 x 50M |
| | | | Citgo | P, S3 | | | | | |
| | | | Equilon | P, S3 | | | | | |
| | | | Mobil | P, S | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | | Mt. Prospect | UNO-VEN | P, S2, **(E)** | | | | | |
| | | Des Plaines | Amoco | P | | | | | |
| | | Franklin Park | Williams Pipeline | P, S3, **(E)** | | | | | |
| | | Forestview | Amoco | P, W, S3 | | | | | |
| | | | Lake River | R, W, S3, **(E)** | | | | | |
| | | Chicago | GATX | | | | | | |
| | | Argo | Equilon | P, S3 | | | | | |
| | | | GATX | R, P, W, S3 | | | | | |
| | | Willow Springs | Marathon/Ashland | P, S3 | | | | | |
| | | Blue Island | Clark | P, S2, **(E)** | | | | | |
| | | | Clark | P, S2 | | | | | |

NOTE: Chicago MSA is nearly 100% ethanol use due to RFG program & sufficient tankage is already in service

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clark | P, S2 | | | | | |
| | | | Martin Oil | W, P, S2, **(E)** | | | | | |
| | | | Martin Oil (closed) | | | | | | |
| | | | ST Services | P, W, S3, **(E)** | | | | | |
| | | Whiting IN | Amoco | P, W, S3, **(E)** | | | | | |
| | | Hammond IN | Clark | P, S3, **(E)** | | | | | |
| | | | Equilon | P, S3 | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | | | Mobil | P, S3 | | | | | |
| | | | Wolfelake Terminals | R, S3 | | | | | |
| | | Shererville | Transmontaigne | P, S3 | | | | | |
| | | East Chicago | Citgo | P, S3 | | | | | |
| | | | Phillips | R, P, S3 | | | | | |
| | | | Transmontaigne | P, S3 | | | | | |
| | Peoria/Pekin | Norris City | LaGloria | P, S2, **(E)** | 18 | 104.58% | 4 | 2 x 3M | 1 x 3M |
| | | Chillicothe | ST Services | P, R, S2 | | | | | |
| | | Creve Couer | Amoco | | | | | | |
| | | North Pekin | Hicks Oil | W, S2 | | | | | |
| | Rockford | Rockford | Clark | P, S2, **(E)** | 18 | 101.03% | 3 | 1 x 2M | - |
| | | | Clark | P, S2, **(E)** | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | Bloomington/Normal | Heyworth | Williams Pipeline | P, S3, **(E)** | 8 | 110.70% | 1 | - | - |
| | | See Peoria/Pekin | | | | | | | |
| | Champaign/Urbana | Champaign | Marathon/Ashland | P, S3 | 9 | 106.40% | 1 | 1 x 3M | - |
| | Decatur | Forsyth | Phillips Petroleum | P, S2, **(E)** | 6 | 106.68% | 2 | 1 x 2M | - |
| | | Harristown | Shell Oil | P, S2 | | | | | |
| | Springfield | Petersburg | Williams Pipeline | P, S2, **(E)** | 11 | 108.53% | 1 | - | - |
| IN | Evansville/Henderson | Evansville | Ashland | W, S2 | 15 | 103.70% | 7 | 3 x 3M | 4 x 2M |
| | | | Marathon/Ashland | | | | | | |
| | | | Transmontaigne | W, S2 | | | | | |
| | | Mt. Vernon | CountryMark | W | | | | | |
| | | | Marathon/Ashland | P, W, S3 | | | | | |
| | | Henderson KY | Transmontaigne | W, S2 | | | | | |
| | | Owensboro KY | Transmontaigne | W, S2 | | | | | |
| | Fort Wayne | Huntington | Ashland | P, S2, **(E)** | 25 | 103.91% | 4 | 2 x 2M | 1 x 5M |
| | | | Citgo | P, S2 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Sun R & M | P, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | Indianapolis | Indianapolis | Amoco | P, S3 | 80 | 104.80% | 10 | 1 x 5M | 2 x 10M |
| | | | Center Term.Co. | P, S2, **(E)** | | | | | 2 x 5M |
| | | | Clark | P, S2, **(E)** | | | | | |
| | | | LaGloria | P, S3, **(E)** | | | | | |
| | | | Marathon/Ashland | S3 | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | | | ST Services | P, S3, **(E)** | | | | | |
| | | Claremont | Clark | P, S2, **(E)** | | | | | |
| | | | Phillips | P, S3 | | | | | |
| | | Zionsville | Equilon | P, S3 | | | | | |
| | South Bend | Granger | Amoco | P, S2 | 13 | 101.22% | 6 | 2 x 2M | 2 x 2M |
| | | South Bend | Transmontaigne | P, S2, **(E)** | | | | | |
| | | Niles MI | Citgo | P, S2 | | | | | |
| | | | Equilon | P, S3 | | | | | |
| | | | Marathon/Ashland | S3 | | | | | |
| | | | Mobil | P, S2, **(E)** | | | | | |
| | Terre Haute | See Indianapolis | | | 8 | 108.66% | | - | - |
| | Bloomington | Seymour | LaGloria | P, S1, **(E)** | 6 | 103.30% | 1 | - | - |
| | | See Indianapolis also | | | | | | | |
| | Elkhart/Goshen | See South Bend | | | 9 | 103.72% | 0 | - | - |
| | Kokomo | Brookston | Amoco | P, S2 | 5 | 100.27% | 1 | 1 x 2M | - |
| | | See Indianapolis also | | | | | | | |
| | Lafayette | See Kokomo | | | 9 | 103.27% | 0 | - | - |
| | | See Indianapolis | | | | | | | |
| | Muncie | Muncie | Equilon | P, S2 | 6 | 104.60% | 3 | 2 x 2M | - |
| | | | Marathon/Ashland | P, S2 | | | | | |
| | | Richmond | Marathon/Ashland | | | | | | |
| | | See Indianapolis also | | | | | | | |
| KS | Topeka | Wakarusa | Williams Pipeline | | 9 | 106.09% | 1 | - | 1 x 5M |
| | | See Kansas City MO | | | | | | | |
| | Wichita | Wichita | Coastal Derby | P, R | 28 | 102.72% | 7 | 3 x 5M | 3 x 3M |
| | | | Conoco | P | | | | | |
| | | | Williams Pipelime | P, S2 | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | Eldorado | Equilon | P, **(E)** | | | | | |
| | | Valley Center | Amoco | P, S2 | | | | | |
| | | Hutchinson | Kaneb Pipeline | | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| KY | Huntington/Ashland | Ashland | Ashland Pet (closed) | | 16 | 103.08% | 2 | 2 x 2M | 1 x 5M |
| | | | Ashland Pet (closed) | | | | | | |
| | | Catlettsburg | Marathon/Ashland | | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | Lexington | Lexington | Ashland Petroleum | P, S2 | 23 | 101.62% | 4 | 3 x 2M | 1 x 5M |
| | | | Chevron | P, S2 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | Louisville | Louisville | Ashland Petroleum | P, W, S3 | 50 | 100.07% | 12 | 5 x 3M | 5 x 5M |
| | | | BP | P, W, S2 | | | | | |
| | | | Chevron | P, W, S3 | | | | | |
| | | | Citgo | P, W, S3 | | | | | |
| | | | Marathon/Ashland | W, S2 | | | | | |
| | | | Marathon/Ashland | P, W, S3 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Sun | P, W, S2 | | | | | |
| | | | Transmontaigne | W, R, P, S2 | | | | | |
| | | Clarksville IN | Ashland Petroleum | W, S2, **(E)** | | | | | |
| | | New Albany IN | Transmontaigne | W, S2, **(E)** | | | | | |
| MI | Detroit/Ann Arbor/Flint | Detroit | Equilon | P, S3 | 270 | 99.37% | 17 | 10 x 3M | 5 x 20M |
| | | | Marathon/Ashland | | | | | | |
| | | | Sun | P, S2 | | | | | |
| | | River Rouge | Amoco | P, W, S3 | | | | | |
| | | Taylor | Amoco | P, S2 | | | | | |
| | | | Ashland Petroleum | P, S2, **(E)** | | | | | |
| | | | BP | P, S3 | | | | | |
| | | | Clark | P, S3 | | | | | |
| | | | Clark | P, S3 | | | | | |
| | | | Cousins Petroleum | P, S2, **(E)** | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | Woodhaven | Mobil | P, W, S3 | | | | | |
| | | Romulus | Citgo | P, S3 | | | | | |
| | | | Equilon | P | | | | | |
| | | | Total | P | | | | | |
| | | Flint | Mobil | P, S2 | | | | | |
| | | Mt. Morris | Marathon/Ashland | P, S2 | | | | | |
| | Grand Rapids/Musk/Holland | North Muskegon | Marathon/Asland | P, S3 | 53 | 101.41% | 3 | 2 x 2M | 1 x 5M |
| | | Ferrysburg | Citgo | P, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Equilon | P, S3 | | | | | |
| | Kalamazoo/Batttle Creek | Marshall | Clark | P, S3 | 23 | 103.54% | 1 | 1 x 5M | - |
| | | See Grand Rapids also | | | | | | | |
| | | See Jackson | | | | | | | |
| | Lansing/East Lansing | Lansing | Total | P | 23 | 102.71% | 1 | 1 x 5M | - |
| | | See Jackson also | | | | | | | |
| | Saginaw/Bay City/Midland | Bay City | Total | P, W | 20 | 100.46% | 3 | 1 x 2M | 1 x 5M |
| | | | UNO-VEN | P, S3, **(E)** | | | | | |
| | | Owosso | Sun | P, S2 | | | | | |
| | Benton Harbor/St. Joseph | See South Bend IN | | | 8 | 100.83% | 0 | - | - |
| | Jackson | Napoleon | Amoco | P | 8 | 102.40% | 4 | 2 x 2M | 2 x 3M |
| | | Jackson | Citgo | P, S2 | | | | | |
| | | | Equilon | P, S2 | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| MN | Minneapolis/St. Paul | Roseville | Amoco | | 143 | 100.23% | 5 | | |
| | | St. Paul | Koch | S3 | | | | | |
| | | | Williams Pipeline | P, R, **(E)** | | | | | |
| | | St. Paul Park | Ashland | P | | | | | |
| | | Pine Bend | Koch | S1 | | | | | |
| | Duluth/Superior | Proctor | Murphy Oil | P, S2 | 12 | 102.18% | 5 | | |
| | | Esko | Murphy Oil | P, S2 | | | | | |
| | | Renshaw | Conoco | P, S3, **(E)** | | | | | |
| | | Superior WI | Amoco | P | | | | | |
| | | | Murphy Oil | P | | | | | |
| | Rochester | Winona | ST Services | P, W, S2 | 6 | 101.43% | 2 | | |
| | | Eyota | Williams Pipeline | P, S2 | | | | | |
| | St. Cloud | Sauk Center | Amoco | P | 9 | 109.86% | 1 | | |
| | | See Minneapolis/St. Paul | | | | | | | |
| MO | St. Louis | St. Louis | Clark | P, W, R, S3, **(E)** | 128 | 100.30% | 12 | 1 x 15M | 3 x 20M |
| | | | Clark | P, W, S3, **(E)** | | | | 3 x 3M | |
| | | | Equilon | P, S1 | | | | | |
| | | | JD Street | P, W, S3, **(E)** | | | | | |
| | | St. Peter | Williams Pipeline | P, S1 | | | | | |
| | | Wood River IL | Amoco | P | | | | | |
| | | Hartford IL | Center Terminal Co. | W, P, S2 | | | | | |
| | | | Clark | W, P, S3, **(E)** | | | | | |

NOTE: All Minnesota terminals have ethanol capability

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clark | W, P, S3, **(E)** | | | | | |
| | | | Conoco | P, S3 | | | | | |
| | | | Hartf.Wood River Ter | P, W, S3 | | | | | |
| | | Cohokia IL | Phillips | P, R, S3 | | | | | |
| | Kansas City MO/KS | Kansas City KS | Phillips | | 88 | 100.89% | 6 | 2 x20M | 1 x 10M |
| | | | Sinclair Pipweline | | | | | 2 x 5M | |
| | | | Williams PL | R, P, S3, **(E)** | | | | | |
| | | Riverside MO | Williams PL | | | | | | |
| | | | Conoco | | | | | | |
| | | Sugars Creek MO | Amoco | | | | | | |
| | Springfield | Mt. Vernon | Conoco | P, S3 | 15 | 97.93% | 2 | 1 x 1M | 1 x 5M |
| | | Brookline Station | Williams Pipeline | P, S2 | | | | | |
| | Columbia | Columbia | Williams Pipeline | P, S3 | 7 | 108.24% | 3 | 2 x 2M | 1 x 2M |
| | | Mexico | Sinclair Pipeline | P, S2 | | | | | |
| | | Jefferson City | Phillips | P, S2 | | | | | |
| | Joplin | Jasper | Williams Pipeline | P, S3 | 8 | 107.37% | 1 | 1 x 2M | - |
| | | See Springfield also | | | | | | | |
| ND | Fargo/Moorehead | Fargo | Williams Pipeline | P, R, S3, **(E)** | 9 | 109.49% | 2 | 1 x 2M | - |
| | | Moorehead MN | Amoco | P | | | | | |
| NE | Omaha | Omaha | Williams Pipeline | P, S3. **(E)** | 35 | 108.12% | 3 | 2 x 3M | 1 x 10M |
| | | Council Bluffs IA | Amoco | P | | | | | |
| | | | National Coop | S3 | | | | | |
| | Lincoln | Roca | Conoco | P, S2, **(E)** | 12 | 101.64% | 2 | 1 x 1M | 1 x 5M |
| | | | Williams Pipeline | P, S2 | | | | | |
| | | See Omaha also | | | | | | | |
| OH | Canton/Massillon | Canton | Ashland Petroleum | P | 20 | 100.04% | 6 | 3 x 3M | 3 x 5M |
| | | | BP | P, S2 | | | | | |
| | | East Canton | Marathon/Ashland | | | | | | |
| | | Akron | Sun R & M | P, S2 | | | | | |
| | | Mogadore | Equilon | P, S2 | | | | | |
| | | Talmadge | UNO-VEN | P, S2 | | | | | |
| | Cincinnati/Hamilton | North Bend | Marathon/Ashland | | 97 | 99.57% | 11 | 1 x 15M | 1 x 20M |
| | | Cincinnati | Ashland Petroleum | R, W, S3 | | | | 4 x 2M | |
| | | | Boswell Oil | P, R, W, S2 | | | | 5 x 5 M | |
| | | | BP | P, S2 | | | | | |
| | | | Marathon/Ashland | | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | Bromley KY | BP | W, P, S3 | | | | | |
| | Covington KY | Ashland Petroleum | W, S3 | | | | | |
| | | Marathon/Ashland | | | | | | |
| | | Transmontaigne | P, W, S2 | | | | | |
| | Lebanon | Marathon/Ashland | P, S3 | | | | | |
| | | TEPPCO | P, S3 | | | | | |
| Cleveland/Akron | Cleveland | BP | P, S2 | 150 | 103.74% | 9 | 2 x 5M | 3 x 25M |
| | | Equilon | P, S2 | | | | | |
| | | Sun R & M | P, S2 | | | | | |
| | | UNO-VEN | P, S2, **(E)** | | | | | |
| | Brecksville | Clark | P, S2, **(E)** | | | | | |
| | | Clark Refining | P, S2, **(E)** | | | | | |
| | | Marathon/Ashland | P, S3 | | | | | |
| | Aurora | Amoco | P, S2 | | | | | |
| | | Aurora Terminals | P, S2, **(E)** | | | | | |
| | See Canton also | | | | | | | |
| Columbus | Columbus | Ashland | P, S2, **(E)** | 74 | 100.01% | 7 | 1 x 5M | 2 x 25M |
| | | BP | P, S3 | | | | | |
| | | Clark | P, S2, **(E)** | | | | | |
| | | Marathon/Ashland | P, S3 | | | | | |
| | | Midwest Terminals | P, S2, **(E)** | | | | | |
| | | Sun R & M | P, S2 | | | | | |
| | Amlin | UNO-VEN | P, S2 | | | | | |
| Dayton/Springfield | Dayton | BP | P, S3 | 48 | 100.79% | 4 | 4 x 5M | - |
| | | Equilon | P, S2 | | | | | |
| | | Sun R & M | P, S2 | | | | | |
| | | UNO-VEN | P, S2 | | | | | |
| | See Cincinnati also | | | | | | | |
| Toledo | Toledo | BP | S2 | 31 | 102.47% | 6 | 3 x 3M | 2 x 5M |
| | | Clark | R, P, W, S2, **(E)** | | | | | |
| | | Sun R & M | S2 | | | | | |
| | | Transmontaigne | P, S3 | | | | | |
| | Oregon | Citgo | P, S3 | | | | | |
| | | Marathon/Ashland | P, S2 | | | | | |
| Youngstown/Warren | Youngstown | Marathon/Ashland | P, S2 | 30 | 102.49% | 3 | 2 x 5M | 1 x 5M |
| | | Sun R & M | P, S1 | | | | | |
| | Niles | BP | P, S2 | | | | | |
| Lima | Lima | BP | S1 | 8 | 104.53% | 3 | 2 x 2M | 1 x 2M |
| | | Equilon | P | | | | | |
| | | Marathon/Ashland | P, S3 | | | | | |
| Mansfield | See Columbus | | | 9 | 102.58% | 0 | - | - |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | See Akron | | | | | | | |
| | Steubenville/Weirton WV | Steubenville | Marathon/Asland | P, S2 | 7 | 105.72% | 5 | 2 x 1M | 1 x 3M |
| | | Wellsville | Marathon/Asland | | | | | | |
| | | East Liverpool | Transmontaigne | W, S2, **(E)** | | | | | |
| | | Newell WV | Quaker State | P, R, W, S3 | | | | | |
| | | Weirton WV | Pet Fuel & Term | W, S3, **(E)** | | | | | |
| OK | Oklahoma City | Oklahoma City | Conoco | P, S3 | 52 | 100.81% | 5 | 2 x 5M | 2 x 10M |
| | | | Williams Pipeline | P, S2 | | | | | 1 x 5M |
| | | | Williams Pipeline | P, S2 | | | | | |
| | | Dell City | Texaco R & M | P, S2 | | | | | |
| | | Shawnee | Sinclair | P, S2 | | | | | |
| | Tulsa | Catoosa | Frontier Terminals | R, W, S3 | 40 | 102.43% | 6 | 2 x 5M | 2 x 10M |
| | | | Southern MO Oil | P, W, S2, **(E)** | | | | | 1 x 5M |
| | | Tulsa | Frontier Terminals | | | | | | |
| | | | Sinclair Pipeline | P | | | | | |
| | | | Sun R & M | P | | | | | |
| | | | Williams Pipeline | P, S3 | | | | | |
| | Lawton | See Oklahoma City<br>See Wichita Falls TX (PADD III) | | | 6 | 113.28% | 0 | - | - |
| SD | Sioux Falls | Sioux Falls | Amoco | P | 9 | 110.15 | 3 | - | 2 x 3M |
| | | | Williams Pipeline | R, P, S3, **(E)** | | | | | |
| | | Rock Rapids IA | Kaneb Pipeline | | | | | | |
| TN | Chattanooga | Chattanooga | Amoco | P, S2 | 23 | 102.42% | 7 | 3 x 5M | 4 x 2M |
| | | | BP | P, S2 | | | | | |
| | | | Chevron | P, S2 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Louis Dreyfus | P, S2 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Southern Facilities | P, S2 | | | | | |
| | Johnson Cty/Kingt/Bristol | See Knoxville | | 23 | 100.05% | 0 | - | | - |
| | Knoxville | Knoxville | Amoco | P, S2 | 33 | 98.84% | 10 | 4 x 10M | 5 x 2M |
| | | | BP | P, S3 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Cummins Terminals | P, S3, **(E)** | | | | | |
| | | | Cummins Terminals | P, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Exxon | P, R | | | | | |
| | | | Louis Dreyfuss | P, S2 | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | | | Motiva | P | | | | | |
| | | | Southern Facilities | P, S2 | | | | | |
| | Memphis | Memphis | Exxon | W, | 55 | 100.19% | 7 | 5 x 5M | 2 x 10M |
| | | | Lion Oil | W, S2 | | | | | |
| | | | Mapco | P, S3 | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Pet. Fuel & Term. | W, S2 | | | | | |
| | | | Truman Arnold | R, W, S2 | | | | | |
| | | West Memphis AR | Truman Arnold | R, W, P, S3 | | | | | |
| | Nashville | Nashville | Amoco | R, S2 | 60 | 103.08% | 11 | 5 x 5M | 5 x 5M |
| | | | Ashland Petroleum | P, S2 | | | | | |
| | | | BP | R, P, S2 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Cumberland Term. | P, S2 | | | | | |
| | | | Exxon | P, W | | | | | |
| | | | Lion Oil | P | | | | | |
| | | | Marathon/Ashland | | | | | | |
| | | | Marathon/Ashland | P, S2 | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Southern Facilities | P, S2, **(E)** | | | | | |
| | Clarksville/Hopkinsville | See Nashville | | | 11 | 109.97% | 0 | - | - |
| | Jackson | See Memphis | | | 6 | 118.87% | 0 | - | - |
| WI | Appleton/Oshkosh/Neehah | See Green Bay | | | 18 | 104.09% | 0 | - | - |
| | Green Bay | Green Bay | Amoco | P, S3 | 11 | 102.25% | 8 | 4 x 2M | 4 x 2M |
| | | | Citgo | P, S3 | | | | | |
| | | | Clark | P, S3 | | | | | |
| | | | Marathon/Ashland | P, S3 | | | | | |
| | | | Mobil | P, S3 | | | | | |
| | | | US Oil | P, S2 | | | | | |
| | | | US Oil | P, S3 | | | | | |
| | | | US Oil | P, S2 | | | | | |
| | Madison | Madison | Transmontaigne | P, S2 | 22 | 103.34% | 8 | 3 x 3M | 3 x 3M |
| | | | US Oil | P, S3 | | | | | |
| | | McFarland | Cenex | P, S2, **(E)** | | | | | |
| | | | Center Terminal Co. | P, S2, **(E)** | | | | | |
| | | | Citgo | P, S2 | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | | Koch | P, S3 | | | | | |
| | | Mobil | P, S2 | | | | | |
| | | US Oil | P, S2 | | | | | |
| Milwaukee/Racine | Milwaukee | Amoco | P | 82 | 100.15% | 11 | | |
| | | Citgo | P, S3 | | | | | |
| | | Clark | P, S3, **(E)** | | | | | |
| | | Equilon | P | | | | | |
| | | Koch | P, S3 | | | | | |
| | | Marathon/Ashland | P, S3 | | | | | |
| | | PTW Inc. | R, P, W, S2 | | | | | |
| | | ST Services | W, S3 | | | | | |
| | | US Oil | P, S2 | | | | | |
| | | US Oil | P, S2 | | | | | |
| | | US Oil | P, S2 | | | | | |
| Eau Claire | Eau Claire | Marathon/Ashland | | 8 | 111.48% | 3 | 2 x 2M | - |
| | Chippawa Falls | Cenex | P, S3, **(E)** | | | | | |
| | | Transmontaigne | P, S2, **(E)** | | | | | |
| Janesville/Beloit | See Rockford IL | | | 8 | 106.56% | 0 | - | - |
| Lacrosse | See Rochester MN | | | 7 | 115.57% | 0 | - | - |
| Sheboygan | See Milwaukee | | | 6 | 100.17% | 0 | - | - |
| | See Appleton | | | | | | | |
| Wausau | Junction City | Koch | P, S3 | 7 | 114.02% | 2 | 1 x 3M | 1 x 3M |
| | Musinee | Williams | P, S2 | | | | | |

NOTE: Sufficient terminals for ethanol exist due to RFG program

**End Part 1 - terminals servicing major population centers (over 100,000 population)**
**Summary included at end of part 2**

## Table H-2B PADD II Terminal Analysis - Case C (part2) Ethanol Demand Outlying Areas - 0.571 bgy



Other Rural Areas

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| IA | Outlying Areas | Clearlake IA | Williams | P, R, S3, **(E)** | | | | | |
| | | Council Bluffs IA | Amoco | P, R, | | | | | |
| | | | National Cooperative | P | | | | | |
| | | Dubuque, IA | Amoco | P, R | | | | | |
| | | Williams | P, S1 | | | | | | |
| | | Duncombe IA | Williams | P, S2 | | | | | |
| | | Fort Madison IA | Sinclair | P, S2 | | | | | |
| | | LeMars IA | Kaneb | P | | | | | |
| | | Milford IA | Kaneb | P | | | | | |
| | | Williams | P. S2, **(E)** | | | | | | |
| | | Ottumwa IA | Amoco | P, W, **(E)** | | | | | |
| | | Riverdale IA | Citgo | P, S2 | | | | | |
| | | Rock Rapids IA | Kaneb | P | | | | | |
| IL | Outlying Areas | Amboy IL | Williams | P, S2, **(E)** | | | | | |
| | | Bartonville IL | Clark | W, S2, **(E)** | | | | | |
| | | Benton IL | Marathon/Ashland | | | | | | |
| | | Chillicothee | ST Services | P, R, S3 | | | | | |
| | | Effingham IL | Equilon | P, S1 | | | | | |
| | | Kankakee IL | Phillips | P, S2 | | | | | |
| | | Peru IL | ST Services | P, W. S2, **(E)** | | | | | |
| | | Petersburg IL | Williams | P, S2, **(E)** | | | | | |
| | | Rochelle IL | Amoco | P, R | | | | | |
| | | St. Elmo IL | Marathon/Ashland | | | | | | |
| IN | Outlying Areas | Mt. Vernon IN | CountryMark | W, S3 | | | | | |
| | | Marathon/Asland | P, W | | | | | | |
| | | Southwind Maritime | W, R | | | | | | |
| | | North Vernon IN | Marathon/Asland | | | | | | |
| | | Oakland City IN | TEPPCO | P, S2 | | | | | |
| KS | Outlying Areas | Delphos KS | Kaneb | P | | | | | |
| | | Olaf KS | Williams | P, S2 | | | | | |
| | | Celina KS | ST Services | P, S1, **(E)** | | | | | |
| | | Wathena KS | Williams | P, S1 | | | | | |
| KY | Outlying Areas | Kuttawa KY | Marathon/Ashland | | | | | | |
| | | Paducah | Marathon/Ashland | W, S2 | | | | | |
| | | | Transmontaigne | W, R. S2, **(E)** | | | | | |

**PADD II**
For outlying areas estimated requirements for additional tankage are based on the total number of terminals in the servicing areas. Collective estimated requirements for outlying areas in PADD II are:

2M - 4
3M - 22
5M - 12
10M - 12

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| MI | Outlying Areas | Traverse City MI | Total | R, W | | | | | |
| MN | Outlying Areas | Alexandria MN | Williams | R, P, S3, **(E)** | | | | | |
| | | Harden MN | Cenex | | | | | | |
| | | Mankato MN | Williams | P, R, S3, **(E)** | | | | | |
| | | Marshall MN | Williams | P, S2, **(E)** | | | | | |
| | | Moorehead MN | Amoco | P | | | | | |
| | | Spring Valley MN | Amoco | P, S2 | | | | | |
| MO | Outlying Areas | Belle MO | Conoco | P. S2 | | | | | |
| | | Cape Girardeau MO | Transmontaigne | W, S2 | | | | | |
| | | Carrollton MO | Sinclair | P, S3 **(E)** | | | | | |
| | | New Madrid MO | Sinclair | | | | | | |
| | | Elmira MO | Williams | P, S2 | | | | | |
| | | Riverside MO | Conoco | P, S3 | | | | | |
| | | Scott City | TEPPCO | P, S1 | | | | | |
| ND | Outlying Areas | Grand Forks ND | Williams | P, S3, **(E)** | | | | | |
| | | Jamestown ND | Amoco | P | | | | | |
| | | | Kaneb | P | | | | | |
| | | Minot ND | Cenex | P, S3, **(E)** | | | | | |
| NE | Outlying Areas | Columbus NE | Kaneb | P | | | | | |
| | | Doniphan NE | Williams | P, R, S3, **(E)** | | | | | |
| | | Geneva NE | Kaneb | P | | | | | |
| | | Norfolk NE | Kaneb | P | | | | | |
| | | North Platte NE | Kaneb | P | | | | | |
| | | Osceola NE | Kaneb | P | | | | | |
| | | Sidney NE | Conoco | P. S2, **(E)** | | | | | |
| | | Superior NE | Kaneb | P | | | | | |
| OH | Outlying Areas | Bryon OH | Transmontaigne | P, S2 | | | | | |
| | | Coshockton OH | TEPPCO | P, S1 | | | | | |
| | | Grafton OBH | BP | P, S2 | | | | | |
| | | Heath OH | Ashland | P, S3 | | | | | |
| | | Sciotoville OH | BP | W, S2 | | | | | |
| | | Taylor OH | Clark | P, S3 | | | | | |
| | | Tiffin OH | BP | P, S2 | | | | | |
| OK | Outlying Areas | Ardmore OK | Total | S2 | | | | | |
| | | Drumright OK | ST Services | P, S3 | | | | | |
| | | Enid OK | Williams | P, S3 | | | | | |
| | | Jenks OK | Conoco | P, S3 | | | | | |
| | | Laverne OK | Phillips | P, S1 | | | | | |
| | | Muskogee OK | Frontier Terminals | R, W, S3 | | | | | |
| | | Ponca City OK | Conoco | R, S2 | | | | | |
| | | Turpin OK | Diamond Shamrock | P, S1 | | | | | |
| SD | Outlying Areas | Aberdeen SD | Kaneb | P | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | Mitchell SD | Kaneb | P | | | | | |
| | | Rapid City SD | Kaneb | P | | | | | |
| | | Watertown SD | Williams | P, R, S2 | | | | | |
| | | Wolsey SD | Kaneb | P | | | | | |
| | | Yankton SD | Kaneb | P | | | | | |
| WI | Outlying Areas | Superior WI | Amoco | P | | | | | |
| | | | Murphy Oil | P | | | | | |
| | | Waupin WI | Koch | P, S2 | | | | | |

**PADD II Summary Case C**

| | |
|---|---|
| Total ethanol for blends | 3300 mmgy |
| Total ethanol for E-85 | 400 mmgy |

**PADD II Terminal Recap**

| | |
|---|---|
| Total # of operating terminals | 401 |
| Total # with water capability | 68 |
| Total # with rail capability | 38 |
| Total listing ethanol | 80 |
| Total S1 | 14 |
| Total S2 | 161 |
| Total S3 | 127 |

**Total Preliminary Estimated Tankage additions**

| Size | Added for Case B1 | Added for Case C |
|---|---|---|
| 1M | 4 | - |
| 2M | 36 | 25 |
| 3M | 36 | 36 |
| 5M | 37 | 42 |
| 10M | 4 | 22 |
| 20M | -- | 9 |
| 25M | -- | 5 |
| 50M | -- | 1 |

# Table H-2C PADD III Terminal Analysis - Case C (part 1)

| | |
|---|---|
| W = water (ship, barge) | S1 = under 100 m barrels |
| R = rail | S2 = 100 m - 250 m barrels |
| P = pipeline | S3 = over 250 m barrels |
| E = ethanol | |

Ethanol imports ....... 0.7 billion gallons
Ethanol produced .... 1.1 billion gallons
Total ethanol used .. 1.8 billion gallons

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| AL | Birmingham | Birmingham | Allied Energy | P, S3, **(E)** | 50 | 102.89% | 11 | 3 x 5M | 2 x 10M |
| | | | Amoco | P | | | | | 2 x 5M |
| | | | Chevron | P, S2 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Crown | P, S2 | | | | | |
| | | | Louis Dreyfus | P, S3 | | | | | |
| | | | Marathon/Ashland | P, S2 | | | | | |
| | | | Motiva | P | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | | Southern Facilities | P, S2, **(E)** | | | | | |
| | Huntsville | See Birmingham | | | 15 | 82.25% | 0 | - | - |
| | | See Chatanooga TN | | | | | | | |
| | Mobile | Mobile | Amoco | W, S2 | 30 | 105.50% | 8 | 5 x 3M | 2 x 10M |
| | | | BP | W, S2 | | | | | |
| | | | BP | W, S2 | | | | | |
| | | | Coastal Fuels | W, S3 | | | | | |
| | | | Coastal Mobil Ref | R, W, S3 | | | | | |
| | | | EOTT Energy | P, W, S3 | | | | | |
| | | | Port of Mobile | W, R | | | | | |
| | | | Shell | W, P, S2, **(E)** | | | | | |
| | | See Pasagoula MS | | | | | | | |
| | Montgomery | Montgomery | Amoco | P | 15 | 87.60% | 7 | 3 x 3M | 3 x 3M |
| | | | BP | P, S2 | | | | | |
| | | | Chevron | P, S2 | | | | | |
| | | | Louis Dreyfus | P, S2 | | | | | |
| | | | Marathon/Ashland | P, S2 | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Southern Facilities<br>ST Services | P, S2, **(E)**<br>P, S2 | | | | | |
| | Anniston | Anniston<br>See Birmingham | Murphy Oil | P, S2 | 6 | 96.95% | 1 | 1 x 1M | - |
| | Auburn/Opelika | See Columbus GA<br>See Montgomery | | | 5 | 92.16% | 0 | - | - |
| | Decatur | See Birmingham<br>See Chattanooga TN | | | 7 | 91.88% | 0 | - | - |
| | Dothan | Columbia<br>See Panama City FL | Stratus Petroleum | W, S2 | 7 | 97.47% | 1 | 1 x 2M | - |
| | Florence | Sheffield<br>See Birmingham | Murphy Oil | W, S2 | 7 | 96.30% | 1 | 1 x 2M | - |
| | Gadsden | See Birmingham | | | 5 | 91.00% | 0 | - | - |
| | Tuscaloosa | See Birmingham | | | 8 | 93.32% | 0 | - | - |
| AR | Fayttevill/Sprngdale | Rogers<br>See Fort Smith | Transmontaigne | P, S2 | 15 | 99.10% | 1 | 1 x 5M | - |
| | Little Rock/N Little Rck | North Little Rock | Exxon<br>LaGloria<br>Transmontaigne<br>Truman Arnold | P<br>P, S2<br>P, S3<br>P, R, S3, **(E)** | 30 | 101.5% | 4 | 2 x 5M | 1 x 10M |
| | Fort Smith | Fort Smith<br>See Fayetteville | Williams Pipeline | P, S2 | 10 | 96.30% | 1 | 1 x 5M | - |
| LA | Baton Rogue | Baton Rogue<br>Port Allen<br><br><br>Sunshine | Exxon<br>Int Terminals<br>Pet Fuel & Term<br>Placid Refining<br>Petro United | <br>R, W<br>R, W, S3<br>P, W<br>W, S3, **(E)** | 30 | 97.58% | 5 | 3 x 5M | 1 x 10M |
| | Lafayette | Lafayette<br>Opeloosa<br>Krotz Springs | Public Terminals<br>Chevron<br>Kinder Morgan | P, S2<br>P, S2 | 20 | 99.84% | 3 | 2 x 5M | 1 x 5M |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | New Orleans | Garyville | Marathon/Ashland | S2 | 70 | 100.97% | 12 | 2 x 20M | 5 x 5M |
| | | | Pet Fuels & Term | W, S3 | | | | 5 x 2 M | |
| | | Kenner | Motiva | P | | | | | |
| | | St. Rose | Int Mtx Tank Term | R, W, S3 | | | | | |
| | | Chalmette | Mobil | S2 | | | | | |
| | | Meraux | Murphy Oil | P, S2 | | | | | |
| | | Gretna | IMTT | | | | | | |
| | | | John W. Stone | | | | | | |
| | | Harvey | Delta Commodities | | | | | | |
| | | | IMTT | W, R, S3 | | | | | |
| | | Westwego | PakTank | R, W, S3 | | | | | |
| | | | ST Services | | | | | | |
| | Shreveport/Bossier City | Shreveport | Pennzoil | P, S2 | 20 | 99.72% | 4 | 2 x 5M | 2 x 5M |
| | | Waskom | Mobil | P, S2 | | | | | |
| | | | Mobil | P, S2 | | | | | |
| | | | Motiva | P, S2 | | | | | |
| | Alexandria | See Lafayette/Opaloosa | | 7 | 103.98% | 0 | - | - | |
| | Houma | See New Orleans | | | 10 | 96.77% | 0 | - | - |
| | Lake Charles | Lake Charles | Citgo | S2 | 9 | 94.10% | 2 | 1 x 2M | 1 x 2M |
| | | Westlake | Conoco | (E) | | | | | |
| | Monroe | Arcadia | Chevron | P, S3 | 8 | 102.71% | 2 | 1 x 3M | 1 x 5M |
| | | | Exxon | P | | | | | |
| MS | Biloxi/Gulfport/Pasc. | Biloxi | Munro Petroleum | W, S2 | 20 | 106.63% | 2 | 1 x 15M | 1 x 5M |
| | | Pascagoula | Chevron | | | | | | |
| | | See Mobile AL | | | | | | | |
| | Jackson | Jackson | Southland Oil | W | 20 | 87.05% | 3 | 1 x 15M | - |
| | | Vicksburg | Citgo | W, S2 | | | | 2 x 2M | |
| | | | Southland Oil | W, S3 | | | | | |
| | Hattiesburg | Purvis | Amerada Hess | P, W | 6 | 99.94% | 1 | 1 x 3M | - |
| NM | Albuquerque | Albuquerque | Chevron | | 45 | 94.42% | 4 | 4 x 10M | - |
| | | | Conoco | | | | | | |
| | | | Diamond Shamrock | | | | | | |
| | | | Phillips | | | | | | |
| | Las Cruces | See El Paso TX | | | 9 | 99.48% | 0 | - | - |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | Santa Fe | See Albuquerque | | | 7 | 92.50% | 0 | - | - |
| TX | Austin/San Marcos | Austin | Koch | P | 60 | 98.59% | 1 | 1 x 25M | 1 x 10M |
| | | See San Antonio | | | | | | | |
| | Beaumont/Port Arthur | Beaumont | Clark | P, S2 | 20 | 100.10% | 6 | 2 x 5M | 4 x 5M |
| | | | Mobil | P, S3 | | | | | |
| | | Vidor | TEPPCO | P, W | | | | | |
| | | Nederland | Unocal | | | | | | |
| | | Port Arthur | Fina | W. S3 | | | | | |
| | | | Motiva | P, W | | | | | |
| | Brownsville/Harlingen | Brownsville | Citgo | W, S2 | 15 | 85.82% | 5 | 3 x 5M | 2 x 3M |
| | | | Statia Terminals | R, W, S3 | | | | | |
| | | | Transmontaigne | W, S2 | | | | | |
| | | Harlingen | Diamond Shamrock | W, S2 | | | | | |
| | | McAllen | Coastal | P, S1 | | | | | |
| | Corpus Christi | Corpus Christi | Citgo | S1 | 20 | 97.29% | 6 | 3 x 5M | 3 x 3M |
| | | | Citgo | P, S3 | | | | | |
| | | | Corpus Refining | W, P, S1 | | | | | |
| | | | Diamond Shamrock | P, W, S3 | | | | | |
| | | | Koch | | | | | | |
| | | | Port of Corpus Christi | | | | | | |
| | Dallas/Fort Worth | Dallas | Mobil | P, S2 | 250 | 95.89% | 16 | 7 x 10M | 2 x 25M |
| | | | Motiva | P, S2 | | | | 3 x 25M | 4 x 10M |
| | | | Citgo | P, S3 | | | | | |
| | | Grapevine | Citgo | P, S3 | | | | | |
| | | | Conoco | P, S2 | | | | | |
| | | | Diamond Shamrock | P, S3 | | | | | |
| | | Irving | Exxon | P | | | | | |
| | | Euless | Koch | P | | | | | |
| | | | Phillips | P, S2 | | | | | |
| | | Aledo | Pride Refining | R, S2 | | | | | |
| | | Fort Worth | Chevron | P, S3 | | | | | |
| | | | Citgo | P, S2 | | | | | |
| | | | Mobil | P, S2 | | | | | |
| | | | Motiva | P, S3 | | | | | |
| | | | Total Petroleum | P | | | | | |
| | | South Lake | Fina | P, S3 | | | | | |
| | El Paso | El Paso | Chevron | S1 | 35 | 93.90% | 4 | 2 x 10M | 1 x 10M |
| | | | Diamond Shamrock | P, S3 | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | | Equilon | P | | | | | |
| | | Navajo | P, S2, **(E)** | | | | | |
| Houston/Galv/Brazoria | Houston | Citgo | P, S2 | 235 | 98.48% | 17 | 6 x 10M | 4 x 25M |
| | | Coastal | P, R, S1 | | | | 2 x 25M | 2 x 10M |
| | | Exxon | P | | | | | 2 x 5M |
| | | Exxon | P | | | | | |
| | | Lyondell-Citgo | | | | | | |
| | | Motiva | P, S2 | | | | | |
| | | Oil Tank Houston | P, W, R, S3 | | | | | |
| | | Valero | | | | | | |
| | Pasadena | GATX | P, W, S3 | | | | | |
| | Pasadena | Motiva | P | | | | | |
| | | Phillips | P, R, S3 | | | | | |
| | Texas City | Intercoastal Term | W, S2 | | | | | |
| | | ST Services | P, W, S3 | | | | | |
| | Seabrook | PetroUnited | R, P, W, S3, **(E)** | | | | | |
| | Galena Park | Chevn/Warren Pet | W, P, R. S3 | | | | | |
| | | Chevron | P, W, S3 | | | | | |
| | | GATX | R, P, W, S3 | | | | | |
| Killeen/Temple | See Austin | | | 15 | 95.33% | 0 | - | - |
| | See Dallas | | | | | | | |
| McAllen/Ednburg/Miss. | See Brownsville | | | 30 | 105.61% | 0 | - | - |
| San Antonio | San Antonio | Citgo | P, S2 | 85 | 102.28% | 7 | 3 x 15M | 4 x 5M |
| | | Coastal | P, S1 | | | | | |
| | | Diamond Shamrock | P, S2 | | | | | |
| | | Exxon | P | | | | | |
| | | Koch | P | | | | | |
| | | Motiva | P, S2 | | | | | |
| | Elmendorf | ST Services | P, S2 | | | | | |
| Abilene | See Dallas/Fort Worth | | 6 | 92.25% | 0 | - | - | |
| Amarillo | Amarillo | Diamond Shamrock | P, S2 | 11 | 99.26 | 4 | 2 x 3M | 2 x 3M |
| | | Phillips | P, S2 | | | | | |
| | Borger | Phillips | R | | | | | |
| | Sunray | Diamond Shamrock | S2 | | | | | |
| Bryan/College Station | Bryan | Citgo | P, S2 | 7 | 98.21% | 3 | 2 x 3M | 1 x 3M |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | Hearne | Mobil<br>Motiva | P, S2<br>P | | | | | |
| Larado | Larado<br>Falfurrias | Diamond Shamrock<br>Coastal | P, S2<br>P, S1 | 10 | 97.48% | 2 | 1 x 5M | 1 x 5M |
| Longview/Marshall | Mt. Pleasant<br>Big Sandy | Conoco<br>Chevron | P, S2<br>P, S2 | 11 | 98.88% | 2 | 1 x 5M | 1 x 10M |
| Lubbock | Lubbock<br>Abernathy | Phillips<br>Diamond Shamrock | P, S2<br>P, S2 | 12 | 99.16% | 2 | 1 x 5M | 1 x 5M |
| Midland/Odessa | Midland<br>Big Springs<br>Odessa | Chevron<br>Fina<br>Shell | P, S2<br>S3 | 13 | 101.60% | 3 | 2 x 3M | 1 x 5M |
| San Angelo | San Angelo<br>See Midland/Odessa | Pride Refining | S2 | 5 | 92.04 | 0 | - | 1 x 5M |
| Sherman/Dennison | Ardmore<br>See Dallas/Fort Worth | Total | | 5 | 90.77% | 1 | 1 x 2m | 1 x 3M |
| Texarkana TX/AR | See Longview/Marshall | | | 6 | 91.94% | 0 | - | - |
| Tyler | Tyler | LaGloria | W, S1, **(E)** | 9 | 99.87% | 1 | - | - |
| Waco | Waco | Citgo<br>Koch<br>Motiva | W, S1<br>P<br>P, S2 | 11 | 101.57% | 3 | | 1 x 5M<br>2 x 3M |
| Wichita Falls | Wichita Falls | Conoco<br>Fina | P, S2<br>P, S2 | 7 | 96.57% | 2 | 1 x 2M | 1 x 5M |

**End Part 1 - terminals servicing major population centers (over 100,000 population)**
**Summary included at end of part 2**

# Table H-2C PADD III Terminal Analysis - Case C (part 2) Ethanol Demand Outlying Areas - 0.431 bgy



| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| **Other Rural Areas** | | | | | | | | | |
| AL | Outlying Areas | Moundville Al | ST Services | P, S3 | | | | | |
| AR | | Arkansas City AR | Transmontaigne | P, W, S3, E | | | | | |
| | | Eldorado | Lion Oil | P | | | | | |
| | | | TEPPCO | P, S3 | | | | | |
| | | Helena AR | TEPPCO | P, W, S3 | | | | | |
| | | Pine Bluff AR | Pet Fuels & Termi | W, S2 | | | | | |
| LA | Outlying Areas | Avondale | Int. Matex | R, W, S3 | | | | | |
| | | Church Point | Canel Refining | W, S3, E | | | | | |
| | | Convent | Motiva | P | | | | | |
| MS | Outlying Areas | Collins MS | Chevron | P, S1 | | | | | |
| | | | Exxon | P | | | | | |
| | | | Louis Dreyfus | P, S2 | | | | | |
| | | | Motiva | P | | | | | |
| | | Greenville MS | Transmontaigne | W, R, S3 | | | | | |
| | | Meridian MS | Amoco | P, S1 | | | | | |
| | | | BP | P, S1 | | | | | |
| | | | Citgo | O, S2 | | | | | |
| | | | Louis Dreyfus | P, S2 | | | | | |
| | | | Motiva | P, S1 | | | | | |
| NM | Outlying Areas | Alamogordo NM | St Services | P, S2 | | | | | |
| | | Artesia NM | Navajo | | | | | | |
| | | Bloomfield NM | Bloomfield Refining | S1 | | | | | |
| | | Gallup NM | Giant Refining | S1 | | | | | |
| | | Tucumcari NM | Diamond Shamrock | P, S2 | | | | | |
| TX | Outlying Areas | Abilene TX | Fina Oil | P, S2 | | | | | |
| | | | Pride Refining | S1 | | | | | |
| | | Aransas Pass TX | Aransas Warehouse | W, S2 | | | | | |
| | | Cato Mills TX | Transmontaigne | P, R, S3 | | | | | |
| | | Placido TX | Coastal | P, S1 | | | | | |
| | | Sweeney TX | Phillips | R | | | | | |
| | | Three Rivers TX | Diamond Shamrock | S2 | | | | | |
| | | Victoria TX | Citgo | P, S1 | | | | | |

**PADD III**
For outlying areas estimated requirements for additional tankage are based on the total number of terminals in the servicing areas. Collective estimated requirements for outlying areas in PADD III are:

2M - 7
5M - 10
10M - 15

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|

**PADD III Summary - Case C**

| | |
|---|---|
| Total ethanol for blends | 1800 mmgy |
| Total ethanol for E-85 | 0 mmgy |

**PADD III Terminal Recap**

| | |
|---|---|
| Total # of operating Terminals | 191 |
| Total # with water capability | 49 |
| Total # with rail capability | 21 |
| Total listing ethanol | 12 |
| Total S1 | 18 |
| Total S2 | 78 |
| Total S3 | 44 |

**Total Preliminary Estimated Tankage additions**

| Size | Added for Case B1 | Added for Case C |
|---|---|---|
| 1M | 1 | - |
| 2M | 12 | 8 |
| 3M | 16 | 14 |
| 5M | 25 | 38 |
| 10M | 19 | 30 |
| 15M | 5 | - |
| 20M | 2 | - |
| 25M | 6 | 6 |
| 50M | -- | - |

# Table H-2D PADD IV Terminal Analysis - Case C (part 1)

Ethanol imports ....... 0.0 billion gallons
Ethanol produced .... 0.4 billion gallons
Total ethanol used .. 0.4 billion gallons

| | |
|---|---|
| W = water (ship, barge) | S1 = under 100 m barrels |
| R = rail | S2 = 100 m - 250 m barrels |
| P = pipeline | S3 = over 250 m barrels |
| E = ethanol | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| CO | Colorado Springs | Colorado Springs | Diamond Shamrock | P, S3 | 26 | 103.63% | 1 | 1 x 10M | |
| | | See Denver | | | | | | | |
| | Denver/Boulder/Greeley | Aurora | Chase Pipeline | P, S3, **(E)** | 122 | 100.55% | 8 | 4 x 10M | 2 x 10M |
| | | Commerce City | Colorado Refining | R, S2 | | | | | |
| | | | Colorado Refining | R, P, S1 | | | | | |
| | | | Conoco | | | | | | |
| | | | Diamond Shamrock | P. S2 | | | | | |
| | | | Phillips | P, S3 | | | | | |
| | | Henderson | Sinclair Pipeline | P, S3, **(E)** | | | | | |
| | | Dupont | Kaneb Pipeline | P | | | | | |
| | Fort Collins | See Denver | | | 12 | 100.96% | 0 | | |
| | Grand Junction | Grand Junction | Conoco | R, S1 | 6 | 103.84% | 2 | | 1 x 5M |
| | | | Total | R | | | | | 1 x 2M |
| | Pueblo | LaJunta | Diamond Shamrock | P, S2 | 7 | 101.83% | 1 | | 1 x 5M |
| | | See Colorado Springs | | | | | | | |
| ID | Boise | Boise | Amoco | P, S3 | 21 | 102.61% | 4 | 2 x 5M | 2 x 5M |
| | | | Flying J | P, S2 | | | | | |
| | | | Northwest Term | P, S3 | | | | | |
| | | | Northwest Term | P, W, S3 | | | | | |
| | | | Sinclair (closed) | | | | | | |

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| MT | Billings | Billings | Conoco | | 7 | 109.62% | 5 | | 1 x 3M |
| | | | Exxon | | | | | | 3 x 2M |
| | | Laurel | Cenex | P, S3 | | | | | |
| | | | Cenex | P, (E) | | | | | |
| | | | Cenex | P, S3 | | | | | |
| UT | Provo/Orem | See Salt Lake City | | | 16 | 91.89% | 0 | - | |
| | Salt Lake City/Ogde | Salt Lake City | Amoco | S1 | 64 | 100.6025% | 6 | 2 x 10M | 4 x 10M |
| | | | Chevron | S1 | | | | | |
| | | North Salt Lake | Conoco | P, S3 | | | | | |
| | | | Flying J | P, R, S3 | | | | | |
| | | Woodcross | Inland Refining | P, R, S1 | | | | | |
| | | | Phillips | | | | | | |

**End Part 1 - terminals servicing major population centers (over 100,000 population)**
**Summary included at end of Part 2**

## Table H-2D PADD IV Terminal Analysis - Case C (part 2) Ethanol Demand Outlying Areas - 0.119 bgy

### Other Rural Areas

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| ID | Outlying Areas | Burley ID | Amoco | P | | | | | |
| | | | Sinclair | P | | | | | |
| | | Pocatello ID | Northwest Terminaling | P, S2 | | | | | |
| MT | Outlying Areas | Bozeman ID | Conoco | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| | | Glendive MT | Cenex | P, S2. (E) | | | | | |
| | | Great Falls MT | Conoco | P, S2 | | | | | |
| | | | Montana Refining | R, S2 | | | | | |
| | | Helena MT | Conoco | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| | | Missoula MT | Conoco | P, S2 | | | | | |
| | | | Exxon | P | | | | | |
| UT | Outlying Areas | Roosevelt UT | Gary-Williams | S2 | | | | | |

**PADD IV**
For outlying areas estimated requirements for additional tankage are based on the total number of terminals in the servicing areas. Collective estimated requirements for outlying areas in PADD IV are:

3M - 3
5M - 8
10M - 2

**PADD IV Summary - Case C**

Total ethanol for blends 400 mmgy
Total ethanol for E-85

**PADD IV Terminal Recap**

| | |
|---|---|
| Total # of operating terminals | 40 |
| Total # with water capability | 1 |
| Total # with rail capability | 6 |
| Total listing ethanol | 4 |
| Total S1 | 5 |
| Total S2 | 12 |
| Total S3 | 11 |

**Total Preliminary Estimated Tankage additions**

| Size | Added for Case B1 | Added for Case C2 |
|---|---|---|
| 2M | -- | 4 |
| 3M | -- | 4 |
| 5M | 2 | 12 |
| 10M | 7 | 8 |
| 20M | -- | - |
| 25M | -- | - |
| 50M | -- | - |

# Table H-2E PADD V Terminal Analysis - Case C (part1)

Ethanol imports ....... 0.9 billion gallons
Ethanol produced .... 0.5 billion gallons
Total ethanol used .. 1.4 billion gallons

W = water (ship, barge)
R = rail
P = pipeline
E = ethanol

S1 = under 100 m barrels
S2 = 100 m - 250 m barrels
S3 = over 250 m barrels

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| AK | Achorage | Anchorage | Chevron<br>Equilon<br>Mapco<br>Port of Anchorage | P, R, W, S3<br>W, S3<br>P, R, W, S3<br>P, R, W, S3 | 10 | 88.74% | 4 | Sufficient Tankage in place | |
| AZ | Phoenix | Phoenix | Arco<br>Cal Jet<br>Chevron<br>Equilon<br>Kinder Morgan<br>Tosco | S2<br>P, S2, **(E)**<br>P, S2<br>P, S3<br>P, S3<br>P, S2, **(E)** | 90 | 68.32% | 6 | | 4 x 20M |
| | Tucson | Tucson | Chevron<br>Equilon<br>Kinder Morgan<br>St Services | P, S2<br>P, S1<br>P, S3<br>P, S2 | 25 | 71.17% | 4 | | 1 x 10M<br>3 x 5M |
| | Flagstaff | See Phoenix | | | 5 | 94.81% | 0 | | - |
| | Yuma | See San Diego (Imperial) | | | 5 | 84.35% | 0 | | - |
| CA | Bakersfield | Bakersfield | Coast Gas<br>Equilon<br>Gibson Env<br>Kern Oil | R, S1<br>P, S1<br>S1<br>S1 | 16 | 56.98% | 4 | 2 x 5M | 2 x 3M |
| | Chico/Paradise | Chico | Kinder Morgan | P, S3 | 5 | 58.60% | 1 | | |
| | Fresno | Fresno | Kinder Morgan | P, S3 | 22 | 57.21% | 1 | 1 x 20M | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| LA/Riverside/Orange Cty | Torrance | Mobil | P, R, S2 | 420 | 59.92% | 36 | | |
| | Terminal Island | GP Resources | W | | | | | |
| | Wilmington | Equilon | R, P, S1 | | | | | |
| | | GATX | P, W, S3 | | | | | |
| | | PAC Tank | P, W, R, S3 | | | | NOTE: All LA area terminals will undergo ethanol conversion before 2003 | |
| | | Wickland | P, W, S3 | | | | | |
| | Bloomington | Arco | P, S2 | | | | | |
| | | Equilon | P, S2 | | | | | |
| | | Kinder Morgan | P, S3 | | | | | |
| | | Tosco | P, S2 | | | | | |
| | Signal Hill | Arco | P, S3 | | | | | |
| | Long Beach | Arco | P, S3 | | | | | |
| | | Arco | P. W, S3 | | | | | |
| | | Equilon | P, S1 | | | | | |
| | | GATX | W, P | | | | | |
| | | Petro Diamond | P, W, R, S3 | | | | | |
| | | Ultramar | P, S1 | | | | | |
| | Ventura | Equilon | P, S1 | | | | | |
| | Van Nuys | Chevron | P, S1 | | | | | |
| | | Equilon | P, S1 | | | | | |
| | Los Angeles | Equilon | P | | | | | |
| | | Kinder Morgan | ? | | | | | |
| | | Mobil | P, S2 | | | | | |
| | | Mobil | P, S1 | | | | | |
| | | Tosco | P, S1 | | | | | |
| | | Tosco | P, S1 | | | | | |
| | Southgate | Arco | P, S3 | | | | | |
| | Montebello | Chevron | P, S2 | | | | | |
| | Santa Fe Springs | Powerine Oil | P, S1 | | | | | |
| | | Tosco | | | | | | |
| | San Bernadino | CAL-NEV | P, S2 | | | | | |
| | Rialto | Tosco | P, S1 | | | | | |
| | Orange | Kinder Morgan | P, S2 | | | | | |
| | Carson | Arco | P, S1 | | | | | |
| | | Equilon | P, W, S3 | | | | | |
| | Huntington Beach | Chevron | P, S1 | | | | | |
| Merced | See San Francisco | | | 5 | 56.98% | 0 | | - |
| Modesto | See Stockton | | | 11 | 57.62% | 0 | - | - |
| Redding | Eureka | Chevron | W, S2 | 4 | 55.62% | 1 | | 1 x 5M |
| | See Chico | | | | | | | |
| Sacramento | West Sacramento | Arco | P, S2 | 46 | 60.45% | 6 | NOTE: All area terminals will undergo ethanol conversion before 2003 | |
| | | Equilon | P | | | | | |
| | | Tesoro | P, S2 | | | | | |
| | Sacramento | Chevron | P, S2 | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | | Tosco | P, S2 | | | | | |
| | Rancho Cordova | Kinder Morgan | P, S3 | | | | | |
| Salinas | See Los Angeles | | | 10 | 61.54% | 0 | | - |
| San Diego | San Diego | Arco | P, S2 | 75 | 60.83% | 8 | | |
| | | Chevron | P, S2 | | | | | |
| | | Equilon | P, S2 | | | | | |
| | | Equilon | P, S2 | | | | | |
| | | Kinder Morgan | P, S3 | | | | | |
| | Imperial | Kinder Morgan | P, S3 | | | | | |
| | | ST Services | P, S2 | | | | | |
| | Nyland | Kinder Morgan | P, S1 | | | | | |
| San Francisco/Oakland | Benicia | Exxon | | 175 | 58.26% | 19 | 8 x 20M | 3 x 10M |
| | Crocket | Wickland | P, R, W, S3 | | | | | |
| | Brisbane | Kinder Morgan | P, S3 | | | | | |
| | South San Francisco | Equilon | P | | | | | |
| | Redwood City | Gibson Env | W | | | | | |
| | San Jose | Equilon | P | | | | | |
| | | Chevron | P, S2 | | | | | |
| | Milipitas | Kinder Morgan | P, S3 | | | | | |
| | Richmond | Arco | P, R, W, S3 | | | | | |
| | | Chevron | P, W, S3 | | | | | |
| | | GATX | W, R, S3 | | | | | |
| | | Texaco | R, W, S3 | | | | | |
| | | Time Oil | P, W, R, S3, **(E)** | | | | | |
| | | Tosco | P, R, W, S3 | | | | | |
| | Pittsburg | Diablo Services | W, S2 | | | | | |
| | Martinez | Chevron | P, S2 | | | | | |
| | | Equilon | P, W | | | | | |
| | | Tosco | P, R, W, S2, **(E)** | | | | | |
| | | Wickland | P, W, S3 | | | | | |
| Sta Barb/S Maria/Lompoc | See Los Angeles | | 10 | 58.50% | 0 | | - | |
| Sn Luis O/Atascadero/P R | See Los Angeles | | 6 | 57.93% | 0 | | - | |
| Stockton/Lodi | Stockton | Arco | P, S1 | 15 | 60.94% | 7 | 3 x 5M | - |
| | | Equilon | P | | | | | |
| | | Kinder Morgan | P, S2 | | | | | |
| | | ST Services | P, S3, **(E)** | | | | | |
| | | Tesoro | P, S3 | | | | | |

NOTE: All San Diego area terminals will undergo ethanol conversion before 2003

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| | | | Tosco | P, S1 | | | | | |
| | | Tracy | Chevron | P, S2 | | | | | |
| | Visalia/Tulare/Pottersville | See Fresno | | | 10 | 63.82% | 0 | - | - |
| | Yuba City | See Sacramento | | | 4 | 66.30% | 0 | | - |
| HI | Honolulu | Honolulu | Aloha Petroleum | W | 25 | 66.16% | 7 | | 2 x 10M |
| | | | Chevron | W, S3 | | | | | 2 x 5M |
| | | | Equilon | W | | | | | |
| | | | Equilon | | | | | | |
| | | | Honolulu Port | W | | | | | |
| | | | Shell | W | | | | | |
| | | | Tosco | W, S3 | | | | | |
| NV | Las Vegas | Las Vegas | CAL-NEV Pipeline | P, S3 | 60 | 99.40% | 2 | | 2 x 25M |
| | | North Las Vegas | Texaco | P, S1 | | | | | |
| | Reno | Sparks | Equilon | P | 14 | 100.15% | 3 | | 2 x 5M |
| | | | Kinder Morgan | P, S3 | | | | | |
| | | | Time Oil | P, S2, **(E)** | | | | | |
| OR | Eugene | Eugene | Kinder Morgan | P, S3 | 13 | 94.45% | 1 | | 1 x 10M |
| | Portland | Portland | Arco | P, W, S3 | 95 | 99.66% | 8 | | 4 x 10M |
| | | | Chevron | P, W, S3 | | | | | |
| | | | Equilon | P, W, S3, **(E)** | | | | | |
| | | | GATX | P, W, R, S3, **(E)** | | | | | |
| | | | GATX | P, W, R, S3 | | | | | |
| | | | Time Oil | R, W, S3, **(E)** | | | | | |
| | | | Time Oil | P, W, S3 | | | | | |
| | | | Tosco | P, W, R, S3, **(E)** | | | | | |
| | Medford/Ashland | North Bend | Newport Petroleum | W, S1 | 7 | 91.09% | 1 | | 1 x 5M |
| WA | Seattle/Tacoma/Bremerton | Richmond Beach | Chevron (closed) | | 120 | 79.22% | 10 | | 2 x 25M |
| | | Seattle | Arco | P, W, **(E)** | | | | | 2 x 5M |
| | | | Crowley Marine | W, S2 | | | | | |
| | | | Equilon | P, W, S3 | | | | | |
| | | | GATX | P, W, S3 | | | | | |
| | | | Time Oil | W, S2, **(E)** | | | | | |

| City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | Blend % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|
| | Renton | Tosco | P, S2 | | | | | |
| | Tacoma | Time Oil | P, R, W, S3, **(E)** | | | | | |
| | | Tosco | P, W, S3, **(E)** | | | | | |
| | | US Oil & Refining | S1 | | | | | |
| | Tumwater | Equilon | P, S1 | | | | | |
| Spokane | Spokane | Conoco | P, S3 | 15 | 83.76% | 3 | | 2 x 5M |
| | | Exxon | P | | | | | |
| | | Tosco | P, R, S3, **(E)** | | | | | |
| Richland/Kernwick/Pasco | Pasco | Northwest Terminaling | P, W, S3 | 7 | 86.74% | 2 | | 2 x 3M |
| | | Tidewater Terminal | P, W, S3 | | | | | |
| Yakima | Moses Lake | Conoco | P, S2 | 8 | 82.90% | 1 | | 1 x 10M |
| | See Richland | | | | | | | |

**End Part 1 - terminals servicing major population centers (over 100,000 population)**
**Summary included at end of part 2**

## Table 5-5E PADD V Terminal Analysis - Case C (part 2) Ethanol Demand Outlying Areas - 0.067 bgy

| | City/MSA | Servicing Terminal | Company | Category | Ethanol Demand mmgy | % of market | # of Term. | Additional Tankage Required Case B-1 | Additional Tankage Required Case C |
|---|---|---|---|---|---|---|---|---|---|
| **Other Rural Areas** | | | | | | | | | |
| OR | Outlying Areas | Millersburg OR | Kinder Morgan | P, S1 | | | | | |
| | | Umatilla OR | Tidewater Terminals | R, W, S2 | | | | | |
| WA | Outlying Areas | Anacortes WA | Texaco | | | | | | |
| | | Ferndale WA | Tosco | | | | | | |
| | | North Clarkston WA | Tidewater Terminals | | | | | | |
| | | Vancouver WA | Cenex | R, W, S2 | | | | | |
| | | | GATX | R, W, S1 | | | | | |
| | | | Tesoro | P, W, S3 | | | | | |

**PADD V**
For outlying areas estimated requirements for additional tankage are based on the total number of terminals in the servicing areas. Collective estimated requirements for outlying areas in PADD V are:

5M - 4
10M - 3

**PADD V Summary - Case C**

| | |
|---|---|
| Total ethanol for blends | 1400 mmgy |
| Total ethanol for E-85 | 0 mmgy |

**PADD V Terminal Recap**

| | |
|---|---|
| Total # of operating terminals | 143 |
| Total # with water capability | 53 |
| Total # with rail capability | 23 |
| Total listing ethanol | 15 |
| Total S1 | 27 |
| Total S2 | 37 |
| Total S3 | 56 |

**Total Preliminary Estimated Tankage additions**

| Size | Added for Case B1 | Added for Case C2 |
|---|---|---|
| 2M | -- | - |
| 3M | -- | 4 |
| 5M | 5 | 17 |
| 10M | -- | 15 |
| 20M | 9 | 4 |
| 25M | -- | 4 |
| 50M | -- | - |

# Appendix I
# Glossary of Commonly Used Terms and Acronyms

## GLOSSARY

In the course of preparing this report, a number of acronyms and common industry terms have been used. For the convenience of the reader some of the frequently used terms are listed here along with a brief description when deemed necessary.

### Acronyms

AAR: (Association of American Railroads) The national trade association of the Class I railroads.

API: (American Petroleum Institute) The major national trade association for the petroleum industry representing companies with interests in exploration, production, transportation, refining, and marketing petroleum products.

BATF: U.S. Bureau of Alcohol, Tobacco & Firearms

bd or BD: (Barrels per day)

bcd or BCD: (Barrels per calendar day)

BDT: (Bone Dry Ton) In this study used to reference 2000 pounds of dried biomass feedstock for ethanol production.

bgy or BGY: (Billion gallons per year)

bsd or BSD: (Barrels per stream day)

CAFE: (Corporate Average Fuel Economy) The average fuel economy of an auto manufacturer's vehicles sold in the U.S. for compliance with federal fuel economy standards.

CARB: (California Air Resources Board) A division of the California Environmental Protection Agency charged with addressing air quality issues in California.

CARBOB: (California Reformulated Blendstock for Oxygenate Blending). A base fuel made such that when the designated oxygenate is added in the specified volume it will meet the requirements of California's reformulated gasoline program.

CBG: (Cleaner Burning Gasoline) The term California has chosen to identify their reformulated gasoline.

CO: Carbon Monoxide.

CG: (Conventional gasoline) Gasoline sold in the U.S. which is not subject to the reformulated gasoline program requirements.

DDGS: (Distillers Dried Grains and Solubles) A coproduct of ethanol production when corn is the feedstock. DDGS typically has a 27% protein content and is used in animal feed rations.

DI: (Driveability Index) See discussion on page 2-10.

DOE: (U.S. Department of Energy)

DOT: (U.S. Department of Transportation)

DSP: (Distilled Spirits Plant) By definition of the Bureau of Tobacco Alcohol and Firearms, an ethanol plant that when properly permitted can ship and receive undenatured ethanol without incurring beverage tax. Such shipments are referred to as being shipped "in bond" and must ultimately be denatured and used for non-beverage use to avoid the beverage alcohol tax.

DWT: (Dead Weight Ton) The weight of a vessel without load. In this study typically used to categorize size of ocean going vessels.

E-10: Commonly used term to describe gasoline containing 10 v% ethanol.

E-5.7: Commonly used term to describe gasoline containing 5.7 v% ethanol.

E-7.7: Commonly used term to describe gasoline containing 7.7 v% ethanol.

E-85: Commonly used term to describe ethanol gasoline blends containing 75 v%-85 v% denatured ethanol. This fuel is used in vehicles specifically designed to allow their use.

EPA: (U.S. Environmental Protection Agency)

EPACT: (1992 Energy Policy Act)

FFV: (Flexible Fueled Vehicle) A vehicle designed to operate on either of two fuels. In this report, a vehicle that can operate on fuel blends of up to 85 v% denatured ethanol, 100 % gasoline, or any combination of the two.

GHG: (Greenhouse Gas) Various gases that contribute to global warming. One of the primary greenhouse gases is carbon dioxide ($CO_2$). Other greenhouse gases include methane ($CH_4$) and nitrous oxide ($N_2O$).

GREET Model: (Greenhouse gases, regulatory emissions, and energy use in transportation) model. A computer model developed by Argonne National Laboratory used to estimate engine and fuel combinations to determine their energy and emissions impact on a "Well to Wheels" basis.

HC: (hydrocarbon)

kPa: (kilopascal) 6.9 kpa is equal to 1.0 psi. Both kPa and psi are used to report vapor pressure of fuels.

m: (thousands) add 000.

mm: (millions) add 000,000

MSW: (Municipal Solid Waste) In this study, those elements of municipal trash or garbage which contain cellulose that could be converted to ethanol. This could include paper waste, wood waste, green waste (e.g. yard clippings, landscape prunings), and other materials.

MTBE: (Methyl tertiary butyl ether)

NEP: (National Energy Policy) In the context of this report the "National Energy Policy-Report of the National Energy Policy Development Group", May 2001, and related Bush administration policies to address issues and concerns.

NESCAUM: (Northeast States for Coordinated Air Use Management) A regional group representing northeastern states . NESCAUM's purpose is to exchange technical information, and to promote cooperation and coordination of technical and policy issues regarding air quality control among the member states. To accomplish this, NESCAUM sponsors air quality training programs, participates in national debates, assists in exchange of information, and promotes research initiatives. Their member states are Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York and New Jersey.

$NO_X$: (Oxides of Nitrogen)

OFD: (Office of Fuels Development) A division of the Department of Energy

OPA90: (1990 Oil Pollution Act) Legislation that requires that certain petroleum products be hauled in double hulled vessels and requires the phase out of single hulled vessels from petroleum products transport.

OPIS: (Oil Price Information Service) An independent service that tracks petroleum product prices and is used by some in the transportation fuels industry to establish key points for pricing formulas. Also publishes various petroleum industry reference manuals.

ORNL: (Oak Ridge National Laboratory)

PADD: (Petroleum Administration for Defense Districts) Originally established for national defense purposes breaking the nation into 5 geographic areas designated PADD I through V. These geographically divided areas are also routinely used for the purpose of study and analysis of the petroleum industry.

psi: (Pounds per square inch)

RBOB: (Reformulated Blendstock for Oxygenate Blending) A base gasoline designed to meet all requirements of the federal reformulated gasoline program when the designated oxygenate is added at specified levels.

RFG: (Reformulated gasoline)

RVP: (Reid vapor pressure) One early test method of measuring the vapor pressure of gasoline. The Reid test method is seldom used now but due to its frequent use in earlier years many in the industry still refer to a fuels vapor pressure as RVP.

SIP: (State Implementation Plan) State plans developed for submission to USEPA to demonstrate steps that will be taken to achieve air quality compliance for criteria pollutants.

STB: (Surface Transportation Board) The federal agency responsible for economic regulation of the rail industry and other surface transportation modes.

$T_{10}$: The distillation temperature at which 10% of a gasoline sample is vaporized.

$T_{50}$: The distillation temperature at which 50% of a gasoline sample is vaporized.

$T_{90}$: The distillation temperature at which 90% of a gasoline sample is vaporized.

T V/L20: Temperature for a vapor to liquid ratio of 20 as determined by ASTM D 2533 or ASTM D 5188 A measure of a fuel’s front end volatility. Also used to assign vapor lock protection classes for gasoline in the ASTM specifications.

VOC: (Volatile Organic Compounds)

VP: (Vapor Pressure) A measure of a fuels volatility typically taken at 100 degrees F by specified ASTM test methods. Fuels with higher VP vaporize more readily and therefore contribute more to evaporative emissions inventory. Lower VP fuels vaporize less readily. The VP of gasoline is adjusted seasonally to provide good vehicle operation as well as to control evaporative emissions in the summer months.

## Commonly Used Industry Terms

| | |
|---|---|
| Barrel: | 42 US gallons. |
| Common carrier: | An independent party delivering products for another party. Examples include trucking companies who haul gasoline for second parties, and pipelines who deliver products for others. Common carriers do not own the product they are hauling or shipping. |
| Complex Model: | A series on equations developed by U.S.EPA used to predict automotive emissions of volatile organic compounds, oxides of nitrogen, and toxics. The equations were developed by inputting actual test results from various test programs and can be used to estimate the emissions impact of various compositional and property changes made to a gasoline. |
| Crack spread: | Gross refinery margin, the difference between the revenues from all refinery products sold and the net cost of the crude oil and feedstocks. Does not include capital costs or operational costs such as labor, maintenance, etc. |
| Day tanks: | Tanks at a terminal complex that are typically much smaller than standard tankage. These tanks may be used for low volume or specialty products and often have only a few days supply. |
| Demurrage: | The additional compensation due to a carrier of freight whose vehicle or vessel is delayed due to failure to load or unload the freight within the time allowed. |
| Dry mill: | Dry mill ethanol plants grind the corn kernel, liquefy it, and then ferment it. Resulting products in a dry mill are ethanol, distillers grains, and $CO_2$. |
| Exchange agreement: | A procedure used between two or more oil companies to minimize transportation costs and service areas where companies may not have their own terminal operations. As an example, refiner A gives refiner B product in one geographical area and refiner B returns a like amount of product to refiner A in a different geographic location. |
| Hub terminal: | See Redistribution terminal. |
| Hypermart: | A retail gasoline outlet built on the out-lot of a chain merchandise discounter such as Walmart or Meijers. These facilities are typically designed for very high volumes and tend to price their gasoline below most other outlets. |

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| Jones Act: | The Merchant Marine Act of 1920 commonly referred to as the Jones Act. Requires shipments of products between U.S. ports to be made by vessels that were built in the U.S., flagged in the U.S., are owned by a U.S. person or entity, and manned by a certified U.S. crew. Ships meeting this criteria are commonly referred to as Jones Act vessels or Jones Act tonnage. |
| Long ton: | 2240 pounds |
| M-85: | A blend of 15v% gasoline and 85v% methanol used to fuel vehicles designed specifically for such fuel use. |
| Metric ton: | 2204.6 pounds |
| Nameplate capacity: | The design capacity of a plant, in this case ethanol plants. |
| Phase separation: | When gasoline ethanol blends encounter too much moisture (greater than 0.45 v% water at 60 degrees F) the water and alcohol will drop to the bottom of the blend, referred to as phase separation. |
| Pipeline interface: | The point in pipeline shipments where two products of different specifications meet. The materials at the interface may mingle resulting in a small amount of product that does not closely resemble the characteristics of either product. Pipeline operators sequence product in a manner to minimize any interface material that would be required to be downgraded or disposed of. |
| Predictive Model: | Developed and used by the California Air Resource Board. Similar to the U.S.EPA Complex Model. The Predictive Model equations were developed with a different data set than EPA's Complex Model and therefore may yield different results for various compositional and property changes made to gasoline. |
| Redistribution terminal: | A terminal which serves as a facility to receive product for redistribution to other terminals. Sometimes referred to as a hub terminal or hub terminal operation. |
| Short ton: | 2000 pounds |
| Skid Mounted: | Equipment which is prefabricated and assembled on a platform (skid). In the study, the primary use of this term refers to skid mounted blending systems, where the entire blending system is delivered preassembled and then plumbed and connected to the necessary pipage at a petroleum products terminal. |
| Staging | In this report, an interim stop in an intermodal transportation scenario. The primary example is when ethanol is shipped by barge to the Gulf Coast and stored in tanks (staged) for loading onto a cargo vessel and then shipped to its final destination on the east or west coasts. |

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| Stream days: | The number of days a refinery or ethanol plant is typically operated to achieve its annual volume. This is less than calendar days due to maintenance turn arounds (e.g. replacing catalysts, cleaning & servicing process units). An operating year is typically based on 330 stream days for a refinery and 350 days for an ethanol plant. |
| Sub-octane: | Industry term used for sub octane gasoline, a fuel designed for ethanol addition at the terminal. Usually 84 or 84.5 octane (R+M)/2. |
| Super pumper: | A retail gasoline outlet designed to handle very high volumes. These facilities typically have several more pump islands and dispensers than the typical service station or C-store. |
| Unit train: | Typically a train of 100 cars. For purposes of this report, 100 tank cars with a nominal capacity of 30,000 gallons each. Unit trains are pulled with dedicated power (i.e., a locomotive) to pull the cars to their destination and back. Note that some unit trains of larger capacity cars may be only 82 to 84 cars. |
| Water bottoms: | Water that exists in the bottom of a petroleum products storage tank. |
| Wet Mill: | A wet mill ethanol plant steeps (soaks in warm water) the corn. This enables separation of the germ, oil, starch, etc. Wet mill ethanol plants produce not only ethanol from the starch but also protein feed, gluten meal, $CO_2$, and corn oil. Most wet mills can also direct a portion of their grind to production of high fructose corn syrup (HFCS) when demand and economics dictate. Compared to dry mills, wet mills require more initial capital investment but have lower ethanol production costs. |