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AFWAL-TR-87-2042
Volume XII

# PRODUCTION OF JET FUELS FROM COAL-DERIVED LIQUIDS

## VOL XII--PRELIMINARY PROCESS DESIGN AND COST ESTIMATE AND PRODUCTION RUN RECOMMENDATION

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A preliminary design for the production of JP-8 jet fuel and other salable products from the Great Plains by-products is given. The design incorporates experimental results from Tasks 2 and 3 with the scoping design from Task 1. The experimental results demonstrated the need for more severe hydrotreating conditions to convert the tar oil to jet fuel than was estimated in Task 1. As a result, capital costs for the revised design are significantly higher and the plant is less profitable than estimated in the Task 1 work. The increase in capital costs is offset somewhat by a higher phenol value in the current market. Refined estimates for the cost of an aromatics recovery unit preclude its economical construction in the new estimate, consequently the revised product slate includes no BTX.

Recommendations are given for a 10,000 barrel production run. No commercial domestic facility exists which can provide suitable expanded-bed hydrotreating facilities for a production run of this size. However, an alternative approach using hot filtration and dilute fixed-bed hydrocracking followed by product fractionation and extinctive hydrotreating of the heavy products is recommended. Commercial domestic facilities which might reasonably accommodate this scheme are listed.

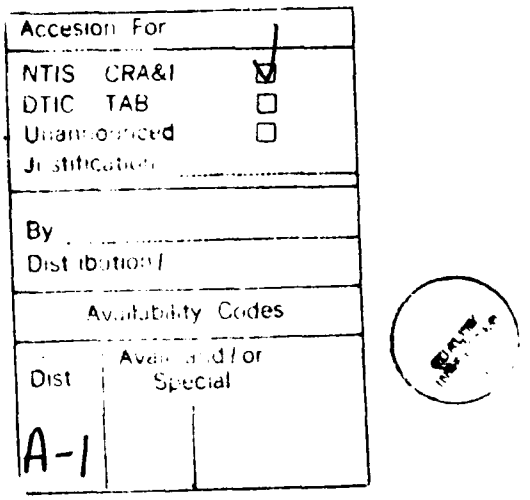
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## SUMMARY

Amoco and Lummus Crest are contracted with the Department of Energy to develop an upgrading scheme for the liquid by-products (tar oil, phenols, and naphtha) produced by the Great Plains Coal Gasification plant in Beulah, North Dakota. These streams are currently burned in the utility boilers and steam superheaters in the Great Plains plant. Task 1 through 3 of the contract are complete. Task 1 results were reported previously (AFWAL-TR-87-2042, Volume VI), as were the results of Tasks 2 and 3 (AFWAL-TR-87-2042, Volume IX). The results of Tasks 4 and 5 are reported here.

A preliminary design for the production of JP-8 jet fuel and other salable products from the Great Plains by-products is given. The design incorporates experimental results from Tasks 2 and 3 with the scoping design from Task 1. The experimental results demonstrated the need for more severe hydrotreating conditions to convert the tar oil to jet fuel than were estimated in Task 1. As a result, capital costs for the revised design are significantly higher, and the plant is less profitable than estimated in the Task 1 work. The increase in capital costs is offset somewhat by a higher phenol value in the current market. In addition, the product slate has changed. BTX production, only marginally profitable in the Task 1 study, was re-evaluated and found to be prohibitive. As a consequence, the flow scheme is simplified by the removal of the aromatics recovery unit from the Task 1 design.

Recommendations are given for a 10,000-barrel production run. No commercial domestic facility exists which can provide suitable expanded-bed hydrotreating facilities for a production run of this size. However, an alternative approach using hot filtration and dilute fixed-bed hydrocracking followed by product fractionation and extinctive hydrotreating of the heavy products is recommended. Commercial domestic facilities which might reasonably accommodate this scheme are listed.

# FOREWORD

In September 1986, the Fuels Branch of the Aero Propulsion and Power Laboratory at Wright-Patterson Air Force Base, Ohio, commenced an investigation of the potential for production of jet fuel from the liquid by-product streams produced by the gasification of lignite at the Great Plains Gasification Plant located in Beulah, North Dakota. Funding was provided to the Department of Energy (DOE) Pittsburgh Energy Technology Center (PETC) to administer the experimental portion of this effort. This report details the effort of Amoco Oil Company, who, as a contractor to DOE (DOE Contract Number DE-AC22-87PC90015), conducted a preliminary analysis of upgrading alternatives for the production of turbine fuels from the Great Plains liquid by-product streams. DOE/PETC was funded through Military Interdepartmental Purchase Request (MIPR) FY1455-86-N0657. Mr. William E. Harrison III was the Air Force Program Manager, Mr. Gary Stiegel was the DOE/PETC Program Manager, and Mark Furlong and Bruce Fleming were the Amoco Program Managers.

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## SECTION I
## INTRODUCTION

The Great Plains Coal Gasification Plant in Beulah, North Dakota, produces about 145 MM SCF/D of substitute natural gas (SNG) from lignite. The plant also produces three liquid by-products: about 2,900 B/D of tar oil, 830 B/D of crude phenols, and 650 B/D of naphtha. These liquids are all products from the devolatilization of lignite in the Lurgi gasifiers. Currently, the by-products are burned in the plant's boilers and superheaters to produce steam. The economic viability of the plant might be improved by producing marketable products, rather than steam, from these by-product liquids. To this end, Amoco and Lummus Crest, under a contract with the United States Department of Energy, are investigating the technical and economic feasibility of converting the by-product liquids to jet fuels and other saleable products. Jet fuels are of particular interest because of the close proximity of Great Plains to several U.S. Air Force bases, and the obvious strategic interest in maintaining a constant, proprietary source of jet fuel for those bases.

## SECTION II

## PROJECT OVERVIEW

As shown in Figure 1, this project is divided into five major tasks: Process Concept Definition, Bench Scale Testing, Pilot Plant Testing, Preliminary Process Design and Economics, and Production Run Recommendation. The results of Tasks 4 and 5 are reported here.

The first task, Process Concept Definition, included three subtasks: Liquid By-product Analysis, Process Modelling and Design, and Economic Modelling. The first subtask (1.1), By-product Analysis, involved analytical characterizations of samples of each by-product taken at six-week intervals. The results from this program, which provided an indication of the average quality of each stream and the variability of that quality over time, were an important input to the second subtask (1.2), Process Modelling and Design. Other inputs to the second subtask included limited experimental processing data on the Great Plains by-products by the Western Research Institute (WRI),[1] Amoco's petroleum refining process models and linear programming technology, Lummus' process simulation and design programs and a market analysis of by-products from Great Plains developed by Sinor Consultants.[2] In addition, throughout Task 1, ANG Coal Gasification Company provided valuable input and advice on all fronts. The major objective of Subtask 1.2 was to produce seven conceptual designs and associated capital and operating costs for facilities to refine the Great Plains by-products. These included designs for maximizing production of each grade of jet fuel (JP-4, JP-8, JP-8X), designs for profitable schemes which produce the various jet fuel grades, and a scheme for maximizing profits. In Subtask 1.3 the results generated by Amoco and Lummus were subjected to economic analysis.

The two products from Tasks 1 were the design and economic results for each of the seven designs and a plan for bench scale testing (Task 2) to confirm any assumptions made in Task 1. The final report for Task 1 was issued by the U.S. Air Force in September 1988.[3] Based on the design and economic results from Task 1 and preliminary results from Task 2, the Department of Energy and the Department of Defense decided on a preferred processing scheme for the Great Plains liquids, the "Profitable JP-8" case developed in Task 1. Amoco carried out pilot plant testing (Task 3) of the process design from Tasks 1 and 2 and provided barrel quantities of product for testing by the United States Air Force and associated contractors. The final report for Tasks 2 and 3 was issued by the U.S. Air Force in June 1989.[4]

The pilot plant results were used by Amoco and Lummus to develop a preliminary process design and economics (Task 4) for a plant to upgrade the liquid by-products at Great Plains. Finally, in Task 5, Lummus suggested existing facilities where the processing scheme might be carried out on a scale sufficient to provide jet fuel for aircraft testing. The results of Tasks 4 and 5 are reported here.

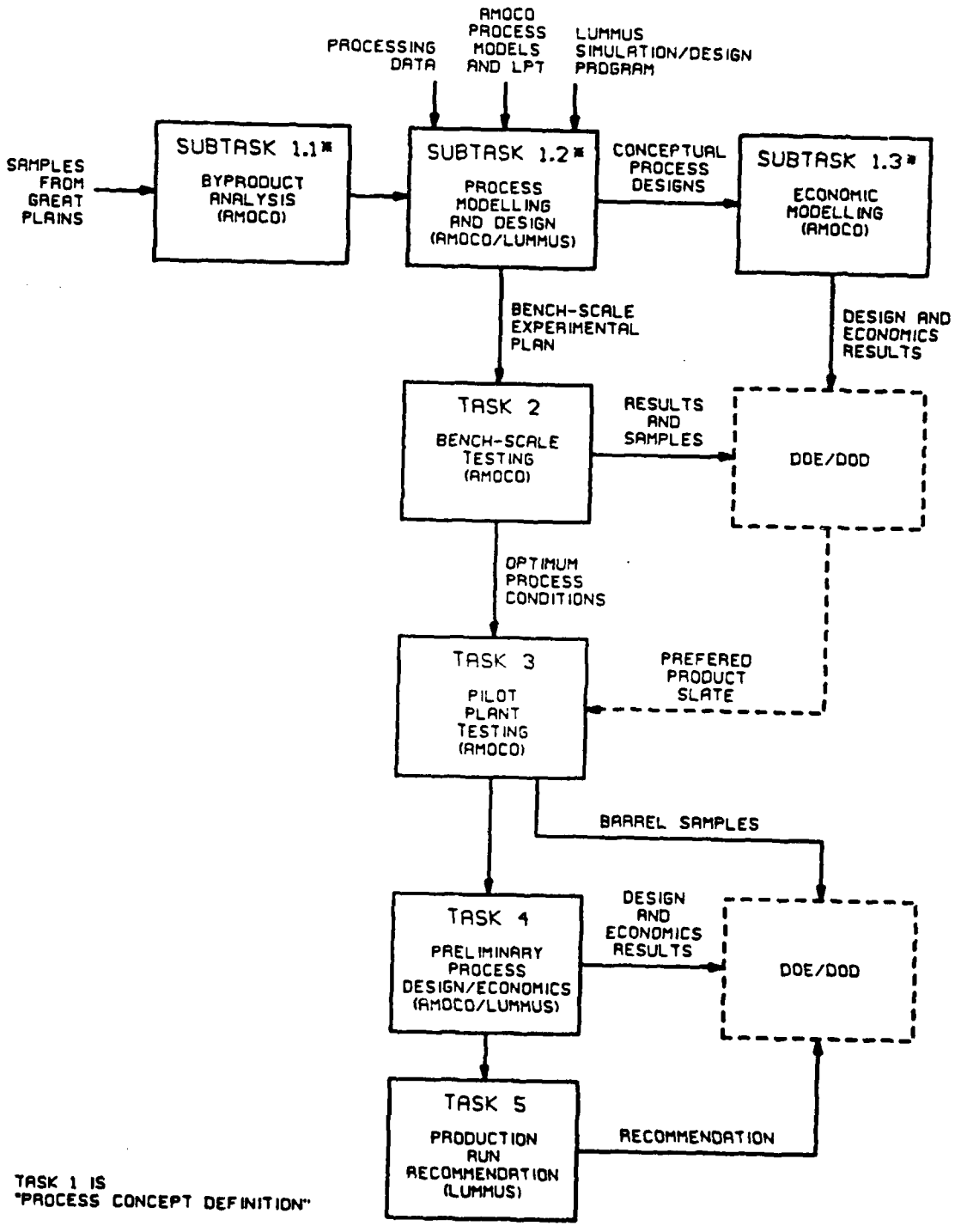



FIGURE 1
PRODUCTION OF JET FUEL
FROM COAL DERIVED LIQUIDS:
AMOCO/LUMMUS ACTIVITIES

## SECTION III

## SOURCE OF BY-PRODUCT LIQUIDS

Tar oils, crude phenols, and naphtha are produced at the Great Plains Gasification Plant; a schematic of the plant is shown in Figure 2. The plant currently produces about 145 MMSCFD of synthetic natural gas (SNG) from North Dakota lignite. The SNG is composed almost entirely of methane, which is derived mostly from synthesis gas ($H_2$ + CO) produced in the Lurgi Mark IV gasifiers and methanated in downstream reactors. The liquid by-products (tar oil, phenolics, and naphtha) are produced during lignite devolatilization in the gasifiers.

The tar oil and phenolics are condensed from the product gas along with water vapor to form a gas liquor. This condensation takes place in heat exchangers located in the gasifier quench, shift converter, gas cooling, and Rectisol units. The liquor is routed to the gas liquor separation unit, where the tar oil is recovered by gravity separation. The heaviest portion of the tar oil, which contains about 20 percent coal dust, is recycled to the gasifiers. The recycle rate of this "dusty tar" is about 1800 B/D. The remaining tar oil, which contains 2-6 percent dust, is produced at a rate of 2900 B/D. The phenolics are recovered from the gas liquor by extraction with isopropyl ether in the Phenolsolvan unit. The resulting crude phenol stream, which is produced at a rate of about 830 B/D, is composed mostly of phenol, cresol, and xylenol, with the remainder being water and neutral oils. The naphtha is condensed from the gasifier raw gas by contacting the stream with cold methanol in the Rectisol unit. The naphtha is produced at a rate of 650 B/D.

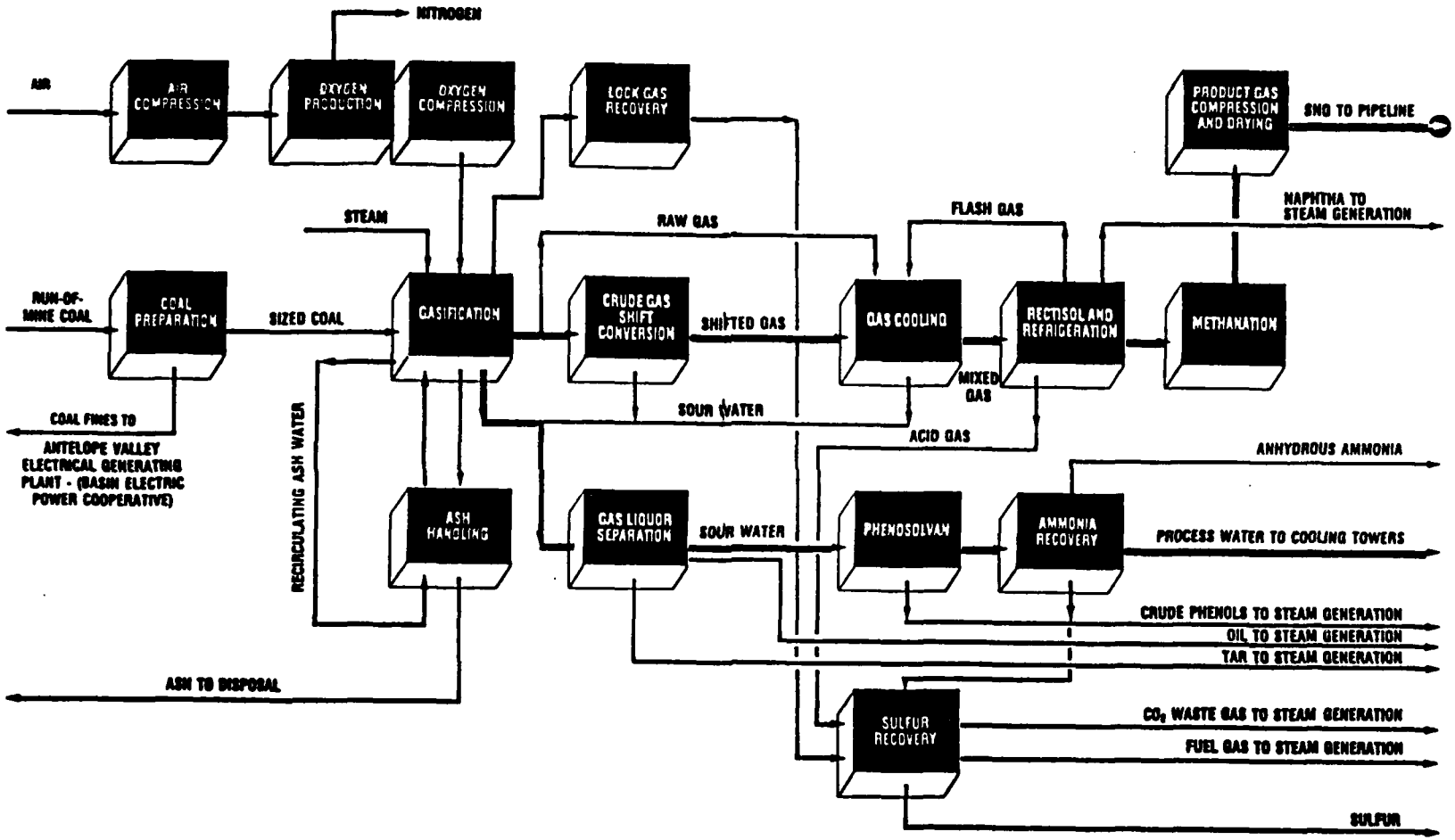



FIGURE 2. GREAT PLAINS GASIFICATION PROCESS BLOCK FLOW DIAGRAM

SECTION IV

TASK 4 RESULTS

## 1. Preliminary Process Design

Lummus Crest Inc., under subcontract with Amoco Oil on this project, generated a preliminary process design to convert the tar oil, naphtha, and phenols streams from the Great Plains Coal Gasification Plant to jet fuels, gasoline, and salable chemicals products. As part of Task 1 of this project, seven processing schemes were generated, as indicated in Table 1. Initial design bases were formulated for each case using proprietary linear programming techniques and process models from Amoco and design expertise at Lummus Crest Inc. The Task 1 results were reported earlier.[3] As a part of Task 2 the U.S. Air Force and the Department of Energy selected Case 4, "Profitable Product Slate Including JP-8," as the case for further study in Tasks 3 through 5.

### a. Overall Process Description

Figure 3 shows the block diagram for the preliminary process design. There are three sections to the design: tar oil processing section, naphtha processing, and phenol processing. Each is described briefly.

Tar Oil Processing--The tar oil stream is treated to make JP-8 jet fuel through an expanded-bed hydrotreater, a desulfurization/ denitrogenation unit (HDS), and a final stage of hydrocracking. Only the fraction of the tar oil boiling above 300°F is treated. The 300°F- fraction is removed by distillation prior to hydrotreating, as the low-boiling fraction is unsuitable for jet fuels.

The first stage hydrotreater consumes 3073 SCF hydrogen per barrel of feed, resulting in a high heat release and necessitating an expanded-bed reactor system to control the reactions. The design basis is a three-stage expanded-bed hydrotreater which removes over 98 percent of the sulfur, nitrogen, and oxygen and converts part of the 525°F+ material to the appropriate boiling range for jet fuel blending. From the hydrotreater, 3224 barrels per day of 200°F+ product is sent to the HDS unit and 162 barrels per day of naphtha is recovered.

The HDS unit desulfurizes and denitrogenates the 200°F+ product from the hydrotreater. Denitrogenation is required to preserve catalyst life in the hydrocracker unit and to produce a 525°F- stream suitable for jet fuel blending. The 525°F+ fraction is sent to the hydrocracker unit, a five-stage unit with 65% conversion per pass. The hydrocracker product is recycled to the HDS unit until the 525°F+ fraction is extinct.

Details of the tar oil processing scheme are given in Appendices A and B, and equipment data and estimate sheets are included in Appendix F.

TABLE 1

PROCESS MODEL AND DESIGN CASE SUMMARY

THE FOLLOWING DESIGN CASES WILL RESULT FROM ACTIVITIES IN THIS SUBTASK:

| CASE | DESCRIPTION |
|---|---|
| 1 | MAXIMUM JP-4 PRODUCTION. |
| 2 | PROFITABLE PRODUCT SLATE INCLUDING JP-4. |
| 3 | MAXIMUM JP-8 PRODUCTION. |
| 4 | PROFITABLE PRODUCT SLATE INCLUDING JP-8. |
| 5 | MAXIMUM JP-8X PRODUCTION. |
| 6 | PROFITABLE PRODUCT SLATE INCLUDING JP-8X. |
| 7 | MAXIMUM PROFIT. |

NOTE: CASES 2, 4, 6, AND 7 REQUIRE LINEAR PROGRAMMING TECHNOLOGY.

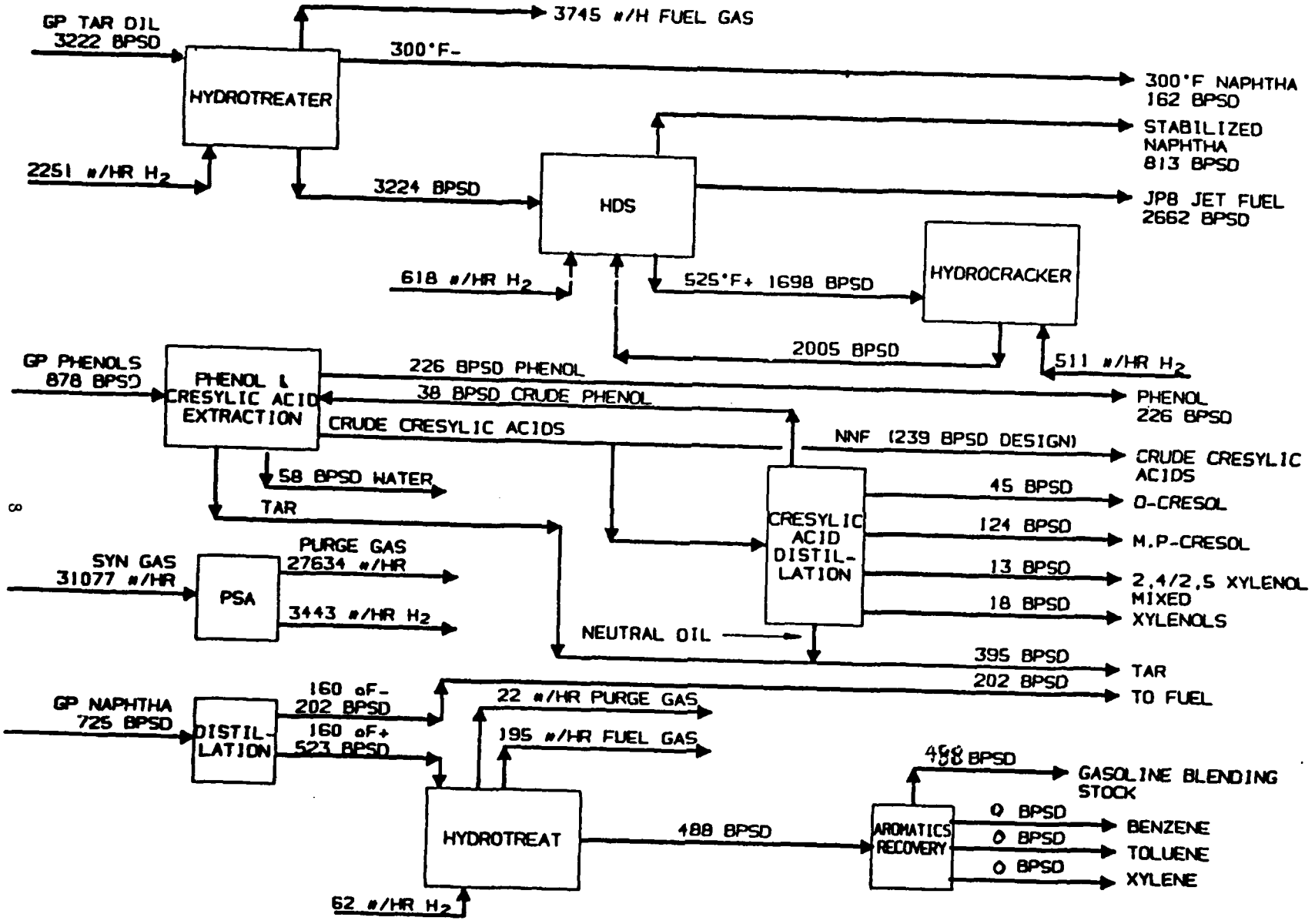



FIGURE 3: PROFITABLE JP-8 DESIGN

Naphtha Processing--Figure 3 shows a naphtha processing scheme that could produce BTX from the 725 barrels per day of raw Great Plains naphtha. The Task 1 study reported this treatment scheme as only marginally profitable. The updated capital and utility estimates have increased in Task 4. The increases are enough to prevent profitable BTX production. As a result, it is recommended that the aromatics recovery unit not be constructed. Figure 3 shows the processing scheme for reference, but with zero flow rates.

A design for BTX production was completed and details are reported in Appendices A and F. The design was necessarily completed before the updated cost data could be fed to the linear program model, which then rejected the naphtha processing as unprofitable.

Phenol Processing--The phenols by-product stream from the Great Plains plant is treated by extraction and distillation to produce phenol, cresols, xylenols, and crude cresylic acids. Approximately 878 barrels of the crude phenol per day are distilled to remove tars and product phenol. Part of the remaining stream, crude cresylic acid, is extracted with hexane and methanol to produce cresols and xylenols.

Details of the phenol processing scheme are given in Appendices A and F, and equipment data and estimate sheets are included in Appendix F.

b. Capital Costs

Capital costs for equipment required for the processing schemes shown in Figure 3 are summarized here. Details are given in Appendix C.

Table 2 summarizes the cost for each section of the processing scheme. The total cost is $121.4 million, an increase of approximately one third over the estimate provided in Task 1. The increase is reflected primarily in the tar oil hydrotreating section, which now includes an additional hydrotreating vessel and preliminary distillation section. Note that the $121 million includes the cost of constructing naphtha distillation and hydrotreating equipment and an ARU (aromatics recovery unit) to produce BTX from the raw naphtha stream. The linear programming model shows that BTX production is unprofitable, so that the ARU is not included in the final design basis for the profitable JP-8 case. In the maximum profit case, neither the ARU nor the distillation/hydrotreater sections are included. The costs are given here for completeness.

The cost estimates were made at Lummus based on the processing schemes and their return cost data for similar equipment items. The equipment was factored to size and present-day costs based on historical ratios. Engineering costs are included on the basis of the number of equipment items, and a 20% contingency is included in the capital estimates. The estimates do not include spare parts, start-up, insurance, taxes, permits, or royalties on processing technologies.

c. Operating Costs

Costs for labor, utilities, catalysts, chemicals, and maintenance supplies are given in Appendix D. Manpower is allocated at 17 people per shift with maintenance integrated with the existing Great Plains maintenance

TABLE 2

CAPITAL COST SUMMARY

| | (Thousands of $) |
|---|---|
| Area 100 Hydrotreater | $ 25,992 |
| Area 200 HDS & JP-8 | 34,761 |
| Area 300 HDC | 5,803 |
| Area 400 OSBL | 12,802 |
| Area 500 Catalyst Handling | 1,409 |
| Area 600 Naph. Dist & HDT | 5,403 |
| Area 700 ARU | 10,338 |
| Area 800 Phenol Ext. | 11,909 |
| Area 850 Cresylic Acid Ext. | 5,361 |
| Area 900 Cresylic Acid Dist | 7,508 |
| | $121,287 |
| Area 700 ARU Solvent Invent. | 110 |
| Total | $121,397 |

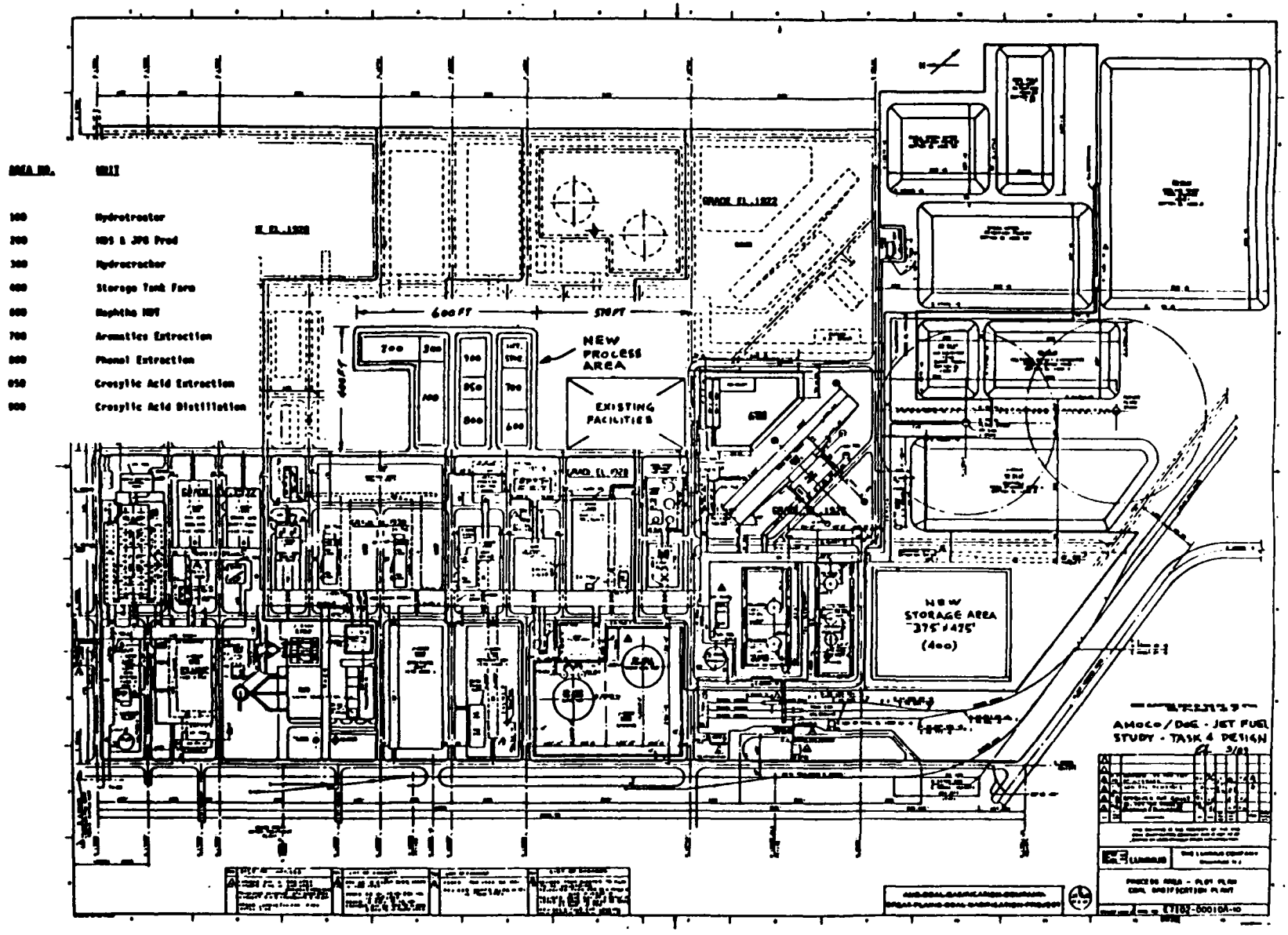



FIGURE 4: PLOT PLAN TIE-IN

crew. A total of 87 additional people would be required. Utilities costs total $93.5 thousand per day, catalysts and chemicals $2.8 thousand per day, and maintenance supplies $6 thousand per day.

d. Plot Plan and Tie-ins

Figure 4 shows the integration of the new processing units with the existing Great Plains facilities. The units will be sited in an area 400 by 600 feet east of the existing Rectisol unit. In addition, a storage tank area, approximately 375 by 425 feet, will be required for storage of product and replacement fuel oil. Details of the plot plan are given in Appendix E. Note that the plot plan includes space allocated for the ARU, which was eliminated after formulation of the plot plan.

2. Preliminary Cost and Profitability Estimates

With capital and operating costs provided by Lummus Crest Inc., Amoco Oil Research and Development estimated the cost and profitability of production of JP-8 and other salable products from the Great Plains by-product tar oil, naphtha, and phenol streams. The estimates were made with Amoco's proprietary linear programming models with product values based on in-house expertise, a report by J. E. Sinor,[2] and a letter from Burns and Roe Services Corporation to J. G. Masin of Amoco (Appendix G). In addition to the estimates for the "Profitable JP-8 Case," revised profitability estimates for the "Maximum Profit Case," in which no JP-8 is manufactured, are provided for comparison. Also, since the profitability of the cases is sensitive to a number of factors, especially fuel replacement cost and the marketability of specialty chemicals like xylenols, a brief analysis of the effects of changes in those variables is provided.

a. Linear Programming Flowsheets

Amoco's proprietary linear programming models use in-house process expertise and current product values to optimize the configuration and flow rates to the most profitable processing scheme. Figures 5 and 6 are flowsheets for the "Profitable JP-8" and "Maximum Profit" cases, respectively. Note that most of the flow rates are given in units of barrels per calendar day, rather than barrels per stream-day, as in the design schematic (Figure 3).

There are two fundamental differences between the design case, Figure 3, and the optimized linear programming case for profitable JP-8 production, Figure 5. First, the linear programming model is constrained to limit sales of cresols and xylenols, giving lower outputs of those products. Second, increases in the capital cost of the aromatics recovery unit caused the LP to reject construction of the ARU, recommended in Task 1, as unprofitable. These differences are discussed below.

Chemical Sales--Both in the Task 1 and Task 4 studies, chemical sales were limited to 10 percent of the United States market. This limitation is an artificial constraint, and no attempt to define the effect of market penetration on the product value has been included. The effect of relaxing this constraint is discussed later.

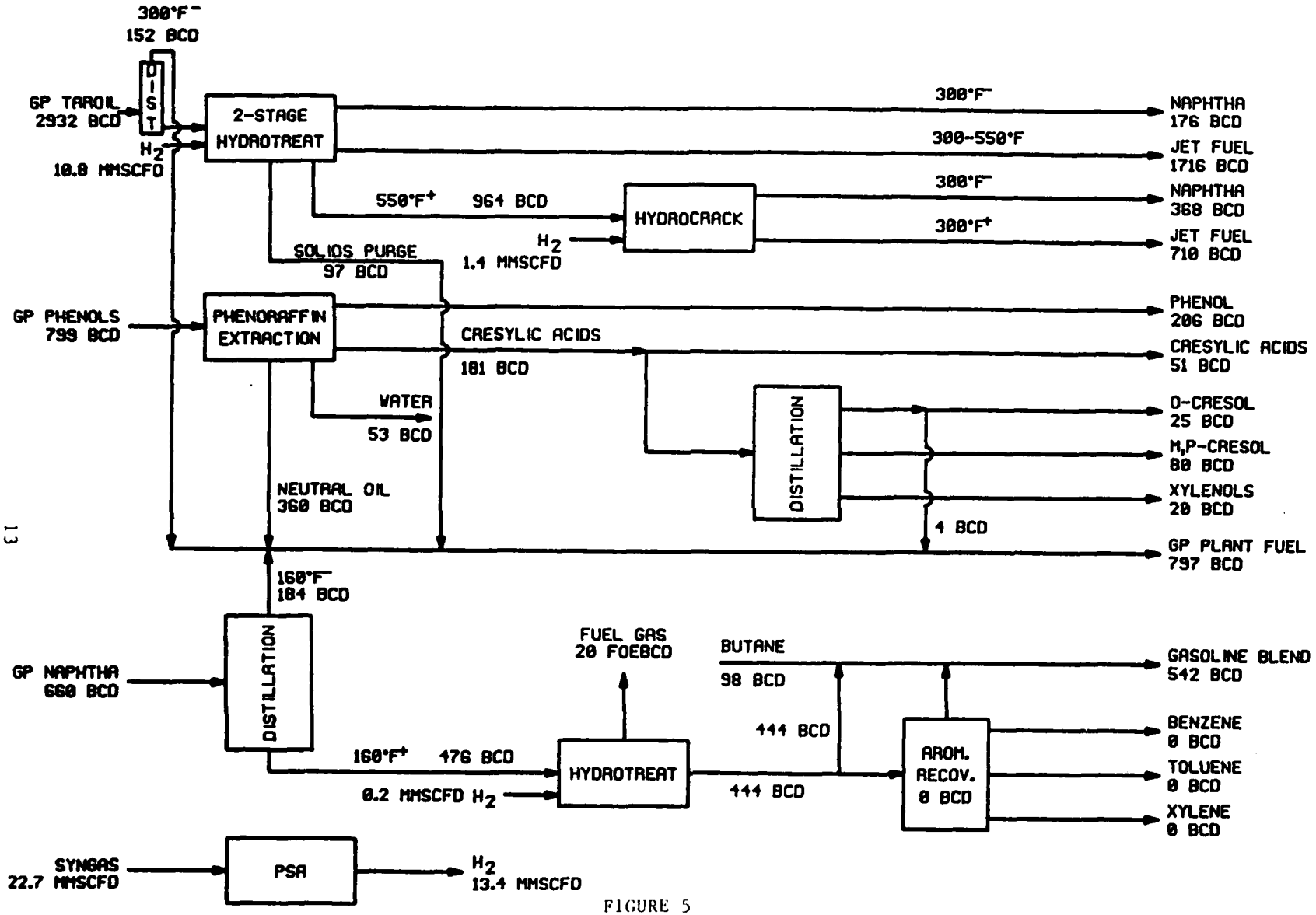



FIGURE 5

GREAT PLAINS CASE 4
BLOCK FLOW DIAGRAM
PROFITABLE JP-8

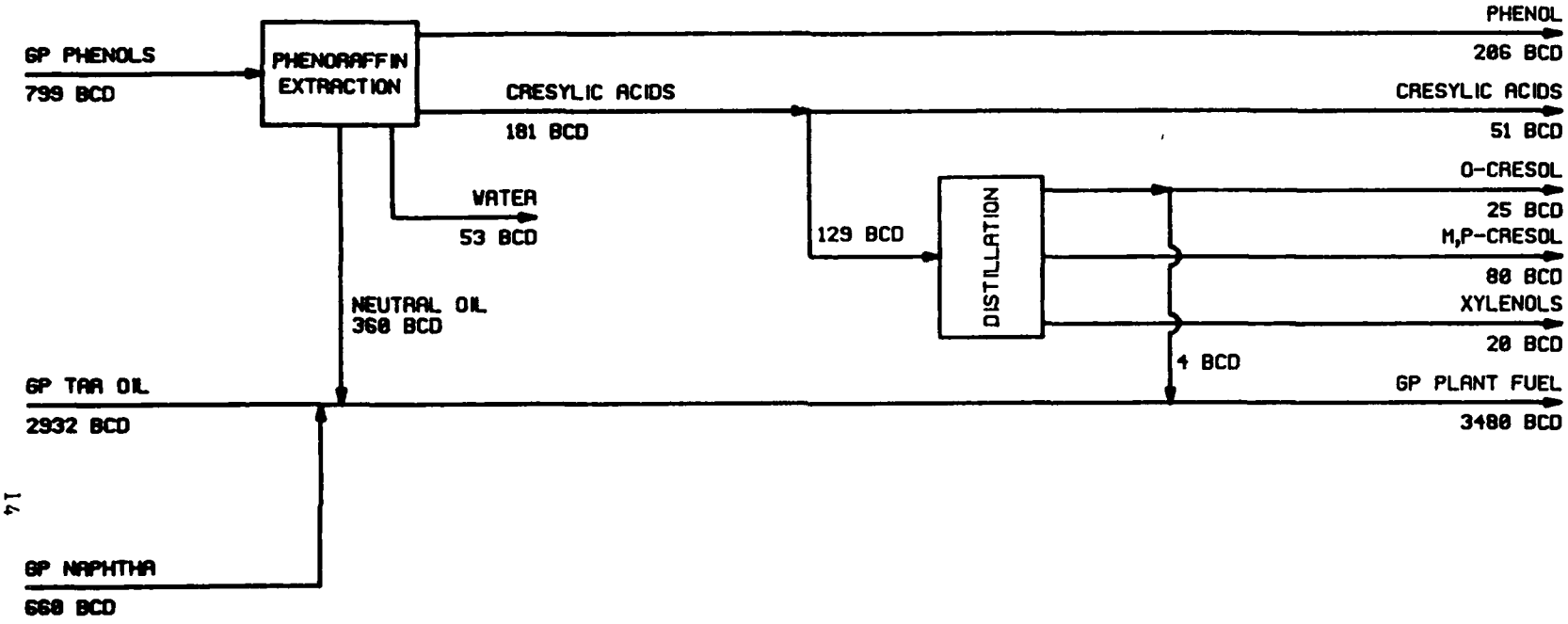



FIGURE 6

GREAT PLAINS CASE 7
BLOCK FLOW DIAGRAM
MAXIMUM PROFIT

TABLE 3

EFFECT OF CHEMICALS SALES LIMITS
MAXIMUM PROFIT CASE

| Chemical | Sales Limits, MBCD | |
|---|---|---|
| | Sinor | SRI |
| Benzene | Unlim | Unlim |
| Toluene | Unlim | Unlim |
| Xylene | Unlim | Unlim |
| Phenol (1) | Unlim | 2.192 |
| o-Cresol | 0.25 | 0.61 |
| m,p-Cresol | 0.80 | 0.38 |
| Xylenols (2) | 0.30 | 0.485 |
| Cresylic Acids | 1.40 | |
| Profit, MM$/yr (3) | 9.2 | 15.1 |

(1) Sinor $80/Bbl, SRI $157-175/Bbl
(2) SRI broke down into individual isomers
(3) Limit to 10% of cresol and xylenols

The market limits were defined in reports by Sinor[2] and SRI (Appendix G). Table 3 summarizes the sales constraints based on information from the cited reports. The Sinor information was used in the Task 1 study; the impact of the SRI values are reported here. Based on the "Maximum Profit" case, the annual profit from sales of chemicals increases from $9.2 million to $15.1 million in going to the updated costs. The primary difference, though, is not that the quantity of chemicals sold has changed, but that the value of phenol has doubled from about $80 per barrel to about $160 per barrel. The impact of the increased phenol value on the "Profitable JP-8" case is discussed in conjunction with the differences in the capital costs, below.

Differences in Capital Costs--Process data from Tasks 2 and 3 redefined the tar oil processing scheme used in Task 1. More severe hydrotreating is required than assumed in the Task 1 estimates and, as a result, the capital costs for the hydrotreater section increase from $45.6 million in Task 1 to $63.2 million in the Task 4 estimate (Table 4). Note that the costs reported in Table 4 include OSBL (outside battery limits) costs and, therefore, are higher than the values reported directly by Lummus (Table 2 and Appendix C), which did not include OSBL. In total, the capital investment for the "Profitable JP-8" case increased from $85 million in Task 1 to $110 million, in spite of the elimination of the ARU.

Tables 5 and 6 summarize the effects of the increased capital cost and the impact of the higher phenol value on the "Profitable JP-8" and "Maximum Profit" cases, respectively. Overall, the increase in capital costs if the ARU is included in the processing scheme causes the "Profitable JP-8" case (Table 5 and Figure 5) to drop from a profit of $4.5 million per year to a deficit of $7.3 million, at the phenol value used in Task 1, $80 per barrel. However, at the updated phenol price, $160 per barrel, the deficit is largely offset. At the higher phenol value, the deficit drops to $1.3 million per year.

BTX production was only marginally profitable in Task I. Revised operating costs now make it unprofitable. Since BTX production is unprofitable, the by-product naphtha stream is hydrotreated and sent to gasoline blending stock in the "Profitable JP-8" case. Without the ARU, the capital investment for the "Profitable JP-8" case drops from $124 million to $110 million, and the case nets a profit of $500,000 per year. The ARU is shown in Figure 5, but the flow rates are listed as zero. The ARU would not be constructed.

The impacts of the phenol value and elimination of the ARU for the "Maximum Profit" case, Figure 6 and Table 6, are similar to those for the "Profitable JP-8" case. At the lower phenol cost and with ARU construction, the profit drops from $14.9 million in Task 1 to $6.6 million in the updated estimate. However, the increased phenol value boosts the profit to $12.7 million. The ARU is unprofitable at the higher revised cost, so the LP reflects this most profitable case. Note that the "Maximum Profit" design provides for no jet fuel production. Consequently, the only hydrogen requirement is for the naphtha hydrotreater, 205,000 SCF per day. The small volume of gasoline blending stock produced by the naphtha hydrotreater, coupled with the costs of building a pressure swing absorption (PSA) unit to produce the hydrogen, makes the naphtha hydrotreater unprofitable. Therefore, the "without ARU" column in Table 6 reflects elimination of the naphtha hydrotreater, as

TABLE 4

GREAT PLAINS INVESTMENT AND UTILITIES SUMMARY

| Unit Investment $MM | Max Profit | | Profit JP-8 | |
|---|---|---|---|---|
| | Task 1 | Task 2 | Task 1 | Task 2 |
| Aromatics Rec | 12.3 | 0 | 12.3 | 0 |
| Phenoraffin | 19.4 | 28.1 | 19.4 | 28.1 |
| Tar Oil Distil | 0 | 0 | 0 | 4.8 |
| Hydrocracking | 0 | 0 | 11.2 | 6.3 |
| Hydrotreating | 0 | 0 | 31.3 | 52.1 |
| Naphtha Distil | 0.2 | 0 | 0.2 | 0.2 |
| Naphtha Hydrotrtg | 4.5 | 0 | 4.5 | 6.2 |
| PSA | 0.5 | 0 | 9.0 | 10.9 |
| Power Distribution | 0.1 | 0.1 | 1.4 | 1.5 |
| Total | 37.0 | 28.2 | 89.3 | 110.3 |
| Utilities | | | | |
| Cat and Chem, $/D | 790 | 450 | 1,780 | 3,430 |
| Fuel, FOEB/D | 926 | 599 | 4,626 | 2,502 |
| Power, MW | 0.2 | 0.1 | 6.8 | 4.1 |
| Cooling Wtr, Mgpm | 0.1 | 2.8 | 2.7 | 6.7 |
| Process Wtr, gpm | 2 | 53 | 43 | 90 |
| Steam, MLb/Hr | 26.9 | 0 | 37.7 | 62.8 |

TABLE 5

EFFECT OF TASK 2 AND 3 PROCESS DATA
PROFITABLE JP-8 CASE

| | Task 1 | Task 4 | | |
|---|---|---|---|---|
| | | With ARU | | W/O ARU |
| Profit, $MM/Yr | 9.0 | -7.3 | -1.3 | 0.5 |
| Capital, $MM | 89.3 | 123.6 | 123.6 | 110.3 |
| Bases | | | | |
| Phenol Price, $/B | 80 | 80 | 160 | 160 |
| Products, BCD | | | | |
| Gasoline | 306 | 306 | 306 | 925 |
| Reformer Feed | 980 | 353 | 353 | 162 |
| BTX | 321 | 334 | 334 | 0 |
| JP-8 | 2,320 | 2,427 | 2,427 | 2,427 |
| Phenol | 283 | 206 | 206 | 206 |
| o-Cresol | 21 | 25 | 25 | 25 |
| m,p-Cresol | 53 | 80 | 80 | 80 |
| Xylenol | 30 | 20 | 20 | 20 |
| Cresylic Acids | 138 | 51 | 51 | 51 |

TABLE 6

EFFECT OF TASK 2 AND 3 PROCESS DATA
MAXIMUM PROFIT CASE

| | Task 1 | Task 4 | | |
|---|---|---|---|---|
| | | With ARU | | W/O ARU |
| Profit, $MM/Yr | 14.9 | 6.6 | 12.7 | 13.7 |
| Capital, $MM | 37.0 | 48.6 | 48.6 | 28.2 |
| Bases | | | | |
| Phenol Price, $/B | 80 | 80 | 160 | 160 |
| Products, BCD | | | | |
| Gasoline | 62 | 62 | 62 | 0 |
| Reformer Feed | 0 | 0 | 0 | 0 |
| BTX | 389 | 390 | 390 | 0 |
| Phenol | 283 | 206 | 206 | 206 |
| o-Cresol | 21 | 25 | 25 | 25 |
| m,p-Cresol | 53 | 80 | 80 | 80 |
| Xylenol | 30 | 20 | 20 | 20 |
| Cresylic Acids | 138 | 51 | 51 | 51 |

well as the ARU. In the "Maximum Profit" case the naphtha would be burned as plant fuel.

b. Economics Summary

Tables 7 and 8 summarize the profitability, investment costs, feed and product flow rates, and cash flows for the "Profitable JP-8" and "Maximum Profit" cases. The Task 1 estimates are included for comparison.

Changes in the tar oil processing scheme as a result of the Task 2 and 3 work, refinements in the capital estimates, and changes in the product values have impacted the product slates for both cases (Table 7). Relative to the Task 1 estimates, the "Profitable JP-8" case now produces more gasoline and liquid fuel and produces correspondingly less BTX and naphtha (reformer feed). A tar oil distillation unit is required for preseparation of the 300°F- fraction before hydrotreating; this was not included in the Task 1 designs. In both the "Profitable JP-8" and the "Maximum Profit" cases, there is no aromatics recovery unit. In addition, the "Maximum Profit" case now no longer has naphtha distillation, naphtha hydrotreaters, or PSA units. As a result the product slate for the "Maximum Profit" case shifts slightly toward less chemicals production.

Table 8 summarizes the cash flows for the "Profitable JP-8" and the "Maximum Profit" cases, comparing the Task 1 and the Task 4 estimates. The "Profitable JP-8" case yields an annual total profit of just $0.5 million now versus $9.0 million in the Task 1 estimate. The primary changes are lower net income from sales, primarily due to the elimination of the ARU, and the increase in capital costs as a result of the more complex tar oil treatment. The primary cause of decreases in the profitability of the "Maximum Profit" case is the decrease in net sales due to the elimination of BTX and gasoline production from the naphtha stream. Increased capital costs for the Phenoraffin unit are balanced by elimination of the naphtha treatment units, so that capital costs remain about even between Tasks 1 and 4. Fuel costs drop significantly, since the naphtha stream remains in the fuel pool. The net effect is that the profit remains about the same as the original estimate.

c. Economic Sensitivities

The profitability of both the "Profitable JP-8" and the "Maximum Profit" cases varies considerably with the value of the product streams and fuel costs. The former was evidenced above by the impact of revised phenol price structures since the Task 1 report. In this section the effects of the cost of replacement fuels and limitations on cresylic acid and cresol sales are discussed.

Replacement Fuel Costs--Figure 7 shows the impact of replacement fuel costs on the "Maximum Profit" case. Essentially, the effect of fuel cost is unchanged, although the curve is slightly flatter now since the naphtha stream remains in the fuel pool and is not processed. The estimates in Tables 4 through 8 are based on a fuel cost of $2.15 per million BTU.

TABLE 7

GREAT PLAINS LIQUID BYPRODUCTS CASE SUMMARY

| | Max Profit | | Profit JP-8 | |
|---|---|---|---|---|
| Economics | Task 1 | Task 4 | Task 1 | Task 4 |
| Profit, $M/CD | 40.9 | 37.4 | 24.7 | 1.3 |
| Profit, $MM/Yr | 14.9 | 13.7 | 9.0 | 0.5 |
| Investment, $MM | 37.0 | 28.2 | 89.3 | 110.3 |
| Feedstocks, BCD | | | | |
| GP Naphtha | 660 | 0 | 660 | 660 |
| GP Phenol | 833 | 799 | 833 | 799 |
| GP Tar Oil | 0 | 0 | 2,896 | 2,932 |
| Syngas, MMSCFD | 0.4 | 0 | 23.2 | 22.7 |
| Products, BCD | | | | |
| Gasoline | 64 | 0 | 306 | 925 |
| Reformer Feed | 0 | 0 | 980 | 162 |
| Jet Fuel | 0 | 0 | 2,320 | 2,427 |
| BTX | 389 | 0 | 321 | 0 |
| Chemicals | 525 | 331 | 525 | 382 |
| Liquid Fuel | 450 | 364 | 456 | 798 |
| Unit Capacity, BCD | | | | |
| Aromatics Rec | 428 | 0 | 355 | 0 |
| Phenoraffin | 833 | 799 | 833 | 799 |
| Tar Oil Distil | 0 | 0 | 0 | 2,932 |
| Hydrocracking | 0 | 0 | 747 | 964 |
| Hydrotreating | 0 | 0 | 4,797 | 4,441 |
| Naphtha Distil | 660 | 0 | 660 | 660 |
| Naphtha Hydrtg | 476 | 0 | 476 | 476 |
| PSA, MMSCFD | 0.4 | 0 | 23.2 | 22.7 |

TABLE 8

GREAT PLAINS ECONOMICS SUMMARY

| | Max Profit | | Profit JP-8 | |
|---|---|---|---|---|
| Cash Flow, $M/CD | Task 1 | Task 4 | Task 1 | Task 4 |
| Net Sales[1] | 79.9 | 55.4 | 158.5 | 143.8 |
| Fuel[2] | -14.6 | 0.2 | -66.9 | -65.2 |
| Cat and Chem | -0.8 | -0.5 | -5.0 | -3.4 |
| Utilities[3] | -0.9 | -0.7 | -7.3 | -8.5 |
| MTIO[4] | -4.1 | -3.1 | -9.8 | -12.1 |
| Fixed Costs[5] | -2.6 | -1.4 | -5.2 | -4.7 |
| Capital Recov[6] | -16.4 | -12.5 | -39.5 | -48.7 |
| Total Profit | 40.8 | 37.4 | 24.8 | 1.3 |
| Total, $MM/Yr | 14.9 | 13.7 | 9.0 | 0.5 |

(1) Includes naphtha, gasoline, BTX, and chemicals, less the cost of purchased gasoline blending stocks (e.g., butane).
(2) Includes Great Plains naphtha, tar oil, phenol, and hydrogen removed from syngas, as well as purchased fuel, less credit for fuel returned to the Great Plains pool. Hydrogen is priced at a premium over fuel value.
(3) Includes power, steam, process water, and cooling water.
(4) Maintenance, taxes, insurance, and overhead charges.
(5) Primarily operating labor.
(6) 16.1%/year of capital. See Table II for basis.

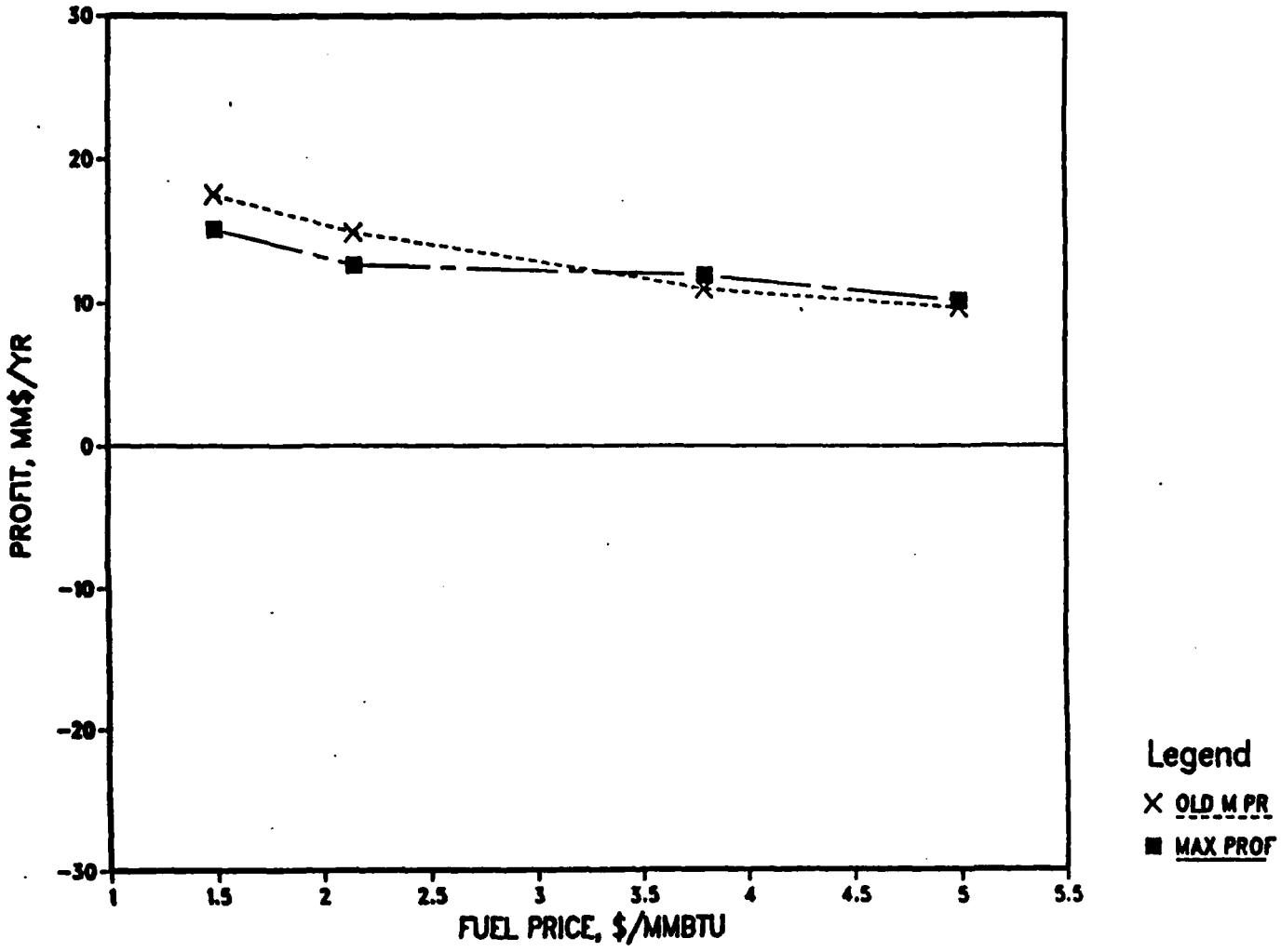



FIGURE 7
MAXIMUM PROFIT CASE
EFFECT OF FUEL PRICE

Effect of Chemical Sales Limitations--Table 9 and Figure 8 show the effect of relaxing the restraints placed on cresol and cresylic acid sales. The profitability estimates reported above are based on cresol and cresylic acid sales limits of 10 percent of the domestic market. The market for these chemicals is small enough so that the Great Plains phenols stream could provide as much as 40 percent of the domestic demand. If the product values held at current levels at all values of percent of U.S. market, the profitability of "Maximum Profit" case would vary according to curves shown in Figure 8. Figure 8 shows the net profit from chemicals sales versus penetration of the domestic cresol and xylenol market. Curves are shown for varying penetrations of the cresylic acids market. Increased market penetration gives increased profits, assuming no change in the product value. Unlimited chemicals sales increase the profitability from $13.7 million per year for the 10 percent limitations to $21.3 million per year.

Effect of Chemical Sales Subsidy on JP-8 Cost--Table 10 lists the costs of JP-8 for the "Profitable JP-8" case when the value of the jet fuel is subsidized by chemical sales and when it is not. The value of JP-8 was taken as $21.84 per barrel for this study. For the subsidized case, the net profitability, $1,300 per day, was distributed to the 2,427 barrels of JP-8 produced to arrive at a net jet fuel cost of $21.3 per barrel. The unsubsidized case was calculated by distributing the net increased cost of going from the "Maximum Profit" case, wherein no JP-8 is produced, to the "Profitable JP-8" case. The net increased costs for jet fuel production were $124,600 per day, the increased capital and operating costs, minus $35,500, the increased sales from additional chemical and fuel manufactured. This $89,100 per day increase in cost yields 2,427 barrels per day of JP-8, which would break even at $36.7 per barrel.

TABLE 9

EFFECT OF CHEMICAL SALES LIMITS

| | % of U.S. Market | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cresol, Xylenol | 0 | 0 | 0 | 10 | 10 | 10 | 20 | 20 | Unl |
| Cresylic Acids | 0 | 10 | 20 | 0 | 10 | 20 | 0 | Unl | Unl |
| Flow Rate, BCD | | | | | | | | | |
| Cresol Sales | 0 | 0 | 0 | 105 | 105 | 55 | 180 | 177 | 231 |
| Xylenol Sales | 0 | 0 | 0 | 30 | 20 | 10 | 60 | 55 | 114 |
| Cresylic Acid Sales | 0 | 140 | 280 | 0 | 51 | 280 | 0 | 114 | 0 |
| Fuel Cresol, Xylenol | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| Unit Capacity, BCD | | | | | | | | | |
| Phenoraffin Extract. | 799 | 799 | 1,167 | 882 | 799 | 1,409 | 1,027 | 1,409 | 1,409 |
| Cresylic Acid Frct | 1,304 | 181 | 181 | 181 | 181 | 181 | 242 | 232 | 345 |
| Tar Oil Frct | 0 | 0 | 1,770 | 399 | 0 | 2,932 | 1,096 | 2,932 | 2,932 |
| Dynaphen | 181 | 41 | 0 | 62 | 0 | 0 | 0 | 0 | 0 |
| Economic Summary | | | | | | | | | |
| Investment, $MM | 51.8 | 49.7 | 58.2 | 52.7 | 48.6 | 63.4 | 56.7 | 64.9 | 54.6 |
| Profit, $M/CD | 17.6 | 26.3 | 35.9 | 31.7 | 18.2 | 44.4 | 43.0 | 51.3 | 58.2 |
| Profit, $MM/Yr | 6.4 | 9.6 | 13.1 | 11.6 | 6.6 | 16.2 | 15.7 | 18.7 | 21.3 |

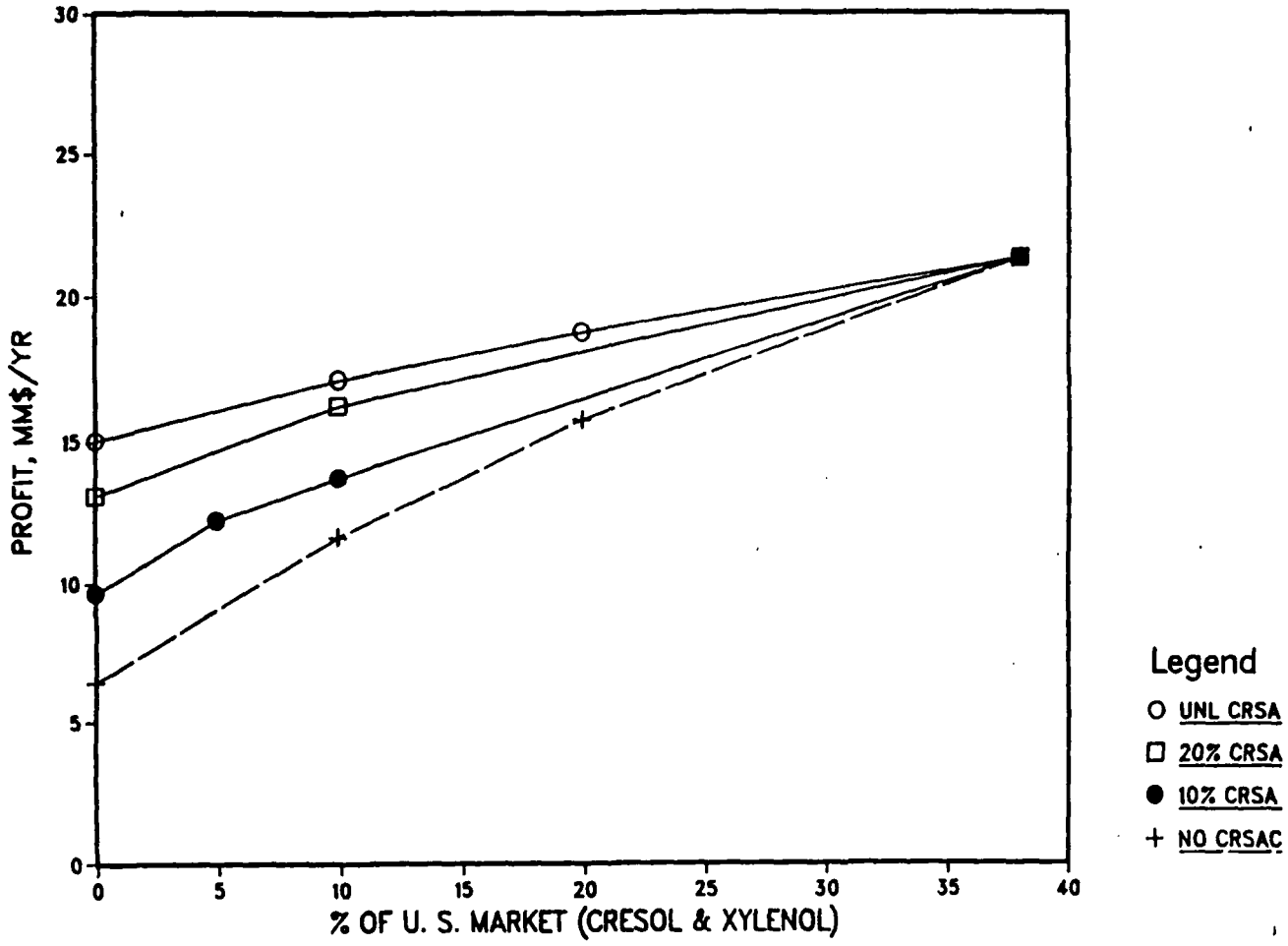



FIGURE 8
MAXIMUM PROFIT CASE
EFFECT OF CHEMICALS SALE

TABLE 10

JET FUEL (JP-8) COSTS
PROFITABLE JP-8 CASE

| | $/Bbl | $/Gal. |
|---|---|---|
| Subsidized by Chemical Sales | 21.3 | 0.51 |
| Unsubsidized | 36.7 | 0.87 |

## SECTION V

## TASK 5 RESULTS

Task 5 calls for the recommendation of a 10,000-barrel test run to produce JP-8 from the Great Plains tar oil stream. Lummus Crest Inc. completed this portion of the contract. Their report is included as Appendix H and is summarized here.

### 1. Production Run Recommendation

Work in Tasks 2 and 3 showed that the first stage of tar oil hydrotreatment requires an expanded bed hydrotreater unit. Two such commercial units exist in the United States, but both are too large to carry out a 10,000-barrel run. Lummus has recommended an alternative approach using a two-stage, fixed-bed hydrocracker system. The tar oil would be treated in five steps:

1. Tar oil hot filtration to remove solids to avoid plugging the first-stage hydrocracker.

2. Hydrocracking at a high recycle rate to handle heat of reaction to lower heteroatom content and to begin aromatics saturation.

3. Fractionation of the hydrotreated products.

4. Recycle hydrocracking of the 550 F+ fraction to extinction.

5. Clay treatment of the blended JP-8 product.

Details of the processing steps are provided in Appendix H.

### 2. Demonstration Run Facilities

Table 11, excerpted from Appendix H, lists U.S. refineries with hydrocracking capacity which might be able to accomplish a 10,000-barrel run according to the recommended scheme. None of the refineries has been contacted regarding this test, and it is not clear whether any of the facilities would be able to match all the equipment needs of the test. In addition to the refineries listed in Table 11, other options are outlined in Appendix H, including the Wilsonville coal liquefaction facility in Wilsonville, Alabama.

TABLE II

LIST OF REFINERIES WITH HYDROCRACKING CAPACITY

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Tesoro Petroleum<br>Kenai Refinery<br>Box 3691<br>Kenai, AK 99611 | Jose Verdin<br>907-776-8191 | 9,000 | Residue |
| Atlantic Richfield<br>Watson Refinery<br>Box 6210<br>Carson, CA 91749 | A. W. Johnson<br>213-548-8000 | 22,000 | Dist. |
| Chevron U.S.A.<br>Richmond Refinery<br>Box 1272<br>Richmond, CA 94802 | J. P. Krider<br>415-620-3000 | 30,000 | Residue |
| Mobil Oil<br>Torrance Refinery<br>3700 West 190th St.<br>Torrance, CA 90509-2929 | L. K. Williams<br>213-328-2550 | 21,700 | Dist. |
| Mobil Oil<br>Beaumont Refinery<br>Box 3311<br>Beaumont, TX 77704 | J. A. Jones<br>409-883-9411 | 32,000 | Dist. |
| Texaco<br>Port Arthur Refinery<br>Box 712<br>Port Arthur, TX 77640 | R. E. Anderson<br>713-982-5711 | 15,000 | Dist. |
| Texaco<br>Bakersfield Refinery<br>Box 1476<br>Bakersfield, CA 93302 | D. R. Hall<br>805-326-4200 | 14,300 | Dist. |
| Texaco<br>Los Angeles Refinery<br>Box 817<br>Wilmington, CA 90748 | R. E. Morris<br>213-835-8261 | 20,000 | Dist. |
| Tosco<br>Avon Refinery<br>Martinez, CA 94553 | J. M. Cleary<br>415-228-1220 | 23,000 | Dist. |

TABLE II

(Continued)

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Unocal<br>1660 West Anaheim St.<br>Box 758<br>Wilmington, CA 90744 | A. V. Mandlekar<br>213-513-7600 | 22,000 | Residue |
| Texaco<br>Delaware City Refinery<br>Delaware City, DE 19706 | R. C. Mifflin<br>302-834-6000 | 19,000 | |
| Hawaiian Independent<br>733 Bishop St.<br>Suite 3000, Box 3379<br>Honolulu, HI 96813 | Everett Lewis<br>808-547-3222 | 16,000 | Residue |
| Clark Oil, Blue Island<br>Division of APEX Oil<br>8182 Maryland Ave.<br>St. Louis, MO 63105 | S. A. Goldstein<br>314-889-9600 | 9,500 | Dist. |
| Marathon<br>Robinson Refinery<br>Robinson, IL 62454 | K. N. Warren<br>618-544-2121 | 23,000 | Dist. |
| Kerr-McGee<br>Wynnewood Refinery<br>Box 305<br>Wynnewood, OK 73098 | John L. Ray<br>405-665-4311 | 5,000 | Dist. |
| Total<br>Arkansas City Refinery<br>1400 South M St.<br>Arkansas City, KS 76005 | Jack Hazen<br>316-442-5100 | 3,200 | Dist. |
| Exxon<br>Baton Rouge Refinery<br>Box 551<br>Baton Rouge, LA 70821-0551 | D. H. Daigle<br>504-359-7711 | 24,000 | Dist. |
| Exxon<br>Billings Refinery<br>Box 1163<br>Billings, MT 59103-1163 | J. A. MacFarlane<br>406-657-5380 | 4,900 | Dist. |
| Exxon<br>Benica Refinery<br>3400 East 2nd St.<br>Benica, CA 94510-1097 | D. L. Wiggins<br>707-745-7011 | 29,500 | Dist. |

TABLE II

(Concluded)

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Sohio<br>1150 South Metcalf St.<br>Lima, OH 45804 | P. Oves<br>419-226-2300 | 23,000 | Dist. |
| Sohio<br>Toledo Refinery<br>Box 696<br>Toledo, OH 43964 | J. T. Jacobson<br>419-698-6408 | 35,000 | Dist. |
| Sohio<br>Marcus Hook Refinery<br>Box 428<br>Marcus Hook, PA 19061 | J. M. Gibson<br>215-499-7000 | 21,000 | |

## SECTION VI

## CONCLUSIONS

Experimental studies in Tasks 2 and 3 showed the need for more severe hydrotreating and hydrocracking to produce jet fuel from the Great Plains tar oil than was anticipated in formulating cost estimates in Task 1. Consequently, the profitability of producing jet fuel and other by-products dropped from $9.0 million per year to $0.5 million per year.

BTX production is no longer profitable in either the "Profitable JP-8" or "Maximum Profit" cases, due to increases in the cost of a small-capacity aromatics recovery unit.

Profitability of chemicals production is improved by new estimates of the value of phenol, which increased from $80 per barrel in Task 1 to $160 per barrel today. The increase in phenol value offsets the increased capital costs for the "Maximum Profit" case nearly completely.

A demonstration run to produce 10,000 barrels of JP-8 jet fuel would require modifications to the processing scheme recommended in Task 3. No existing commercial expanded-bed hydrotreater would be suitable for the work. However, the work could probably be carried out in a fixed-bed hydrocracker unit at high recycle rates. Production facilities have been recommended.

## SECTION VII

## RECOMMENDATIONS

Before a production run can be carried out, contact with a number of refining facilities will be required to assure that their facilities can accomplish the work.

The profitability of the chemicals or jet fuel production schemes discussed in this report is highly dependent on fuel and product values and changes in construction costs. Profitability will vary dramatically, as evidenced by the changes in the estimates over the year elapsed between Task 1 and Task 4. Caution should be exercised in utilizing the estimates presented herein.

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# APPENDIX A

## LCI Report on "Profitable JP-8" Design: Case Description

# 1.0 CASE DESCRIPTION

## 1.1 Overall Process Description

The purpose of this design basis is to produce JP-8 type aviation turbine fuel and chemical byproducts to maximize profit from Great Plains liquid by products. Figure 1 presents a block diagram for the process and referring to Figure 1 the flow is as follows:

- The total Tar Oil byproduct stream (47,670 #/hr, 3222 BPSD) is first fractionated in the Preflash Tower into a 300°F- stream which is sent back to the main boiler in the SNG plant, and a 300°F+ stream which is charged to the expanded bed hydrotreater.

- The hydrotreater is a 3 stage expanded bed type process which removes over 98% of the sulfur, nitrogen, and oxygen compounds and begins the conversion of 525°F+ material. The hydrotreater adds a large quantity of hydrogen to the feed (3073 SCF/bbl) which results in a high heat of reaction. An expanded bed type reactor was chosen to both control and utilize the heat of reaction. Three stages were used to both control the temperature rise as well as to obtain the high efficiency associated with staging a back-mixed reactor.

- The hydrotreater produces 6 streams:

  - A low pressure fuel gas stream (25 psig) which is a mixture of recycle PSA off gas, atmospheric tower overhead gas, as well as overhead gas from Area 200 fractionation.

  - Very low pressure fuel gas (2 psig) which is sent to the low pressure burner.

  - Unstabilized naphtha which is sent to the combined naphtha stabilizer in the HDS unit (Area 200). After stabilization, to control vapor pressure, the naphtha is sent to storage and gasoline blending.

  - A 200°F+ stream (atmospheric bottoms) containing most of the hydrotreater liquid product, which is sent to the HDS unit (Area 200).

  - A solids laden vacuum bottoms product which is sent to the battery limits.

  - Wastewater containing NH4OH and NH4HS which is sent to the PHOSAM unit in the SNG plant for recovery of the H2S and NH3.

- Approximately 950 #/day of spent catalyst which is shipped to a catalyst reclaimer in the same drums that the catalyst is received in.

. The $200^{o}F+$ stream from the expanded bed hydrotreater (Area 100) is charged to the HDS unit (Area 200).

. The HDS and JP-8 Fractionation Unit (Area 200) follows the expanded bed hydrotreater. Here the sulfur and especially nitrogen removal is continued to levels compatible with the catalyst in the hydrocracker. In the fractionation section the liquid products (JP-8 and light naphtha) from this plant are stabilized, as well as the hydrotreater naphtha.

. The unit produces 7 steams:

- A high pressure purge gas which is sent to the recycle compressor in Area 100.

- Off gas from both the JP-8 tower and the naphtha stabilizer which are sent to Area 100 to be compressed for fuel gas.

- Off gas from the LP Separator, sent to either fuel gas, or PSA off gas.

- A stabilized light naphtha stream sent to storage.

- Stabilized JP-8 sent to storage.

- A nonconverted $525^{o}F+$ stream (fractionator bottoms) which is sent to the fixed bed hydrocracker (Area 300).

- A sour water stream sent to Area 100.

. The Hydrocracker Unit (Area 300) converts the $525^{o}F+$ material to naphtha and JP-8 turbine fuel. For this service a 5 stage unit was chosen with 65% conversion per pass.

. The hydrocracker produces 3 streams:

- High pressure purge gas (approximately 90% hydrogen) which is sent to the recycle compressor in Area 100.

- A combined liquid stream which is sent to the fractionation tower in Area 200.

- A small sour water stream which is sent to Area 100.

- Hydrogen make-up for all three units; Hydrotreater, HDS and Hydrocracker as well as the Naphtha Hydrotreater (Area 600) is supplied from a PSA Hydrogen Unit. High pressure (355 psig) synthesis gas from the Rectisol Unit (which contains about 63% hydrogen) is charged to the PSA unit which recovers 86% of the contained hydrogen as a high pressure 99.99% purity hydrogen gas product. The remaining purge gas is available at low pressure (5 psig) and has a fuel value of about 565 BTU/$ft^3$. This $H_2$, CO & $CH_4$ rich gas is recompressed into the methanation unit of the SNG plant.

- The crude naphtha byproduct stream (8738#/hr, 725 BPSD) is charged to the distillation and hydrotreating unit (Area 600).

- The distillation removes the material boiling below 160°F, which is sent to the SNG plant fuel pool, and produces a bottoms product which is charged to the hydrotreater.

- The fixed bed hydrotreater is a single bed reactor which removes 99% + of the sulfur, nitrogen and oxygen compounds. Hydrogen is added to the feed at the rate of 430 SCF/bbl.

- The naphtha hydrotreater produces 4 streams:

  - High pressure purge gas (approximately 90% hydrogen) which is sent to the Rectisol Unit in the SNG plant for recovery of the $H_2$ and $CH_4$.

  - Naphtha which is stabilized to control vapor pressure, and then sent to the aromatics recovery unit (Area 700).

  - A low pressure off gas which is sent to the Stretford unit in the SNG plant.

  - Wastewater containing, NH4OH and NH4HS which is sent to the PHOSAM unit in the SNG plant for recovery of the H2S and NH3.

- The hydrotreated naphtha is charged to the extraction section of the Aromatics Recovery Unit (Area 700) where it is contacted with a solvent to extract the aromatic components from the stream. The raffinate is sent to storage and gasoline blending while the solvent is recovered from the aromatic extract. The aromatic extract is then sent to fractionation to produce the BTX products.

- Five streams are produced in the Aromatics Recovery Unit.

  - A hydrocarbon gasoline blending stock which is sent to storage and gasoline blending.

- A small process water stream which is sent to the waste treatment plant in the SNG plant.

- Three product streams Benzene, Toluene and Xylene which are sent to storage.

. The crude phenol byproduct stream (13,550 #/hr, 878 BPSD), is fed to the crude phenol processing units.

- Area 800 : Phenol Extraction
- Area 850 : Cresylic Acid Extraction
- Area 900 : Cresylic Acid Distillation

. In the Phenol Extraction Area (800) the crude phenol is first distilled to remove the tar (approximately 35% of the feed) and secondly fractionated to remove the phenol and cresylic acid from the light ends cut. The light ends cut is fractionated to recover the entrained phenol.

. The phenol and cresylic acid stream is flashed in a thin film evaporator over a concentrated sulfuric acid mixture to remove pyridine type substances. The vapor phase is dried and then distilled to extract phenol from the cresylic acid mixture.

. The phenol product is purified with steam and sent to storage. The resulting cresylic acid mixture is sent to Section 850.

. The tars produced are water washed and sent to fuel.

. Streams produced in the Phenol Extraction Area are:

- Phenol product sent to storage
- Cresylic acid mixture sent to Section 850
- Tar product sent to storage and fuel for the SNG plant boilers.

. The remaining cresol/xylenol mixture is sent to the Cresylic Acid Extraction Area (850) where it is double solvent (hexane and methanol) extracted to remove neutral hydrocarbons. The resulting crude cresylic acid is dried and sent either to storage or distillation (Area 900).

. The solvents are re-extracted by distillation and recycled to the extractor column.

- Streams produced in the Cresylic Acid Extraction Area are:

  - Neutral Oil mixed with Tars from 800 Area
  - Crude Cresylic Acid sent to distillation (Area 900) or intermediate storage

- The Crude Cresylic Acid is sent to Cresylic Acid Distillation (Area 900) where it is progressively distilled in a 2 block operation scheme.

- Block operation 1 extracts M/P Cresol product, Crude Phenol, o-Cresol and Mixed Xylenol streams:

- Block operation 2 extracts o-Cresol, 2.4/2,5 Xylenols and Mixed Xylenol products and slop cut stream.

- Streams produced in the Cresylic Acid Distillation Area are:

  - O-Cresol product sent to storage
  - M/P Cresol product sent to storage
  - 2,4/2,5 Xylenols and Mixed Xylenols products sent to storage
  - Slop cut mixed with the Tar product from Area 800.
  - A Crude Phenol stream which is recycled to Area 800.

## 1.2 Overall Material Balance

The overall material balance which is presented below presents the overall material balance for the major process units computed on the basis that the fuel value of the feed will be replaced by fuel gas, tar oil and 160$^{0}$F- distillate produced in the process and the difference made up by the purchase of #6 Fuel Oil. Detailed Material Balances for each process area are presented in Section 2 with the Process Flow Diagrams.

The overall balance is as follows:

Feeds

| | |
|---|---|
| 3222 | BPSD of Tar Oil |
| 878 | BPSD of Crude Phenol |
| 725 | BPSD of Crude Naphtha |
| 4290 | BPSD of #6 Fuel Oil |
| 11.07 | MMSCFD equivalent SNG product loss due to the syngas feed to the PSA unit |

Products

| | |
|---|---|
| 2662 | BPSD of JP-8 turbine fuel |
| 162 | BPSD of 300°F - Naphtha for gasoline blending |
| 813 | BPSD of stabilized naphtha |
| 226 | BPSD of Phenol |
| 45 | BPSD of o-Cresol |
| 124 | BPSD of m,p-Cresol |
| 13 | BPSD 2,4/2,5 Xylenols |
| 18 | BPSD of Mixed Xylenols |
| 395 | BPSD of Tar Oil for Fuel |
| 202 | BPSD of 160°F- Distillate for Fuel |
| 46 | BPSD of Gasoline Blending Stock |
| 315 | BPSD of Benzene |
| 112 | BPSD of Toluene |
| 15 | BPSD of Xylene |
| 6.94 | MMSCFD equivalent SNG product credit due to HDT, & PSA purge gas reinjection into SNG plant. |

Net Changes in Boiler Fuel Fired

| Fuel | #hr | BTU/# | MMBTU/hr | MMSCFD | BTU/ft$^3$ | BPSD |
|---|---|---|---|---|---|---|
| Tar Oil | -47670 | 17000 | -810.4 | | | - 3222 |
| Crude Phenol | -13550 | 13070 | -177.1 | | | -878 |
| Crude Naphtha | -8738 | 18500 | -161.7 | | | -725 |
| Fuel Gas | 3940 | 18000 | 70.9 | 2.19 | 777 | |
| 160°F- distillate | 2164 | 17400 | 37.7 | | | 202 |
| Tar Oil | 6117 | 15000 | 91.8 | | | 395 |
| Import Steam | 89000 | 710 | -63.2 | | | |
| Fuel Oil to Boiler | 56222 | 18000 | 1012. | | | 4061 |
| Total | | | 0.0 | | | |
| Fuel Oil to Process Heaters | 3172 | 18000 | 57.1 | | | 229 |

| Net Changes in SNG Production | EQV SNG MMSCFD | PSA/Purge Gas #Mol/SD |
|---|---|---|
| SNG equivalent of Syn Gas to PSA | 11.07 | 75443 |
| SNG Credit for PSA Purge Gas | 6.92 | 34388 |
| SNG Credit for Hdtrs Purge Gas | 0.02 | 163 |
| Total SNG Production Loss | 4.13 | |

## 1.3 Overall Utility Balance

The overall utility consumption of the complex is as follows:

| | |
|---|---|
| #6 Fuel Oil | 4290 BPSD |
| SNG Equipment of Syn Gas & Purge Gas | 4.13 MMSCFD |
| Power | 7950 kW |
| Cooling Water | 8860 GPM ($30^{o}$F rise) |
| Process Water | 100 GPM |

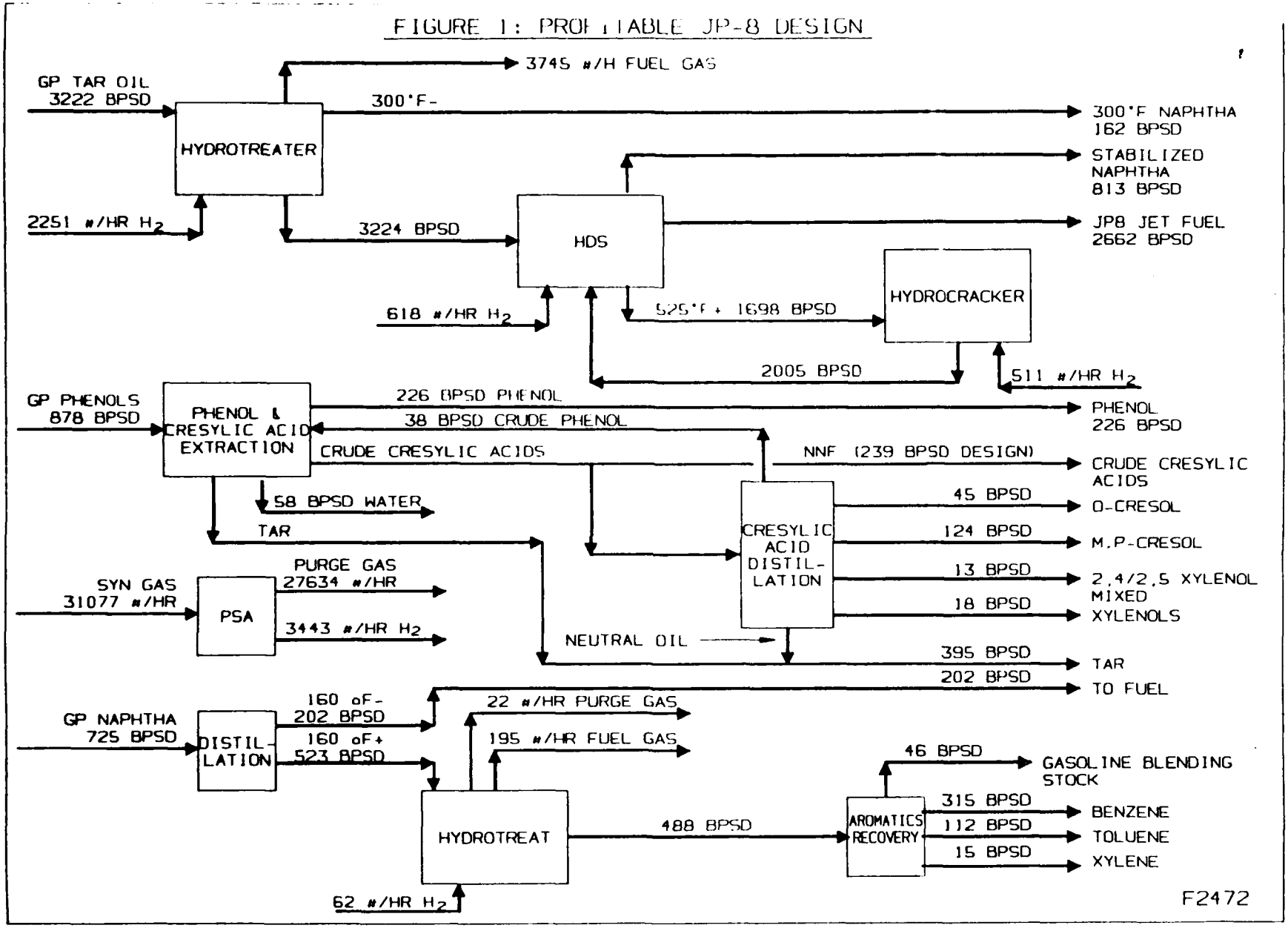
In addition the process utilizes steam as summarized below which was debited against boiler requirements.

| | |
|---|---|
| HP Steam Import | 70,000 #/H |
| MP Steam Import | 34,500 #/H |
| LP Steam Export | 15,090 #/H |
| Condensate Return | 101,500 #/H |
| Boiler Feedwater Import | 13,000 #/H |

PLOT:0497 USER:D.RAPI 312 DR: IF2472 LOC: EXT: PAPER:W DATE: 04/06/89



FIGURE 1: PROFITABLE JP-8 DESIGN



APPENDIX B

LCI Report on "Profitable JP-8" Design:
Process Description

# 2.0 PROCESS DESCRIPTION

## 2.1.1 Hydrotreater (Area 100)

### 2.1.1.1 Reaction Section

Operating conditions for the hydrotreater were provided to Lummus by Amoco[1] and these conditions are presented in Table 2.1.1. This information was supplemented by LCI's calculated product properties and detailed yield and elemental balances (2). The basic processing step selected was the expanded bed hydrotreater (LC Fining) system. Due to the extremely high exothermic heat of reaction it was necessary to use 3 reactors with interstage cooling. Referring to Process Flow Diagram E5571-101 the flow is as follows:

- Feed Tar Oil from battery limits is delivered into the Day Tank FA-101, from where it is charged to the Preflash Tower DA-101 through Pump GA-114 and Preflash Heater BA-101.
- In DA-101 the Feed Tar Oil is stripped of 300$^{o}$F- components which are sent back to the SNG plant to be used as fuel.
- The 300$^{o}$F+ part, which represents the bulk of the Tar Oil is charged into the hydrotreater through Feed Pump GA-101. The charge oil is combined with feed hydrogen gas prior to entering Feed Heater BA-102. The preheated mixture is then charged to the First Reactor DC-101.
- The Expanded Bed Reactor DC-101 approaches isothermal conditions in which the heat of reaction is used to heat the feed up to 760$^{o}$F.
- The effluent from DC-101 is cooled with both the quench gas from the Recycle Gas Compressor GB-101 as well as the quench naphtha from GA-102. The combined mixture is charged into the Second Reactor DC-102.
- The effluent from DC-102 is cooled in the same manner as the previous effluent and is then charged to the Third Reactor DC-103.
- The effluent from DC-103 flows to the High Pressure/High Temperature Separator FA-102. Both the vapor and the liquid from FA-102 are let down (to 385 psig) to the Low Pressure/High Temperature Separator FA-103. This design uses the LCI patented and commercially proven low pressure hydrogen recovery scheme.

- Hot liquid from FA-103 flows to the Vacuum Tower DA-103 for solids removal. The vapors from FA-103 flow through exchangers EA-103 and EA-104 (H.P. steam generator and BWF preheater) and then are flashed in the Low Pressure/Intermediate Temperature Separator FA-104.

- The vapors from FA-104 flow through Air Cooler EC-101 where they are cooled to 120°F. Process water is injected upstream of EC-101 to convert the $H_2S$ and $NH_3$ in the gas to an aqueous $NH_4OH/NH_4HS$ solution. From EC-101 the vapor and liquid stream enter the Low Pressure/Low Temperature Separator FA-105. The hydrocarbon liquid from FA-105 is joined by the liquid from FA-104 and the combined stream if fed to the Atmospheric Tower Feed Surge Drum FA-109.

- The gas stream is sent to Recycle Gas PSA Unit PA-104. The resulting 99.99% pure hydrogen stream is combined with a portion of the gas that bypassed the PSA unit and together with high pressure purge gas form Areas 200 and 300 enters the Recycle Gas Compressor GB-101, where it is recompressed to reaction level pressure.

- At the compressor discharge the recycle gas stream is joined by the hydrogen make-up stream from Area 200.

- The PSA unit off gas (at about 5 psig) is combined with other low pressure gases from Area 200, and after compression to fuel gas header pressure in the Fuel Gas Compressor GB-102 and subsequent cooling in Fuel Gas Cooler EA-107, is sent to the boiler plant as fuel gas.

- The water phase from FA-105 joins other sour water streams from Areas 100, 200 and 300 and is sent to the PHOSAM unit in the SNG plant to recovery $H_2S$ and $NH_3$.

Table 2.1.1 Hydrotreater Conditions

| | |
|---|---|
| Reactor Type | Expanded Bed |
| Number of Reactors | 3 |
| Catalyst Addition Rate Lbs/Bbl | 0.2 (1/3 per Reactor) |
| Reactor Temperature | 760°F |
| Reactor Pressure (Outlet 3rd Reactor) | 2225 psia |
| Heat Release, Btu/Bbl | 80,150 per Reactor |
| Hydrogen Chemical Consumption SCF/BBL | 3073 |
| Ratio of $H_2$ in feed to Chemical $H_2$ | 2.0 min. |
| Catalyst Type | Shell 324 M (NiMo) |

2.1.1.2 Fractionation Section

Referring to Process Flow Diagram E5571-102 the flow is as follows. The hot liquid from FA-103 is fed to a refluxed Vacuum Flash Tower DA-103. Here a concentrated (with approximately 30% solids) bottoms stream is withdrawn and sent to battery limits for disposal.

- The top vapor is partially condensed with BFW in the HVGO Condenser/BFW Exchanger EA-101, generating both reflux and a heavy gas oil product stream.
- From the HVGO Accumulator FA-106 the LVGO vapor is condensed in the LVGO Condenser EA-102 and is pumped together with the HVGO stream to the Atmospheric Tower Feed Surge Drum FA-109.
- The vapor off the LVGO Accumulator FA-107 (mainly non-condensable gas) is directed to the Vacuum System PA-101.
- From the Vacuum Hotwell FA-108, a low pressure fuel gas is sent to a special burner in BA-101. The vacuum system uses medium pressure steam. The steam condensate is pumped out by the Sour Water Pump GA-106. This stream with all other sour water streams originating in Areas 200 and 300, is directed to the PHOSAM unit.

- The hydrocarbon liquid streams from FA-104 and FA-105 as well as the two vacuum gas oil streams are all combined in the Atmospheric Tower Feed Surge Drum FA-109. Both the vapor and liquid are fed to the Atmospheric Tower DA-102. This tower is reboiled by high pressure steam in the Atmospheric Tower Reboiler EA-105. The tower is provided with a water cooled, Atmospheric Tower Overhead Condenser EA-106 which generates both reflux and a light naphtha product. Both the overhead naphtha and the hot bottoms are sent to the HDS unit (Area 200) where the former is stabilized, while the latter represents the unit feed.

2.1.2 HDS and JP-8 (Area 200)

2.1.2.1 Reaction Section

The operating conditions for the Hydrotreater, were given by Amoco [1] and presented in Table 2.1.2. This information was supplemented by LCI's calculated product properties[2]. Certain parameters such as unit pressure and hydrogen recycle rate had to be increased by LCI in order to achieve a satisfactory hydrogen partial pressure. As shown on the Process Flow Diagram E5571-201 the flow is as follows:

- Hot atmospheric tower bottoms from Area 100 flow to the HDS Feed Surge Drum FA-201, from where the HDS Feed Pump GA-201 pumps the feed to the HDS reactor loop.

- Make up hydrogen from the rectisol unit (see composition in Table 2.1.3) for all three hydroprocessing units is being purified in a PSA unit (PA-201) located in Area 200.

- At the conditions given a 10 bed PSA unit will recover 86% wt. of the hydrogen in the feed according to the manufacturer, Union Carbide EP&P Division.

- The system uses 10 absorption vessels which are sequenced through adsorption, depressurization, purging, and repressurization steps. The process continuously produces product and purge gas (see composition in Table 2.3). It is purchased as a skid mounted unit and the control of the unit is fully automated. Drawing 5571-203 presents a schematic of a Union Carbide Polybed PSA unit.

- The unit, PA-201, selectively absorbs all components except $H_2$ and produces a 99.99% vol. purity stream at about 345 psig and 80$^0$F.

- This hydrogen stream is compressed in the Make-up Hydrogen Compressor GB-202 to a pressure high enough to satisfy all four hydroprocessing unit pressure levels.

- A controlled amount of make-up hydrogen joins the HDS recycle gas stream and together with the hydrocarbon feed enter the reaction loop.

- This reactor feed mixture is first preheated against reactor effluent in the HDS reactor Feed Effluent Exchanger EA-201, then heated in the HDS Feed Heater BA-201 after which it enters the HDS Reactor DC-201. Cold recycle gas is introduced as quench gas between the two reactor beds.

- The reactor effluent after being cooled in EA-201 passes through the HDS Reactor Effluent Condenser EC-201 where all the liquid reaction products are condensed. Prior to entering EC-201 wash water is injected into the hydrocarbon stream to convert $H_2S$ and $NH_3$ present to an aqueous $NH_4OH/NH_4H$ solution. From EC-201, the vapor and liquid enter the HDS Reactor Effluent HP/LT Separator FA-202. The hydrocarbon liquid is pressured to the fractionation section. Sour water is pressured to Area 100.

- The vapor is compressed in the HDS Recycle Gas Compressor GB-201 and joins the reactor hydrogen make-up, as treat gas. Part of the recycle serves as reactor interbed quench gas.

Table 2.1.2 HDS Reactor Operation

| | |
|---|---|
| Reactor Type | Fixed Bed |
| Number of Reactors | 1 |
| Number of Beds/Reactor | 2 |
| Catalyst per Bed | Bed 1 1/3<br>Bed 2 2/3 |
| WHSV - $HR^{-1}$ | 1.0 |
| Hydrogen Chemical Consumption SCF/Bbl | 608 |
| Reactor Pressure (outlet) | 2400 psia |
| $H_2$ Partial Pressure @ Outlet | 1709 psia |
| $H_2$ Recycle Rate SCF/Bbl | 1836 (excluding quench) |
| Heat Release BTU/Bbl | 41660 |
| Catalyst Type | Shell 354 (NiW) |

Table 2.1.3 PSA Unit Feed and Purge Gas Properties

Feed Gas (from Rectisol Unit)

| | | |
|---|---|---|
| Pressure | 355 psig | |
| Temp. | 65°F | |
| Composition | | Mol% |
| H2 | | 63.19 |
| CO | | 18.61 |
| CO2 | | 1.48 |
| CH4 | | 16.21 |
| C2H6 | | 0.31 |
| COS, H2S, CS2 | < | 0.01 |
| N2 + Ar | | 0.19 |
| H2O | < | 0.01 |

Purge Gas

| | |
|---|---|
| Pressure | 5 psig |
| Temperature | 100°F |
| Composition | Mol % |
| H2 | 19.32 |
| CO | 40.76 |
| CO2 | 3.24 |
| CH4 | 35.51 |
| C2H6 | 0.69 |
| N2+Ar | 0.41 |
| Others | 0.06 |

2.1.2.2 Fractionation Section

Referring to Process Flow Diagram E5571-202 the flow is as follows.

- HP/LT separator liquids from both the HDS unit (FA-202 in Area 200) and the HDC Unit (FA-302 in Area 300) are pressured to the JP-8 Tower Feed Surge Drum FA-204.
- Flash gas is sent to fuel, while the liquid after preheat against JP-8 tower bottoms in the JP-8 Tower Feed/Effluent Exchanger EA-202 is further heated in the JP-8 Tower Feed Heater BA-202 and sent to the JP-8 Tower DA-201.
- In this tower JP-8 is taken as a sidestream (with an approximate TBP range of 280 - 525$^{o}$F), and all the unconverted 525$^{o}$F+ material leaves the tower as bottoms.
- The overhead product naphtha is sent to naphtha stabilization. Since this is a steam stripped tower and so is the JP-8 Product Stripper DA-202, the sour water generated in the JP-8 Tower Overhead Reflux Drum FA-205 is sent to Area 100 (to the suction of GA-106) to be pumped back to the SNG plant.
- The JP-8 is steam stripped in DA-202, and after serving as a heating medium in the Naphtha Stabilizer Reboiler EA-205, is cooled in the JP-8 Product Cooler EC-202 and sent to storage.
- The naphtha from FA-205 is joined by light naphtha from Area 100, preheated in the Naphtha Stabilizer Feed/Bottoms Exchanger EA-204, and fed to the Naphtha Stabilizer DA-203.
- Here most of the $C_4^-$ hydrocarbons are stripped out of the naphtha and joining the overhead gas from the JP-8 Tower DA-201, are sent to Area 100 to be compressed to fuel gas pressure.
- The stabilized naphtha bottoms product after being cooled by exchanger with feed in EA-204 is cooled to storage temperature in the Stabilized Naphtha Cooler EA-207.
- The 525$^{o}$F+ material leaves the JP-8 tower bottoms and is pumped by GA-204 and cooled by EA-202 before being sent to the Hydrocracker (Area 300).

2.1.3 Hydrocracker (Area 300)

The operating conditions for the Hydrocracker were provided to Lummus by Amoco[1] and these conditions are presented in Table 2.1.4. This information was supplemented by LCI's calculated product properties and detailed elemental balances (2). The basic processing step is a five bed hydrocracking reactor with interbed quench. Referring to Process Flow Diagram E5571-301 the flow is as follows.

- The 525°F+ material (JP-8 tower bottoms from Area 200) is fed to the HCR Feed Surge Drum FA-301, from which it is pumped via HCR Feed Pump GA-301, mixed with recycle gas, preheated in the HCR Reactor Feed/Effluent Exchanger EA-301 and HCR Feed Heater BA-301 before being charged to the Hydrocracker Reactor DC-301.

- The five bed hydrocracker is quenched with recycle gas between stages to control the bed temperature. The hydrocracker has a conversion of 70% per pass.

- The HCR reactor effluent mixed phase is cooled in HCR Feed/Effluent Exchanger EA-301, injected with water to convert the $H_2S$ and $NH_3$ present to an aqueous $NH_4OH/NH_4HS$ solution, and then enters EC-301 where all liquid reaction products are condensed. The vapor liquid mixture enters the HCR HP/LT Separator FA-301 from which the hydrocarbon liquid is pressured back to the JP-8 tower feed stream in Area 200.

- The sour water phase in the HP/LT Separator is sent to the SNG plant Phosam unit with the Area 100 and 200 sour water streams.

- The vapors from the HP/LT Separator are sent to the HCR Recycle Gas Compressor GB-301 via FA-303 K.O. Drum. A purge stream is extracted from this stream to control the contaminants and sent to Area 100. The GB-301 Recycle Compressor effluent is partially used as quench gas for the HCR Reactor. The remaining gas is mixed with fresh makeup hydrogen and combined with the HCR Reactor liquid feed stream.

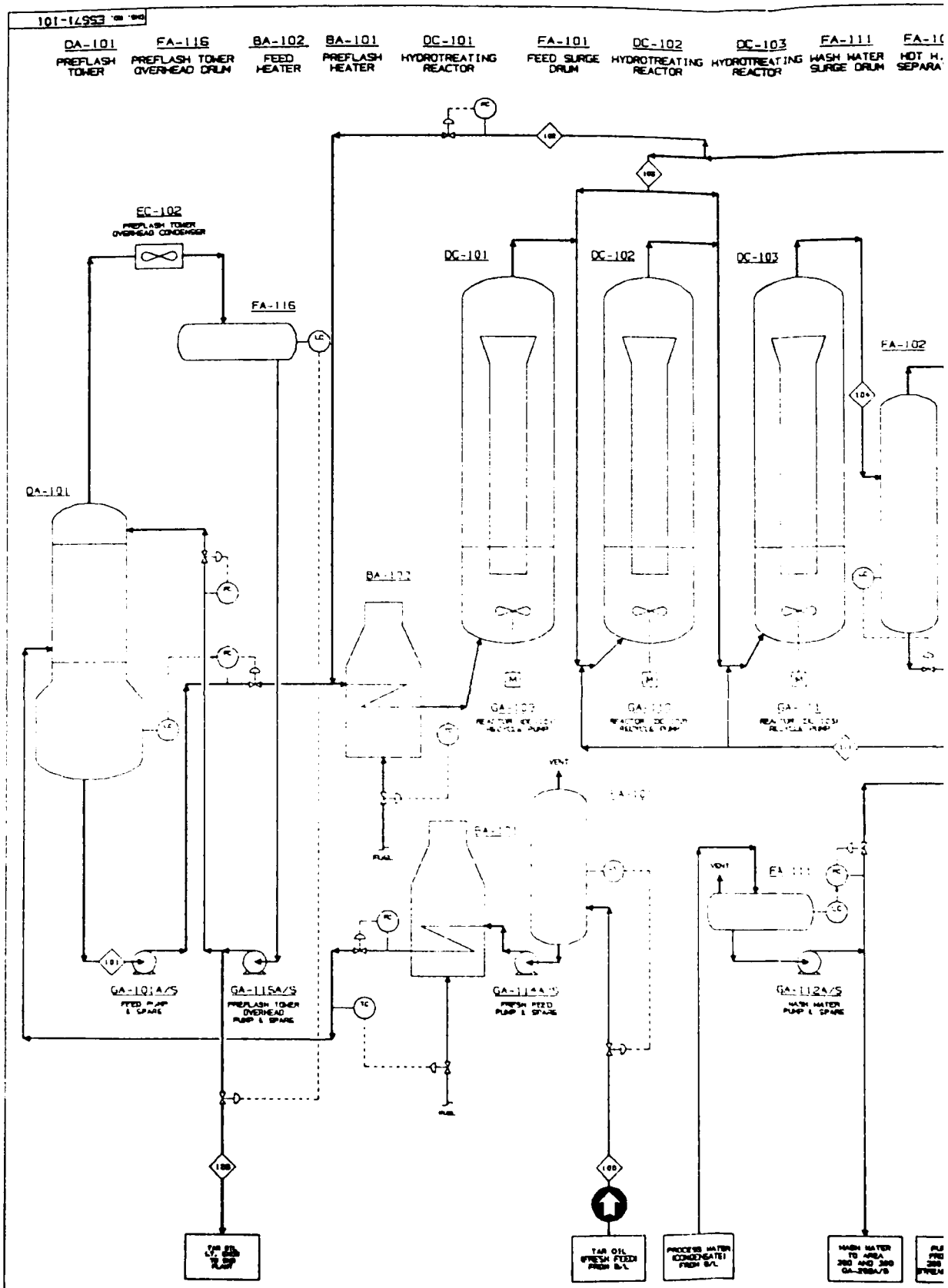
Table 2.1.4 HCR Operating Conditions

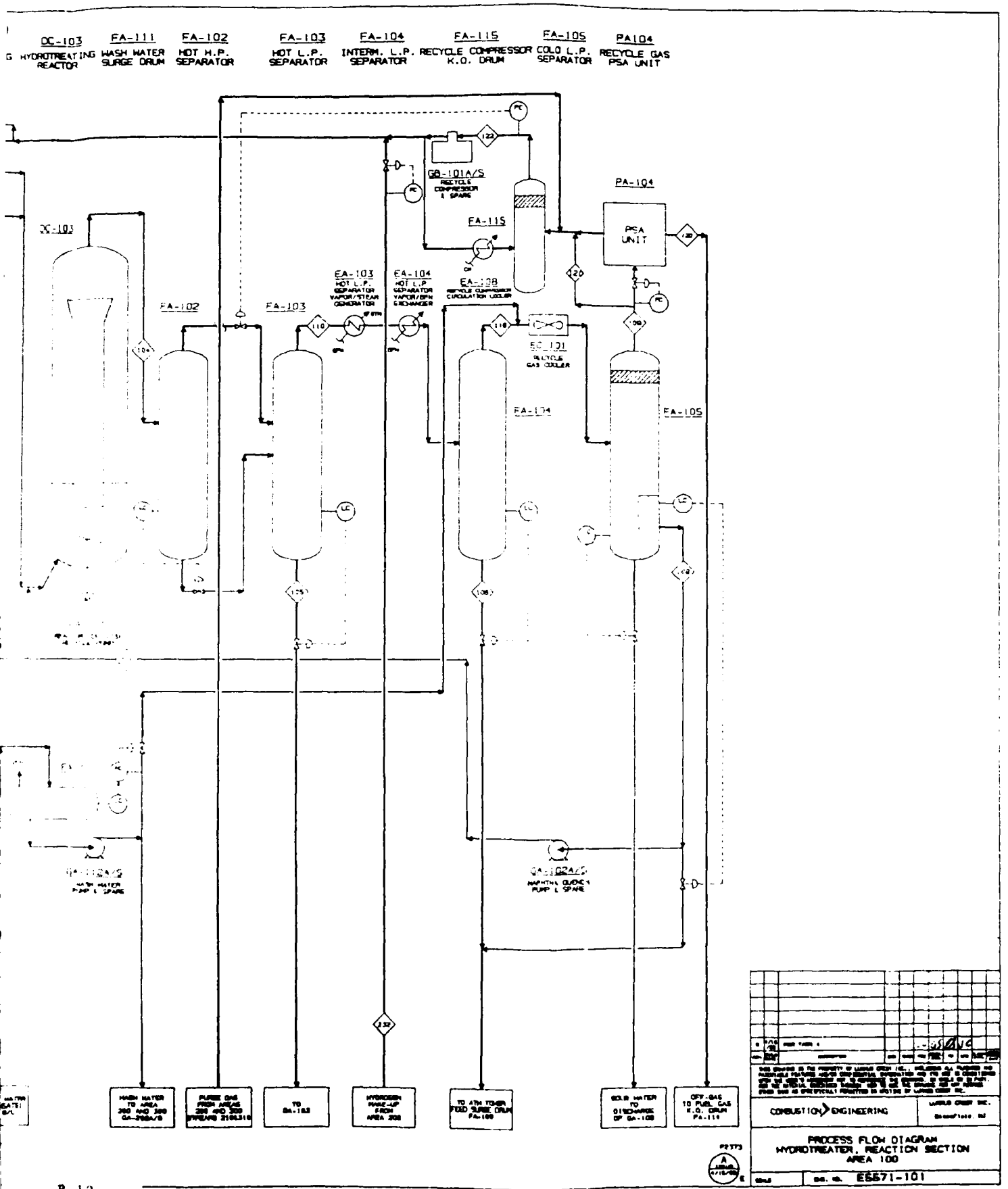
| | |
|---|---|
| Reactor Type | Fixed Bed |
| Number of Reactors | 1 |
| Number of Beds/Reactor | 5 |
| Catalyst per Bed | 10% Bed 1<br>22.5 % Beds 2-5 |
| WHSV, $HR^{-1}$ | 0.7 |
| Hydrogen Chemical Consumption | SCF/BBl 1123 |
| Reactor Pressure (outlet) | 1700 psia |
| $H_2$ Partial Pressure (outlet) | 1441 psia |
| Hydrogen Recycle Rate SCF/BBl | 6973 (excluding quench) |
| Heat Release BTU/BBl | 84806 |
| Catalyst Type | Davison SMR 6-1881 |

2.1 Tar Oil Stream - cont'd

2.1.4 Process Flow Diagrams

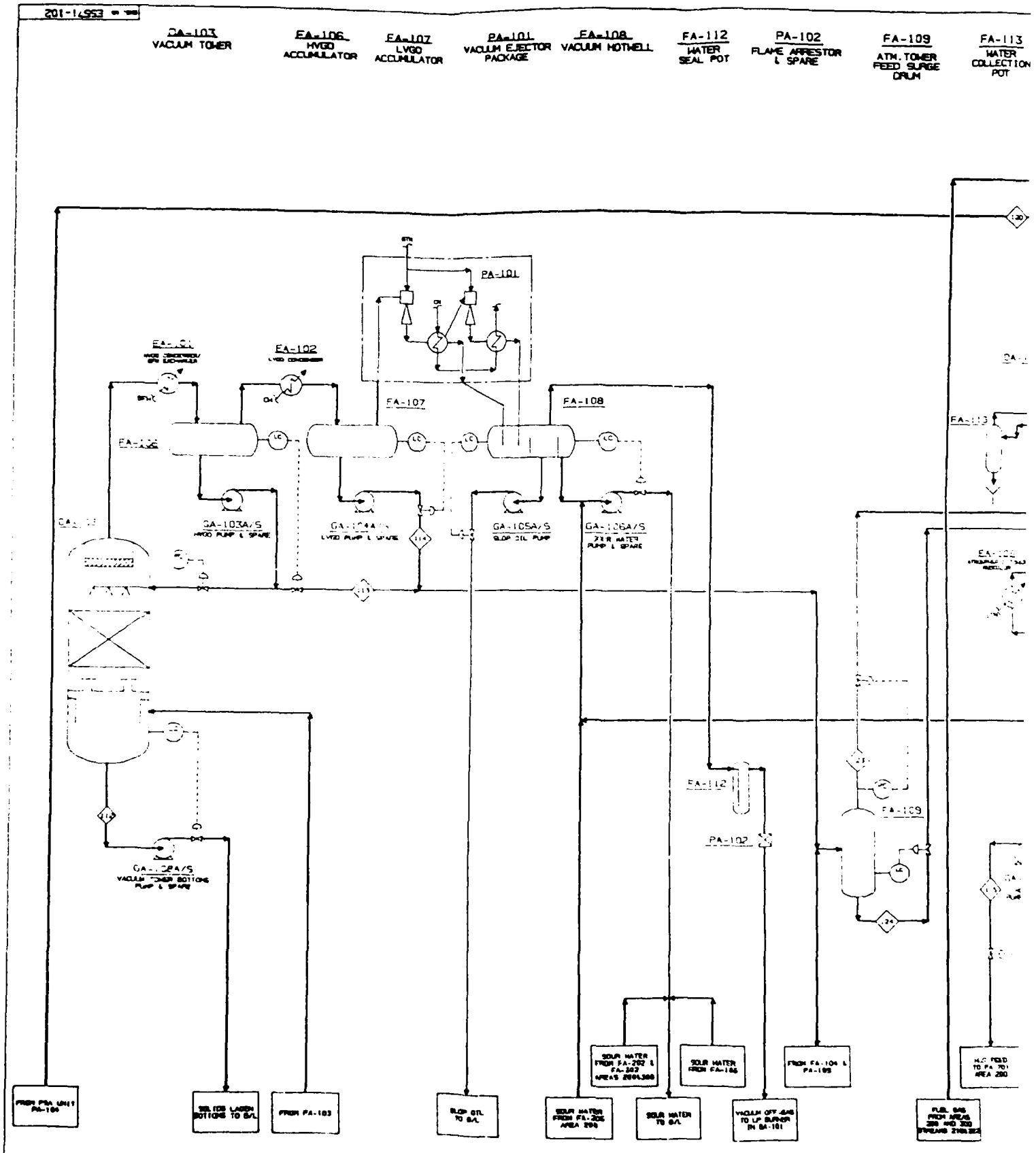
| Dwg. | Title |
|---|---|
| E5571-101 | Hydrotreater, Reaction Section |
| E5571-102 | Hydrotreater, Fractionation Section |
| E5571-201 | HDS, Reaction Section |
| E5571-202 | HDS, Fractionation Section |
| E5571-301 | Hydrocracker |
| SKB5571-103 | PSA Unit (PA-104) |
| SKB5571-203 | (PSA Unit PA-201) |


DA-101
PREFLASH TOWER
FA-116
PREFLASH TOWER OVERHEAD DRUM
BA-102
FEED HEATER
BA-101
PREFLASH HEATER
DC-101
HYDROTREATING REACTOR
FA-101
FEED SURGE DRUM
DC-102
HYDROTREATING REACTOR
DC-103
HYDROTREATING REACTOR
FA-111
WASH WATER SURGE DRUM
EC-102
PREFLASH TOWER OVERHEAD CONDENSER
FA-116
DA-101
DC-101
DC-102
DC-103
FA-102
BA-122
VENT
GA-101A/S
GA-115A/S
PREFLASH TOWER OVERHEAD PUMP & SPARE
GA-114A/S
GA-112A/S
WASH WATER PUMP & SPARE
TAR OIL FRESH FEED FROM B/L
PROCESS WATER (CONDENSATE) FROM B/L
WASH WATER TO AREA 300 AND 500






PLOT: 13:9 USER:D.RAPI 312 DR: IF2373 LOC: EXT: PAPER:W DATE: 04/21/89


DA-103
VACUUM TOWER
EA-106
HVGO ACCUMULATOR
EA-107
LVGO ACCUMULATOR
PA-101
VACUUM EJECTOR PACKAGE
EA-108
VACUUM HOTWELL
EA-112
WATER SEAL POT
PA-102
FLAME ARRESTOR & SPARE
EA-109
ATM. TOWER FEED SURGE DRUM
EA-113
WATER COLLECTION POT
EA-102
EA-107
EA-108
EA-112
EA-109
PA-102
PA-101
GA-103A/S
GA-105A/S
GA-106A/S
SOUR WATER FROM FA-106
SOUR WATER TO S/L
VACUUM OFF-GAS TO LP BURNER IN BA-101
SOLIDS LADEN BOTTOMS TO S/L
SLOP OIL TO S/L



DATE: 04/21/89

PA-102
FLAME ARRESTOR & SPARE

FA-109
ATM. TOWER FEED SURGE DRUM

FA-113
WATER COLLECTION POT

DA-102
ATMOSPHERIC TOWER

FA-110
ATM. TOWER OVERHEAD ACCUMULATOR

FA-114
FUEL GAS K.O. DRUM

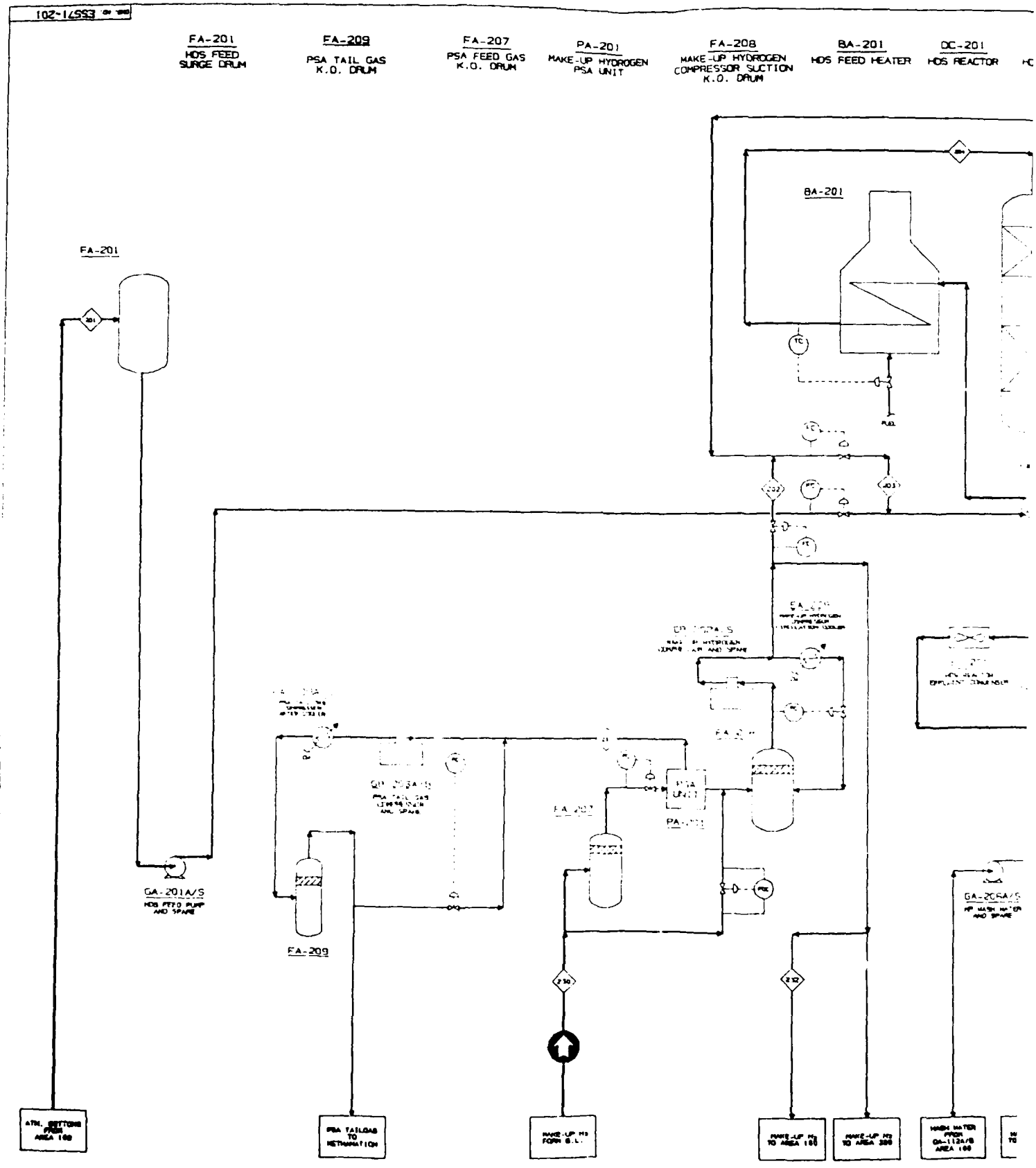



COMBUSTION ENGINEERING

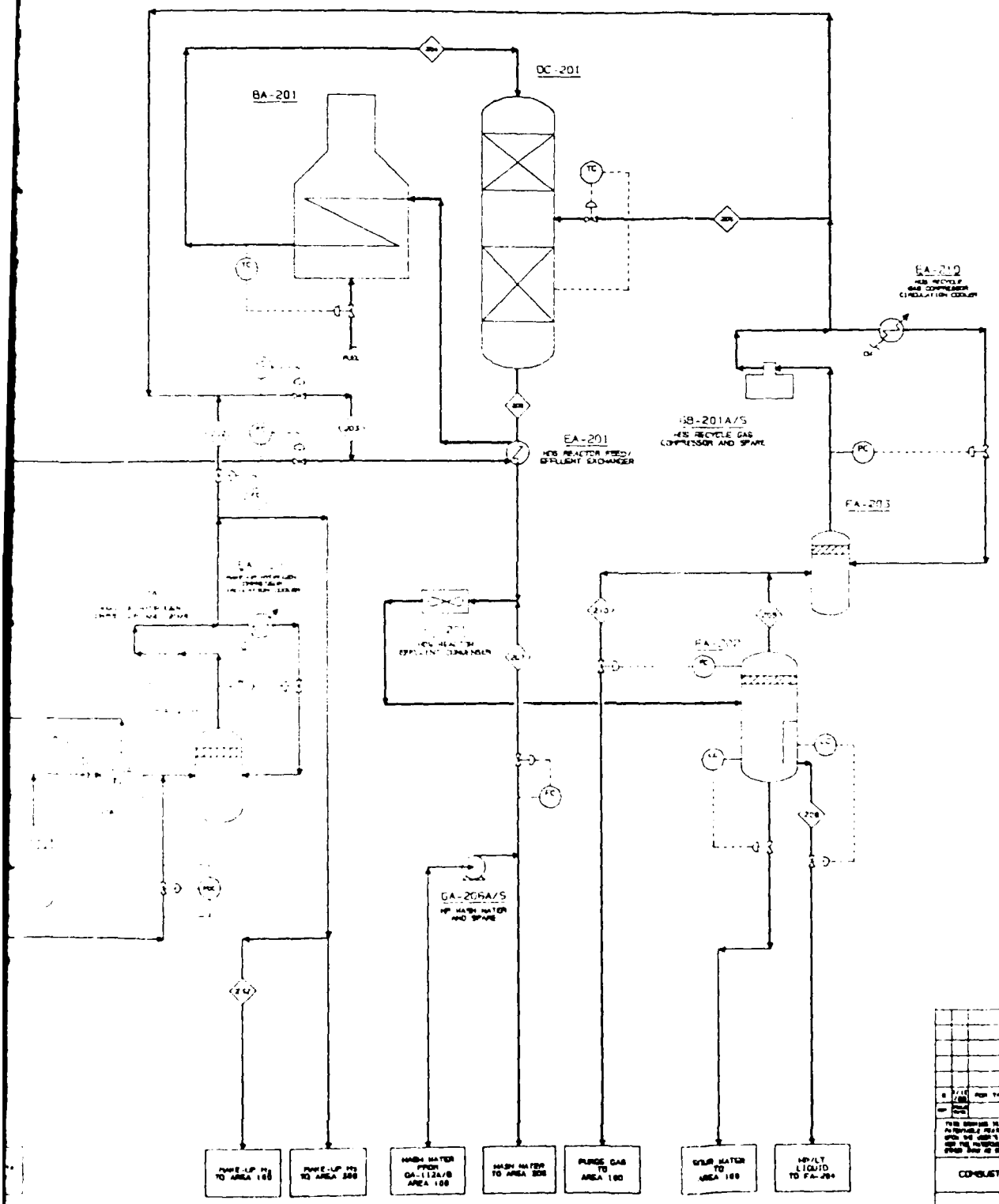
PROCESS FLOW DIAGRAM
HYDROTREATER, FRACTIONATION SECTION
AREA 100

DWG. NO. E5571-102

PLOT:1321 USER:D.RAPI 312 DR: IF2373 LOC: EXT: PAPER:W DATE: 04/21/89


FA-201
HDS FEED SURGE DRUM
FA-209
PSA TAIL GAS K.O. DRUM
FA-207
PSA FEED GAS K.O. DRUM
PA-201
MAKE-UP HYDROGEN PSA UNIT
FA-208
MAKE-UP HYDROGEN COMPRESSOR SUCTION K.O. DRUM
BA-201
HDS FEED HEATER
DC-201
HDS REACTOR
BA-201
FA-201
GA-201A/S
FA-209
PSA UNIT
PA-201
FA-207
ATM. BOTTOMS FROM AREA 100
PSA TAILGAS TO METHANATION
MAKE-UP H2 FROM B.L.
MAKE-UP H2 TO AREA 100
MAKE-UP H2 TO AREA 200
WASH WATER FROM GA-112A/B AREA 100

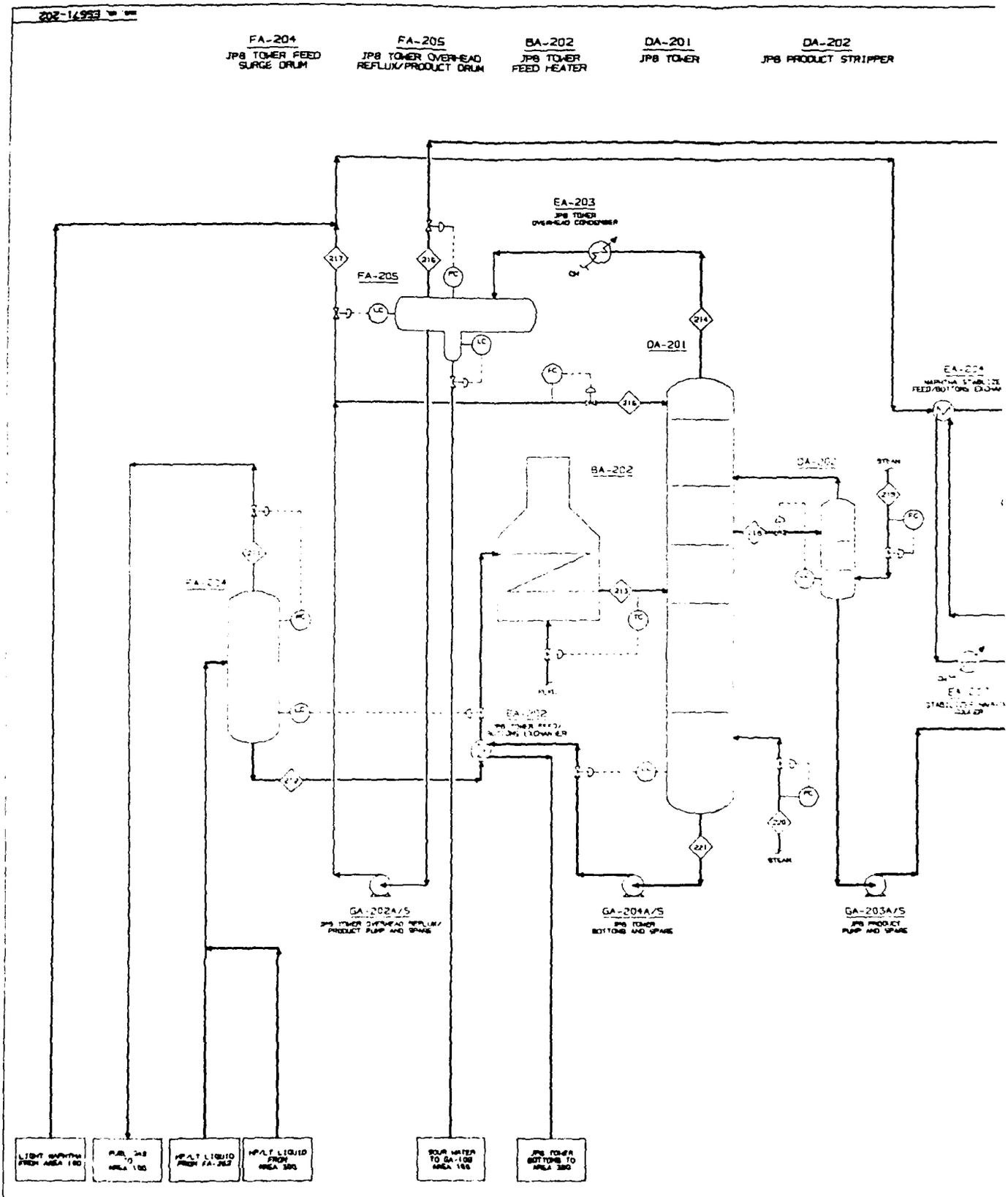
| | | | | | |
|---|---|---|---|---|---|
| -201<br>HYDROGEN<br>NIT | FA-208<br>MAKE-UP HYDROGEN<br>COMPRESSOR SUCTION<br>K.O. DRUM | BA-201<br>HDS FEED HEATER | DC-201<br>HDS REACTOR | FA-202<br>HDS REACTOR EFFLUENT<br>HP/LT SEPARATOR | FA-203<br>HDS RECYCLE GAS COMPRESSOR<br>SUCTION K.O. DRUM |




COMBUSTION ENGINEERING

PROCESS FLOW DIAGRAM
HDS. REACTION SECTION
AREA 200

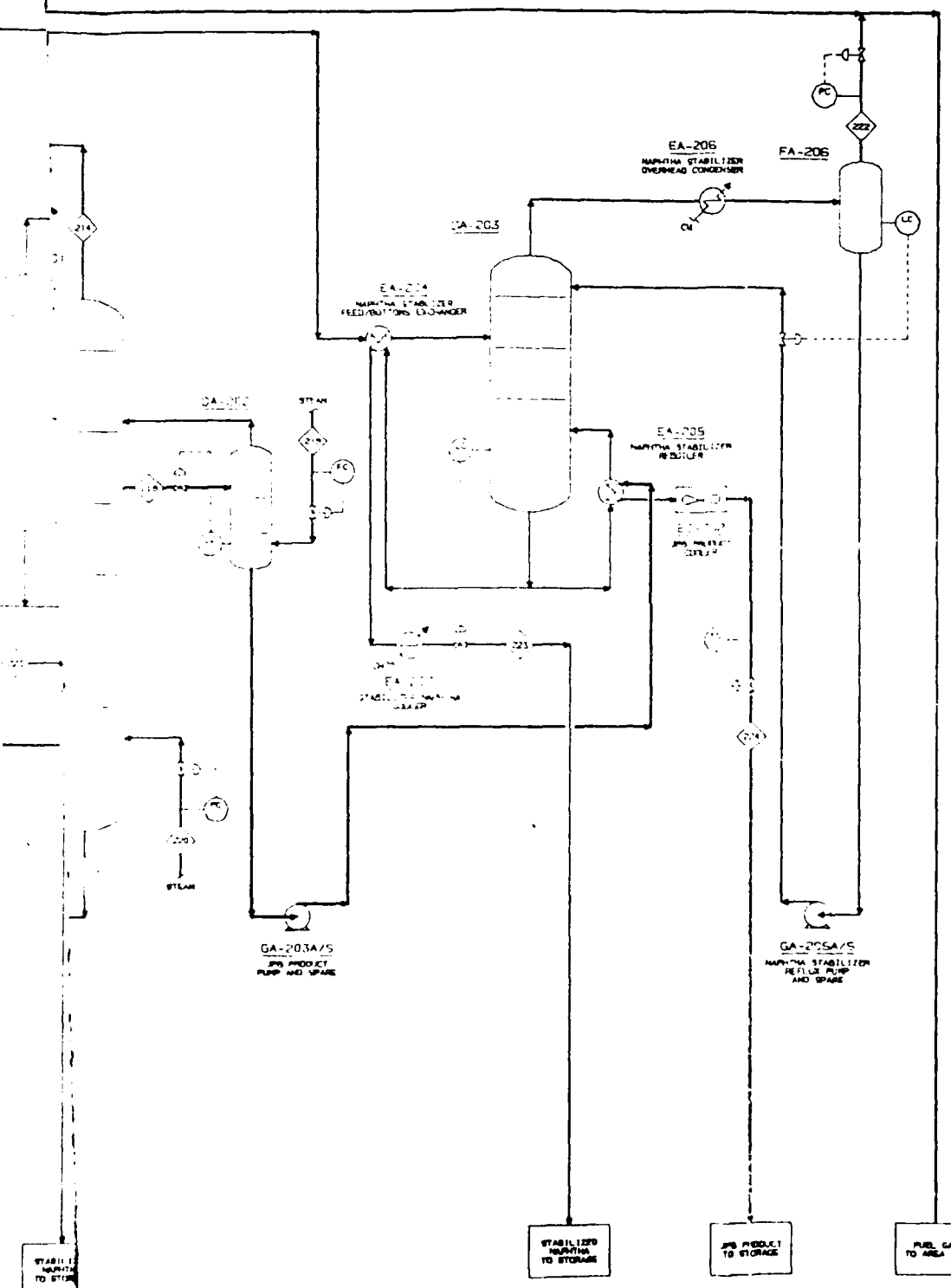
DWG. NO. ES571-201


FA-204
JP8 TOWER FEED SURGE DRUM
FA-205
JP8 TOWER OVERHEAD REFLUX/PRODUCT DRUM
BA-202
JP8 TOWER FEED HEATER
DA-201
JP8 TOWER
DA-202
JP8 PRODUCT STRIPPER
EA-203
JP8 TOWER OVERHEAD CONDENSER
FA-205
DA-201
BA-202
FA-204
STEAM
STEAM
GA-202A/S
GA-204A/S
GA-203A/S

DA-202
JP8 PRODUCT STRIPPER

DA-203
NAPHTHA STABILIZER

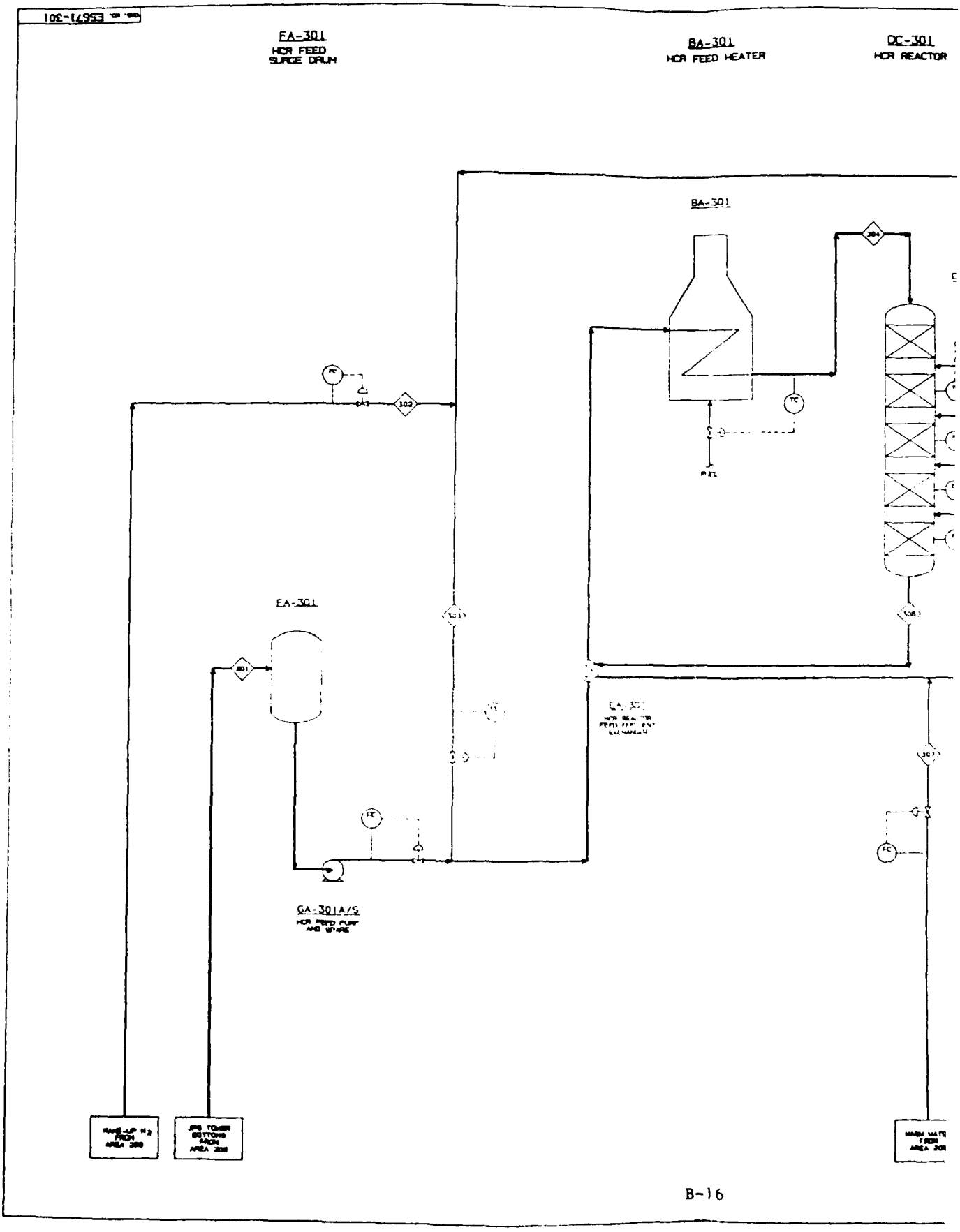
FA-206
NAPHTHA STABILIZER OVERHEAD REFLUX DRUM




COMBUSTION ENGINEERING

PROCESS FLOW DIAGRAM
HDS, FRACTIONATION SECTION
AREA 200

DWG. NO. E5571-202

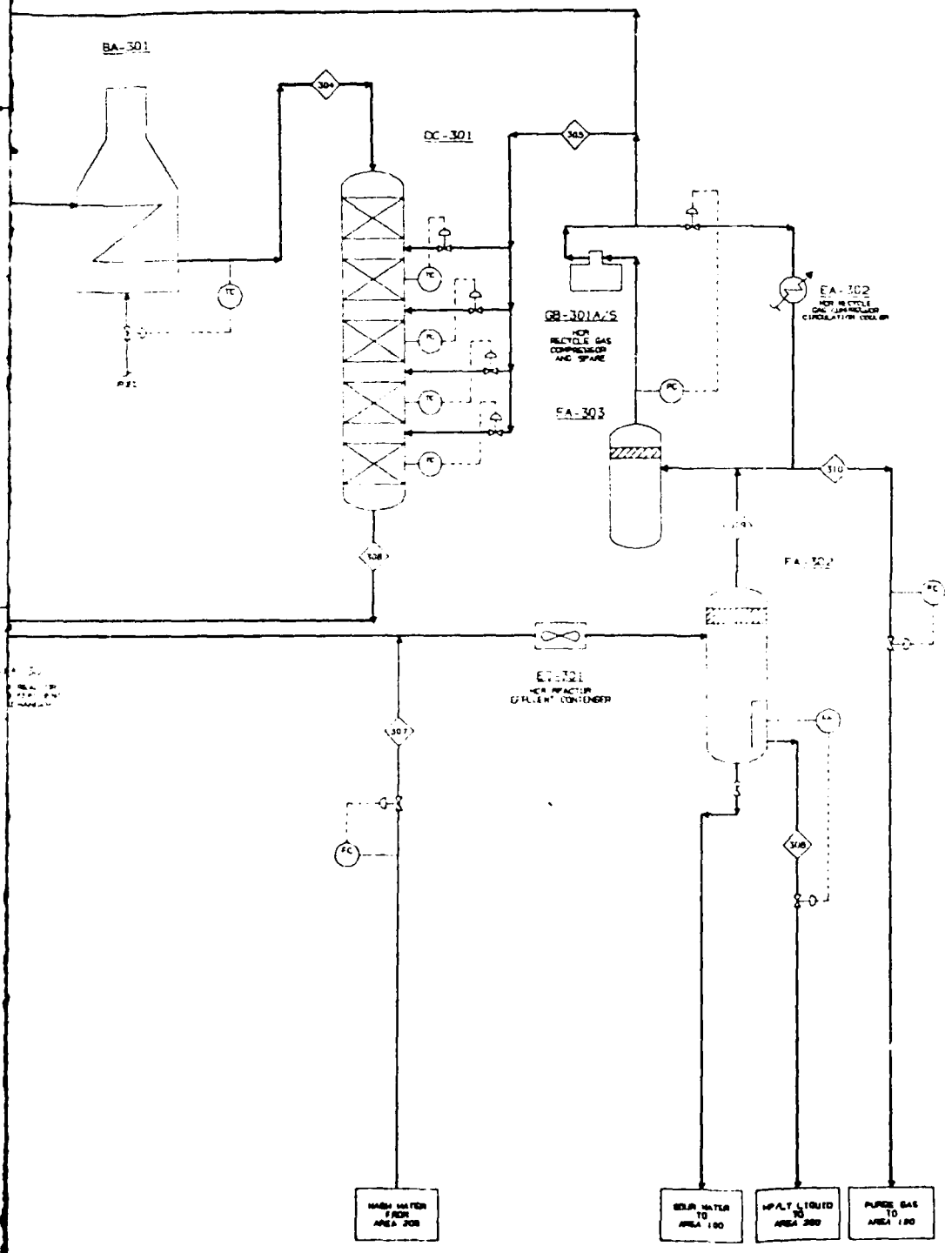

EA-301
HCR FEED
SURGE DRUM
BA-301
HCR FEED HEATER
DC-301
HCR REACTOR
BA-301
EA-301
GA-301A/S
HCR FEED PUMP
AND SPARE

BA-301
HCR FEED HEATER

DC-301
HCR REACTOR

EA-303
HCR RECYCLE GAS
COMPRESSOR K.O. DRUM

EA-302
HCR REACTOR EFFLUENT
HP/LT SEPARATOR





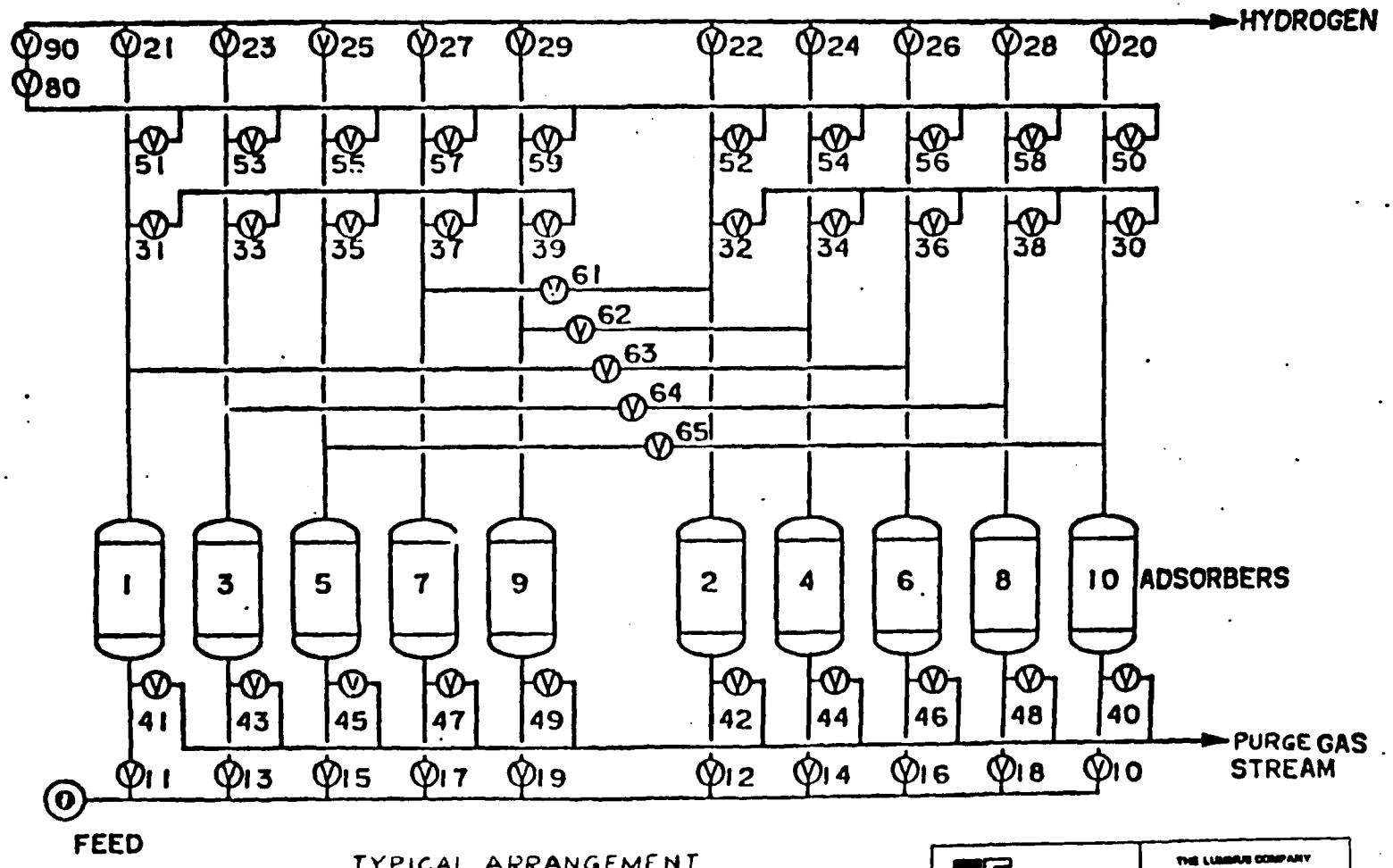

COMBUSTION ENGINEERING

PROCESS FLOW DIAGRAM
HYDROCRACKER
AREA 300

ES571-301

PLOT:1220 USER:D.RAP1 312 DR: IF2504 LOC: EXT: PAPER:W DATE: 04/20/89

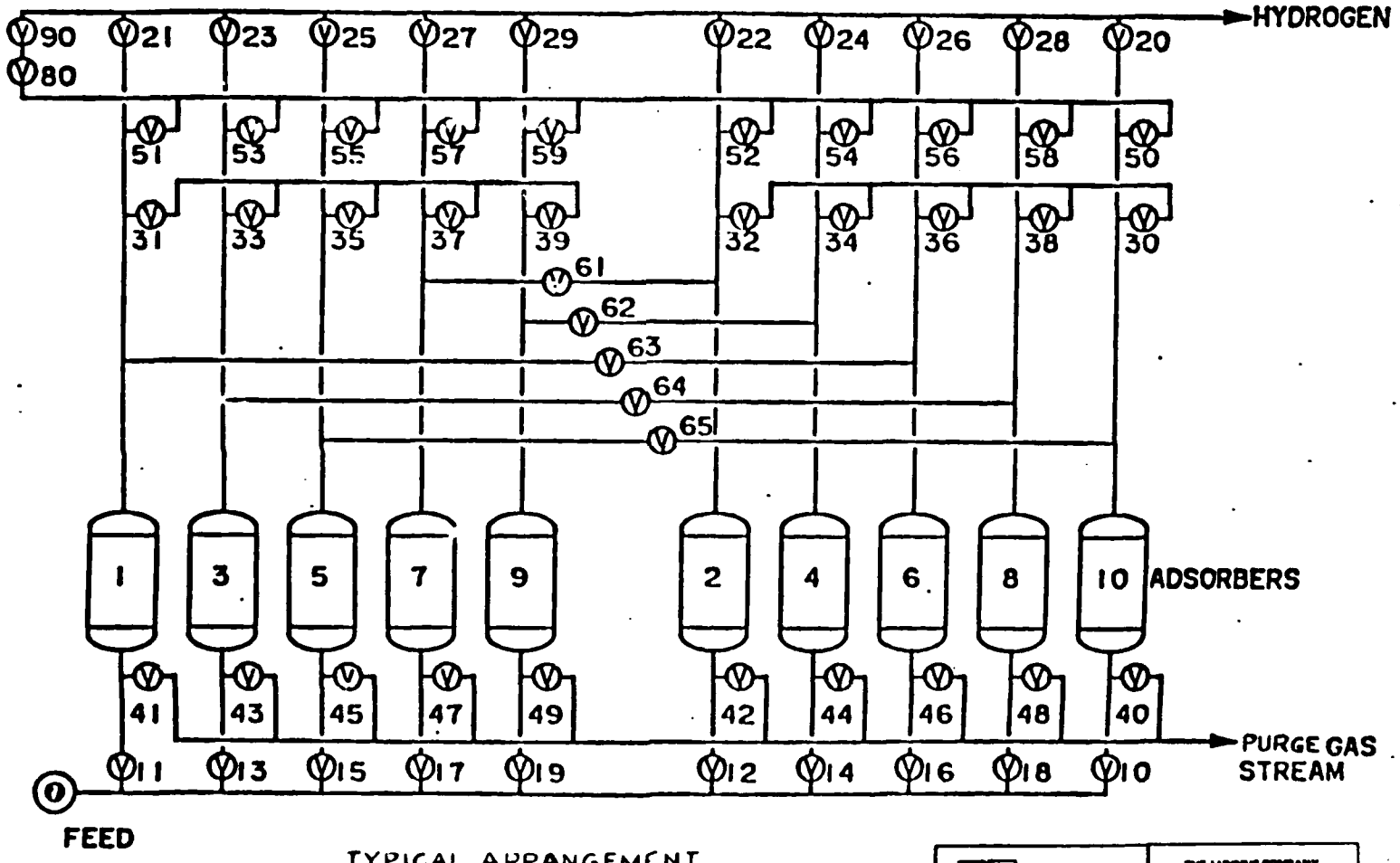
## SCHEMATIC FLOW SHEET - POLYBED PSA UNIT




TYPICAL ARRANGEMENT
NUMBER OF ABSORBERS: 4
ITEM NUMBER PA-104

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A | 9/4/84 | FOR TASK 4 | GS | ES | | | LUMMUS | THE LUMMUS COMPANY | |
| A | 9/4/84 | FOR SCRATCH 1-2 | ML | ES | | | TITLE PSA (HYDROGEN UNIT) | | |
| REV | DATE | DESCRIPTION | PREP | PROJ ENGR | APPR | APPR | CLIENT AMOCO/DOE JET FUEL STUDY | | |
| | | | | | | | PROJ NO 5571 AREA 100 | | |
| | | | | | | | PROFITABLE JP-8 DESIGN | | |
| | | | | | | | VENDOR NO | DWG NO 5571- | 13 |

## SCHEMATIC FLOW SHEET - POLYBED PSA UNIT




TYPICAL ARRANGEMENT
NUMBER OF ABSORBERS: 10
ITEM NUMBER PA-201

| REV | ISSUED | DESCRIPTION | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|
| 1 | 1/96 | FOR TASK 4 | GS | ES | |
| 0 | 1/96 | FOR SUBTASK 1.2 | ML | ES | |

THE LUMMUS COMPANY

TITLE PSA (HYDROGEN UNIT)
CLIENT AMOCO/DOE JET FUEL STUDY
PROJ NO 5571 AREA 200
PROFITABLE JP-8 DESIGN
VESSEL NO
DWG NO 5571-203

2.1 Tar Oil Stream - cont'd

2.1.5 Material Balances

The following Material Balances were developed for Areas 100, 200 and 300.

DOE/AMOCO STUDY - 05571
FEED/PRODUCT SUMMARY
SECTIONS 100,200,300

| | | |
|---|---|---|
| **FEEDS** | | |
| **TAR OIL** | | |
| SOURCE | 300 F+ COAL-DERIVED TAR OIL | |
| GRAVITY | 6.4 | API |
| SULFUR | 4948 | WPPM |
| NITROGEN | 7291 | WPPM |
| OXYGEN | 54846 | WPPM |
| CARBON | 84.71 | WT% |
| HYDROGEN | 8.60 | WT% |
| BS&W | .5 | WT% |
| DISTILLATION, ASTM D 2887 | | |
| 0 VOL% | 279 | F |
| 10 | 371 | F |
| 20 | 414 | F |
| 30 | 468 | F |
| 40 | 498 | F |
| 50 | 556 | F |
| 60 | 603 | F |
| 70 | 683 | F |
| 80 | 765 | F |
| 90 | 877 | F |
| 95 | 948 | F |
| 100 | 1018 | F |
| FLOW RATE | 45763 | LB/H |
| | 3060 | BPSD |
| TEMPERATURE AT B.L. | 128 | F |
| PRESSURE AT B. L. | 35 | PSIG |
| **HYDROGEN MAKE UP** | | |
| SOURCE | FROM RECTISOL UNIT | |
| COMPOSITION | | |
| H2 | 63.19 | MOL% |
| CO | 16.67 | MOL% |
| CO2 | 1.48 | MOL% |
| CH4 | 16.27 | MOL% |
| C2+S | 0.31 | MOL% |
| COS, H2S, CS2 | <0.01 | MOL% |
| N2, AR | 0.19 | MOL% |
| H2O | <0.01 | MOL% |
| FLOW RATE | AS REQUIRED | |
| TEMPERATURE | 65 | F |
| PRESSURE | 355 | PSIG |
| **PRODUCTS** | | |
| **STABILISED NAPHTHA** | | |
| GRAVITY | 65.5 | API |
| FLOW RATE | 8512 | LB/H |
| | 813 | BPSD |
| ESTIMATED RVP | 10 | PSI |
| **JET FUEL(JPB)** | | |
| GRAVITY | 37.4 | API |
| FLOW RATE | 32500 | LB/H |
| | 2662 | BPSD |
| ESTIMATED FLASH POINT | 100 | F |
| ESTIMATED POUR POINT | -70 | F |
| DISTILLATION, ASTM D-86 | | |
| 0 VOL% | 298 | F |
| 5 VOL% | 313 | F |
| 10 VOL% | 323 | F |
| 30 VOL% | 366 | F |
| 50 VOL% | 408 | F |
| 70 VOL% | 449 | F |
| 90 VOL% | 492 | F |
| 95 VOL% | 512 | F |
| 100 VOL% | 547 | F |

JET FUEL POUR
JOB 5571
MTL BAL - AREAS
100, 200, 300

DOE/AMOCO STUDY - 05571
SECTIONS 100,200,300
YIELD SUMMARY

| | LC-FINING YIELD | | | | | |
|---|---|---|---|---|---|---|
| | WT% | VOL% | API | SP.GR. | LB/H | BPSD |
| FEED | | | | | | |
| IBP-550 | 49.50 | 51.89 | 12.78 | 0.98 | 22652.78 | 1584.92 |
| 550+ | 50.00 | 47.86 | 0.25 | 1.07 | 22881.60 | 1461.85 |
| SOLIDS | 0.50 | 0.26 | | 2.00 | 228.82 | 7.85 |
| | 100.00 | 100.00 | 6.15 | 1.03 | 45763.20 | 3054.62 |
| PRODUCTS | | | | | | |
| H2S | 0.49 | | | | 224.24 | |
| NH3 | 0.83 | | | | 379.83 | |
| H2O | 5.74 | | | | 2626.81 | |
| C1 | 0.59 | | | | 270.00 | |
| C2 | 0.47 | | | | 215.09 | |
| C3 | 0.39 | | | | 178.48 | |
| C4 | 0.36 | 0.63 | | 0.58 | 164.75 | 19.36 |
| C5 | 0.94 | 1.53 | | 0.63 | 430.17 | 46.76 |
| C6-200 | 2.86 | 3.98 | 60.00 | 0.74 | 1308.83 | 121.54 |
| 200-550 | 59.16 | 71.57 | 35.00 | 0.85 | 27073.51 | 2185.99 |
| 550+ | 32.23 | 34.30 | 15.00 | 0.97 | 14749.48 | 1047.77 |
| SOLIDS | 0.48 | 0.25 | | 2.00 | 219.66 | 7.54 |
| | 104.54 | 112.26 | | | 47840.85 | 3428.96 |
| C4+ | 96.03 | 112.26 | 29.41 | 0.88 | 43946.40 | 3428.96 |
| C5+ | 95.67 | 111.62 | 29.10 | 0.88 | 43781.65 | 3409.60 |
| C6+ | 94.73 | 110.09 | 28.47 | 0.88 | 43351.48 | 3362.84 |
| 200+ | 91.87 | 106.11 | 27.49 | 0.89 | 42042.65 | 3241.30 |

CHEMICAL H2 CONSUMPTION : 3072.98 SCF/BBL
CONVERSION (550+) : 35.54 WT%

JET FUEL STUDY
DOE 5571
MAT. BAL. ACCUM
ICL 200,300

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

| STREAM ID | 100 | 101 | 102 | 103 | 104.1 | 104.2 | 104 | 105 | 106 |
|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | TAR OIL FEED | FRESH FEED | TOT.GAS TO 1ST RX | QUENCH GASES | RX EFFL. VAPOR | RX EFFL. LIQUID | REACTOR EFFLUENT | LP/HT LIQUID | LP/MT LIQUID |
| PHASE | LIQUID | LIQUID | VAPOR | VAPOR | VAPOR | LIQUID | MIXED | LIQUID | LIQUID |
| COMPOSITION,LBMOLS/H | | | | | | | | | |
| H2O | | | 0.98 | 0.57 | 146.20 | 4.24 | 150.44 | 0.74 | 3.47 |
| NH3 | | | | | 22.89 | 0.45 | 23.34 | 0.05 | 0.22 |
| H2S | | | | | 6.59 | 0.13 | 6.72 | 0.01 | 0.06 |
| H2 | | | 1390.51 | 808.68 | 1156.39 | 13.63 | 1170.02 | 0.81 | 2.58 |
| C1 | | | 4.47 | 2.60 | 23.70 | 0.33 | 24.03 | 0.03 | 0.09 |
| C2 | | | 1.75 | 1.02 | 9.90 | 0.18 | 10.08 | 0.02 | 0.07 |
| C3 | | | 0.84 | 0.49 | 5.57 | 0.12 | 5.69 | 0.02 | 0.06 |
| C4 | | | 0.39 | 0.23 | 3.83 | 0.10 | 3.93 | 0.02 | 0.07 |
| C5 | | | 0.41 | 0.24 | 7.78 | 0.24 | 8.02 | 0.05 | 0.21 |
| 150 F NBP | | | 0.22 | 0.13 | 10.35 | 0.38 | 10.73 | 0.09 | 0.43 |
| 180 F NBP | | | 0.12 | 0.07 | 9.34 | 0.37 | 9.71 | 0.09 | 0.47 |
| 212.5 F NBP | | | 0.12 | 0.07 | 18.50 | 0.80 | 19.30 | 0.22 | 1.17 |
| 237.5 F NBP | | | 0.08 | 0.04 | 19.19 | 0.89 | 20.08 | 0.27 | 1.46 |
| 262.5 F NBP | | | 0.05 | 0.03 | 21.70 | 1.09 | 22.79 | 0.35 | 2.00 |
| 312.5 F NBP | | | 0.04 | 0.02 | 62.92 | 3.76 | 66.68 | 1.41 | 8.60 |
| 387.5 F NBP | | | | | 48.03 | 3.80 | 51.83 | 1.79 | 11.79 |
| 462.5 F NBP | | | | | 35.70 | 3.83 | 39.53 | 2.20 | 14.90 |
| 512.5 F NBP | | | | | 9.85 | 1.31 | 11.16 | 0.85 | 5.51 |
| 537.5 F NBP | | | | | 7.79 | 1.16 | 8.95 | 0.79 | 4.92 |
| 600 F NBP | | | | | 19.53 | 3.92 | 23.45 | 3.00 | 15.59 |
| 700 F NBP | | | | | 11.56 | 3.85 | 15.41 | 3.35 | 11.09 |
| 800 F NBP | | | | | 6.14 | 3.55 | 9.69 | 3.32 | 6.23 |
| 900 F NBP | | | | | 2.85 | 3.02 | 5.87 | 2.94 | 2.92 |
| 1000 F NBP | | | | | 0.02 | 0.05 | 0.07 | 0.05 | 0.02 |
| LCF FEED | | 242.40 | | | | 0.09 | | 0.09 | |
| TOTAL FLOW LBMOL/H | 278.43 | 242.40 | 1399.98 | 814.19 | 1666.32 | 51.29 | 1717.52 | 22.56 | 93.93 |
| LB/H | 47670.00 | 45763.20 | 3095.80 | 1800.50 | 50559.40 | 7255.10 | 57814.50 | 5383.50 | 17880.20 |
| TEMPERATURE, DEG.F | 128.00 | 414.00 | 268.00 | 268.00 | 760.00 | 760.00 | 760.00 | 745.00 | 500.00 |
| PRESSURE, PSIG | 35.00 | 6.10 | 2245.00 | 2245.00 | 2210.00 | 2210.00 | 2210.00 | 385.00 | 330.00 |
| MOLECULAR WEIGHT | 171.21 | 188.79 | 2.21 | 2.21 | 30.34 | 141.45 | 33.66 | 238.63 | 190.36 |
| GRAVITY, DEG. API | 7.90 | 6.40 | | | | 27.00 | | 16.10 | 22.00 |
| VAPOR FLOW, MMSCFD | | | 12.75 | 7.42 | 15.18 | | | | |
| LIQUID FLOW, BPSD | 3222.35 | 3060.17 | | | | 557.62 | | 385.31 | 1330.90 |
| DENSITY AT P,T, LB/FT3 | 62.50 | 54.54 | 0.60 | 0.60 | 5.02 | 38.83 | | 40.06 | 45.85 |
| VISCOSITY AT P,T, CP | 5.80 | 1.50 | 0.01 | 0.01 | 0.02 | 0.15 | | 0.18 | 0.27 |
| VAPOR COMPRESSIBILITY | | | 1.07 | 1.07 | 1.03 | | | | |
| CONDUCTIVITY, BTU/H.F.FT | 0.07 | 0.06 | 0.10 | 0.10 | 0.08 | 0.01 | | 0.05 | 0.05 |
| SURFACE TENSION, DYNE/CM | 36.00 | 25.00 | | | | | | 4.87 | 12.26 |
| VAPOR FLOW AT P,T, ACFM | | | 86.47 | 50.29 | 167.76 | | | | |
| LIQUID FLOW AT P,T, USGPM | 95.19 | 104.72 | | | | 23.32 | | 16.77 | 48.67 |
| ENTHALPY, MMBTU/H | -1.37 | 10.49 | -0.78 | -0.45 | 27.75 | 2.79 | 30.54 | 1.86 | 3.41 |

JET FUEL STUDY
JOB 5571
MTL. BAL AREAS
100 200 300

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

| STREAM ID | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 |
|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | LP/LT LIQUID | LP/LT VAPOR | LP/HT VAPOR | NAPHTHA QUENCH | VAC.TWR BOTTOMS | VAC.TWR DIST.#1 | VAC.TWR DIST.#2 | ATM.TWR BOTTOMS | LIGHT NAPHTHA | ATM.TWR O/H GAS |
| PHASE | LIQUID | VAPOR | VAPOR | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | LIQUID | VAPOR |
| COMPOSITION,LBMOLS/H | | | | | | | | | | |
| H2O | 11.53 | 5.16 | 149.69 | 2.97 | | | 0.07 | 0.02 | 6.70 | 5.62 |
| NH3 | 4.03 | | 23.29 | 1.04 | | | | | 0.27 | 2.95 |
| H2S | 0.72 | | 6.70 | 0.18 | | | | | 0.03 | 0.56 |
| H2 | 3.21 | 1163.42 | 1169.21 | 0.83 | | | | | | 4.96 |
| C1 | 0.35 | 23.57 | 24.01 | 0.09 | | | | | | 0.35 |
| C2 | 0.74 | 9.25 | 10.06 | 0.19 | | | | | 0.01 | 0.61 |
| C3 | 1.17 | 4.45 | 5.68 | 0.30 | | | | | 0.06 | 0.87 |
| C4 | 1.77 | 2.08 | 3.92 | 0.46 | | | | | 0.26 | 1.13 |
| C5 | 5.58 | 2.18 | 7.98 | 1.44 | | | | 0.02 | 1.71 | 2.64 |
| 150 F NBP | 9.03 | 1.19 | 10.64 | 2.32 | | | 0.02 | 1.60 | 3.80 | 1.79 |
| 180 F NBP | 8.52 | 0.62 | 9.62 | 2.19 | | | 0.04 | 5.09 | 1.41 | 0.38 |
| 212.5 F NBP | 17.26 | 0.65 | 19.08 | 4.44 | | | 0.13 | 13.79 | 0.35 | 0.05 |
| 237.5 F NBP | 17.96 | 0.40 | 19.82 | 4.62 | | | 0.19 | 14.99 | 0.06 | 0.01 |
| 262.5 F NBP | 20.19 | 0.26 | 22.45 | 5.20 | | | 0.28 | 17.33 | 0.01 | |
| 312.5 F NBP | 56.44 | 0.23 | 65.27 | 14.53 | | 0.03 | 1.30 | 51.93 | | |
| 387.5 F NBP | 38.22 | 0.02 | 50.04 | 9.84 | | 0.09 | 1.68 | 41.96 | | |
| 462.5 F NBP | 22.42 | | 37.32 | 5.77 | 0.01 | 0.27 | 1.92 | 33.75 | | |
| 512.5 F NBP | 4.80 | | 10.31 | 1.24 | | 0.19 | 0.66 | 9.93 | | |
| 537.5 F NBP | 3.23 | | 8.16 | 0.83 | | 0.23 | 0.56 | 8.11 | | |
| 600 F NBP | 4.85 | | 20.44 | 1.25 | 0.03 | 1.55 | 1.42 | 22.16 | | |
| 700 F NBP | 0.97 | | 12.06 | 0.25 | 0.11 | 2.76 | 0.48 | 15.04 | | |
| 800 F NBP | 0.13 | | 6.36 | 0.03 | 0.40 | 2.84 | 0.08 | 9.24 | | |
| 900 F NBP | 0.01 | | 2.93 | | 1.37 | 1.57 | 0.01 | 4.50 | | |
| 1000 F NBP | | | 0.02 | | 0.04 | | | 0.03 | | |
| LCF FEED | | | | | 0.09 | | | | | |
| TOTAL FLOW LBMOL/H | 233.13 | 1213.48 | 1695.06 | 60.01 | 2.05 | 9.53 | 8.84 | 249.49 | 14.67 | 21.92 |
| LB/H | 27802.00 | 3888.30 | 52430.90 | 7155.00 | 962.10 | 2821.80 | 1530.00 | 41496.80 | 744.70 | 684.00 |
| TEMPERATURE, DEG.F | 110.00 | 110.00 | 740.00 | 132.00 | 599.00 | 400.00 | 100.00 | 410.00 | 120.00 | 120.00 |
| PRESSURE, PSIG | 310.00 | 310.00 | 385.00 | 2310.00 | -13.00 | 85.00 | -13.00 | 27.30 | 150.00 | 20.30 |
| MOLECULAR WEIGHT | 119.26 | 3.20 | 30.93 | 119.23 | 469.32 | 296.10 | 173.08 | 166.33 | 50.76 | 31.20 |
| GRAVITY, DEG. API | 40.60 | | | 40.60 | 5.10 | 12.40 | 26.30 | 28.70 | 59.00 | |
| VAPOR FLOW, MMSCFD | | 11.05 | 15.44 | | | | | | | 0.20 |
| LIQUID FLOW, BPSD | 2320.18 | | | 597.11 | 63.73 | 196.90 | 117.07 | 3223.61 | 68.79 | |
| DENSITY AT P,T, LB/FT3 | 50.01 | 0.17 | 0.96 | 50.10 | 53.39 | 53.99 | 54.89 | 45.54 | 44.64 | 0.18 |
| VISCOSITY AT P,T, CP | 0.75 | 0.01 | 0.02 | 0.79 | 1.42 | 0.93 | 2.06 | 0.28 | 0.28 | 0.01 |
| VAPOR COMPRESSIBILITY | | 1.01 | 1.00 | | | | | | | 0.98 |
| CONDUCTIVITY, BTU/H.F.FT | 0.07 | 0.07 | 0.08 | 0.07 | 0.04 | 0.05 | 0.07 | 0.05 | 0.09 | 0.01 |
| SURFACE TENSION, DYNE/CM | 24.84 | | | 23.59 | 18.60 | 23.27 | 30.79 | 14.11 | 21.57 | |
| VAPOR FLOW AT P,T, ACFM | | 384.37 | 907.99 | | | | | | | 63.40 |
| LIQUID FLOW AT P,T, USGPM | 69.38 | | | 17.82 | 2.25 | 6.52 | 3.48 | 113.73 | 2.08 | |
| ENTHALPY, MMBTU/H | 0.07 | -1.76 | 28.68 | 0.14 | 0.22 | 0.33 | -0.02 | 5.96 | 0.06 | 0.23 |

JET FUEL ST...
J03 557...
MTL BAL ...
100, 200, 3...

DOE/AMOCO STUDY-05571
DOE/AMOCO STUDY-05571
SECTION 100 - LC-FINING
MATERIAL BALANCE

| STREAM ID | 118 | 120 | 121 | 122 | 123 | 124 | 125 | 126 |
|---|---|---|---|---|---|---|---|---|
| STREAM NAME | LP/MT GASES | PSA TAIL GAS | PSA BY-PASS | TOT.GAS TO RX'S | ATM.TWR VAP.FEED | ATM.TWR LIQ.FEED | FUEL GASES | 300F- TAR OIL |
| PHASE | VAPOR | VAPOR | VAPOR | VAPOR | VAPOR | LIQUID | VAPOR | LIQUID |
| COMPOSITION,LBMOLS/H | | | | | | | | |
| H2O | 146.22 | 3.61 | 1.55 | 1.55 | 0.16 | 12.18 | 10.43 | |
| NH3 | 23.08 | | | | 0.17 | 3.04 | 3.35 | |
| H2S | 6.65 | | | | 0.04 | 0.55 | 0.65 | |
| H2 | 1166.63 | 81.44 | 349.02 | 2199.18 | 1.97 | 3.00 | 92.92 | |
| C1 | 23.92 | 16.50 | 7.07 | 7.07 | 0.07 | 0.28 | 23.44 | |
| C2 | 9.99 | 6.47 | 2.77 | 2.77 | 0.05 | 0.57 | 12.89 | |
| C3 | 5.62 | 3.12 | 1.34 | 1.33 | 0.04 | 0.89 | 10.29 | |
| C4 | 3.85 | 1.46 | 0.62 | 0.62 | 0.03 | 1.35 | 11.38 | |
| C5 | 7.77 | 1.53 | 0.66 | 0.65 | 0.05 | 4.32 | 6.22 | |
| 150 F NBP | 10.22 | 0.83 | 0.36 | 0.36 | 0.04 | 7.15 | 3.87 | |
| 180 F NBP | 9.15 | 0.44 | 0.19 | 0.19 | 0.03 | 6.85 | 1.51 | |
| 212.5 F NBP | 17.91 | 0.46 | 0.20 | 0.20 | 0.04 | 14.15 | 0.78 | |
| 237.5 F NBP | 18.36 | 0.28 | 0.12 | 0.12 | 0.03 | 15.03 | 0.47 | |
| 262.5 F NBP | 20.44 | 0.18 | 0.08 | 0.08 | 0.02 | 17.32 | 0.24 | |
| 312.5 F NBP | 56.67 | 0.16 | 0.07 | 0.07 | 0.04 | 51.89 | 0.16 | |
| 387.5 F NBP | 38.25 | 0.02 | 0.01 | 0.01 | 0.01 | 41.95 | 0.02 | |
| 462.5 F NBP | 22.42 | | | | | 33.75 | | |
| 512.5 F NBP | 4.80 | | | | | 9.93 | | |
| 537.5 F NBP | 3.23 | | | | | 8.11 | | |
| 600 F NBP | 4.85 | | | | | 22.16 | | |
| 700 F NBP | 0.97 | | | | | 15.04 | | |
| 800 F NBP | 0.13 | | | | | 9.24 | | |
| 900 F NBP | 0.01 | | | | | 4.50 | | |
| 1000 F NBP | | | | | | 0.03 | | |
| LCF FEED | | | | | | | | |
| TOTAL FLOW LBMOL/H | 1601.14 | 112.89 | 362.51 | 2212.65 | 2.79 | 283.28 | 178.62 | 26.57 |
| LB/H | 34550.80 | 1244.20 | 1166.50 | 4896.30 | 43.40 | 42881.90 | 3398.20 | 1907.00 |
| TEMPERATURE, DEG.F | 500.00 | 110.00 | 105.00 | 105.00 | 301.00 | 301.00 | 107.00 | 120.00 |
| PRESSURE, PSIG | 330.00 | 1.30 | 305.00 | 280.00 | 185.00 | 185.00 | 1.20 | 50.00 |
| MOLECULAR WEIGHT | 21.58 | 11.02 | 3.22 | 2.21 | 15.56 | 151.38 | 19.02 | 71.77 |
| GRAVITY, DEG. API | | | | | | 30.30 | | 43.90 |
| VAPOR FLOW, MMSCFD | 14.58 | 1.03 | 3.30 | 20.15 | 0.03 | | 1.63 | |
| LIQUID FLOW, BPSD | | | | | | 3364.48 | | 162.20 |
| DENSITY AT P,T, LB/FT3 | 0.73 | 0.03 | 0.17 | 0.11 | 0.38 | 48.15 | 0.05 | 47.50 |
| VISCOSITY AT P,T, CP | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.43 | 0.01 | 1.50 |
| VAPOR COMPRESSIBILITY | 1.00 | 1.00 | 1.01 | 1.01 | 0.99 | | 1.00 | |
| CONDUCTIVITY, BTU/H.F.FT | 0.05 | 0.03 | 0.07 | 0.08 | 0.04 | 0.06 | 0.02 | 0.08 |
| SURFACE TENSION, DYNE/CM | | | | | | 17.96 | | |
| VAPOR FLOW AT P,T, ACFM | 792.41 | 741.39 | 117.05 | 765.53 | 1.89 | | 1138.05 | |
| LIQUID FLOW AT P,T, USGPM | | | | | | 111.15 | | 5.01 |
| ENTHALPY, MMBTU/H | 14.29 | 0.08 | -0.53 | -3.91 | 0.01 | 3.76 | 0.57 | 0.21 |

JET FUEL STUDY
DOE 5571
MTL BAL A-2
100, 200, 300

DOE/AMOCO STUDY - 05571
SECTIONS 100,200,300
YIELD SUMMARY

| | HYDROTREATING YIELD | | | | | |
|---|---|---|---|---|---|---|
| | WT% | VOL% | API | SP.GR. | LB/H | BPSD |
| FEED | | | | | | |
| IBP-550 | 64.50 | 67.38 | 35.01 | 0.85 | 26765.44 | 2161.12 |
| 550+ | 35.50 | 32.63 | 15.00 | 0.97 | 14731.36 | 1046.48 |
| SOLIDS | 0.00 | | | | | |
| | 100.00 | 100.00 | 27.90 | 0.89 | 41496.80 | 3207.60 |
| PRODUCTS | | | | | | |
| H2S | 0.01 | | | | 4.15 | |
| NH3 | 0.02 | | | | 8.30 | |
| H2O | 0.11 | | | | 45.65 | |
| C1 | 0.61 | | | | 253.13 | |
| C2 | 0.44 | | | | 182.59 | |
| C3 | 0.35 | | | | 145.24 | |
| C4 | 0.15 | 0.23 | | 0.58 | 62.25 | 7.31 |
| C5 | 1.09 | 1.53 | | 0.63 | 452.32 | 49.17 |
| C6-200 | 2.50 | 3.00 | 60.00 | 0.74 | 1037.42 | 96.34 |
| 200-550 | 65.83 | 69.58 | 37.00 | 0.84 | 27317.34 | 2231.95 |
| 550+ | 29.93 | 28.46 | 20.10 | 0.93 | 12419.99 | 913.01 |
| SOLIDS | | | | | | |
| | 101.04 | 102.81 | | | 41928.37 | 3297.77 |
| C4+ | 99.50 | 102.81 | 33.21 | 0.86 | 41289.32 | 3297.77 |
| C5+ | 99.35 | 102.59 | 33.09 | 0.86 | 41227.07 | 3290.46 |
| C6+ | 98.26 | 101.05 | 32.43 | 0.86 | 40774.76 | 3241.29 |
| 200+ | 95.76 | 98.05 | 31.71 | 0.87 | 39737.34 | 3144.96 |

CHEMICAL H2 CONSUMPTION : 607.87 SCF/BBL
CONVERSION (550+) : 15.69 WT%

JET FUEL STUDY
JOB 5571
MTL BML AREAS
100, 200, 300

DOE/AMOCO STUDY-05571
SECTION 200 - HDS/JP8 DISTILLATION
MATERIAL BALANCE

| STREAM ID | 201 | 202 | 203 | 204 | 205 | 206.1 | 206.2 | 206 | 207 | 208 |
|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | FRESH FEED | MAKE-UP HYDROGEN | TOT.GAS TO RX | REACTOR FEED | HYDROGEN QUENCH | RX EFFL. VAPOR | RX EFFL. LIQUID | REACTOR EFFLUENT | WASH WATER | HP/LT LIQUID |
| PHASE | LIQUID | VAPOR | VAPOR | MIXED | VAPOR | VAPOR | LIQUID | MIXED | LIQUID | LIQUID |
| COMPOSITION,LBMOLS/H | | | | | | | | | | |
| N2 | | | | | | | | | | |
| CO | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| H2O | | | 0.51 | 0.51 | 0.21 | 2.95 | 0.30 | 3.25 | 66.61 | 0.97 |
| NH3 | | | 0.13 | 0.13 | 0.05 | 0.61 | 0.06 | 0.67 | | 0.45 |
| H2S | | | 0.06 | 0.06 | 0.02 | 0.18 | 0.02 | 0.20 | | 0.11 |
| H2 | | 306.73 | 611.02 | 611.02 | 244.98 | 601.18 | 39.33 | 640.51 | | 30.19 |
| C1 | | | 32.92 | 32.92 | 13.20 | 57.51 | 4.39 | 61.90 | | 10.51 |
| C2 | | | 3.94 | 3.94 | 1.58 | 10.59 | 1.00 | 11.59 | | 5.37 |
| C3 | | | 0.82 | 0.82 | 0.33 | 4.01 | 0.44 | 4.45 | | 3.13 |
| C4 | | | 0.10 | 0.10 | 0.04 | 1.07 | 0.14 | 1.21 | | 1.05 |
| C5 | | | 0.23 | 0.23 | 0.09 | 5.74 | 0.85 | 6.59 | | 6.21 |
| 150 F NBP | | | 0.08 | 0.08 | 0.03 | 4.44 | 0.76 | 5.20 | | 5.09 |
| 180 F NBP | | | 0.06 | 0.06 | 0.03 | 5.95 | 1.09 | 7.04 | | 6.94 |
| 212.5 F NBP | | | 0.03 | 0.03 | 0.01 | 5.31 | 1.05 | 6.36 | | 6.31 |
| 237.5 F NBP | | | 0.03 | 0.03 | 0.01 | 8.10 | 1.70 | 9.80 | | 9.75 |
| 262.5 F NBP | | | 0.02 | 0.02 | 0.01 | 8.96 | 2.02 | 10.98 | | 10.94 |
| 312.5 F NBP | | | 0.03 | 0.03 | 0.01 | 26.86 | 6.98 | 33.84 | | 33.80 |
| 387.5 F NBP | | | 0.01 | 0.01 | | 30.55 | 10.11 | 40.66 | | 40.65 |
| 462.5 F NBP | | | | | | 30.02 | 12.95 | 42.97 | | 42.97 |
| 512.5 F NBP | | | | | | 9.02 | 4.71 | 13.73 | | 13.73 |
| 537.5 F NBP | | | | | | 10.68 | 6.15 | 16.83 | | 16.83 |
| 600 F NBP | | | | | | 11.70 | 8.73 | 20.43 | | 20.43 |
| 700 F NBP | | | | | | 5.59 | 6.49 | 12.08 | | 12.07 |
| 800 F NBP | | | | | | 2.18 | 4.08 | 6.26 | | 6.26 |
| 900 F NBP | | | | | | 0.94 | 3.00 | 3.94 | | 3.95 |
| HDS FEED | 249.49 | | | 249.49 | | | | | | |
| TOTAL FLOW, LBMOL/H | 249.49 | 306.73 | 649.99 | 899.48 | 260.60 | 844.14 | 116.35 | 960.49 | 66.61 | 287.71 |
| LB/H | 41496.80 | 618.40 | 1976.60 | 43473.40 | 792.50 | 29567.50 | 14696.20 | 44265.90 | 1200.00 | 41837.20 |
| TEMPERATURE, DEG.F | 410.00 | 100.00 | 108.00 | 740.00 | 109.00 | 760.00 | 760.00 | 760.00 | 120.00 | 120.00 |
| PRESSURE, PSIG | 35.00 | 2535.00 | 2469.00 | 2405.00 | 2530.00 | 2385.00 | 2385.00 | 2385.00 | 2354.00 | 2335.00 |
| MOLECULAR WEIGHT | 166.33 | 2.02 | 3.04 | 48.33 | 3.04 | 35.03 | 126.31 | 46.09 | 18.02 | 145.41 |
| GRAVITY, DEG. API | 28.70 | | | | | | 40.50 | | | 38.40 |
| VAPOR FLOW, MMSCFD | | 2.79 | 5.92 | | 2.37 | 7.69 | | | | |
| LIQUID FLOW, BPSD | 3223.61 | | | | | | 1225.74 | | 76.52 | 3446.84 |
| DENSITY AT P,T, LB/FT3 | 45.53 | 0.79 | 1.15 | | 1.12 | 6.11 | 42.18 | | 61.71 | 51.42 |
| VISCOSITY AT P,T, CP | 0.28 | 0.01 | 0.01 | | 0.01 | 0.03 | 0.14 | | 0.56 | 1.35 |
| VAPOR COMPRESSIBILITY | | 1.08 | 1.08 | | 1.08 | 1.05 | | | | |
| CONDUCTIVITY,BTU/H.F.FT | 0.05 | 0.09 | 0.08 | | 0.08 | 0.01 | 0.11 | | 0.37 | 0.07 |
| SURFACE TENSION, DYNE/CM | 14.11 | | | | | | 43.44 | | 68.25 | 22.53 |
| VAPOR FLOW AT P,T, ACFM | | 13.00 | 28.68 | | 11.82 | 80.60 | | | | |
| LIQUID FLOW AT P,T, USGPM | 113.74 | | | | | | 43.49 | | 2.43 | 101.54 |
| ENTHALPY, MMBTU/H | 5.96 | -0.57 | -1.03 | 18.87 | -0.41 | 15.01 | 6.08 | 21.09 | 0.11 | 0.45 |

JET FUEL STUDY
JOB 5571
MTL BAL AREAS
100, 200, 300

DOE/AMOCO STUDY-05571
SECTION 200 - HDS/JP8 DISTILLA
MATERIAL BALANCE

| STREAM ID | 209 | 210 | 211 | 212 | 213.1 | 213.2 | 213 | 214 | 215 | 216 |
|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | HP/LT VAPOR | PURGE GASES | LP/LT VAP TO FUEL | JP8 TWR FEED | JP8 HTR VAPOR | JP8 HTR LIQUID | JP8 HTR OUTLET | JP8 TWR O/H GAS | JP8 TWR REFLUX | JP8 TWR NET G. |
| PHASE | VAPOR | VAPOR | VAPOR | LIQUID | VAPOR | LIQUID | MIXED | VAPOR | LIQUID | VAPOR |
| COMPOSITION,LBMOLS/H | | | | | | | | | | |
| N2 | | | | | | | | | | |
| CO | | | | | | | | | | |
| CO2 | | | | | | | | | | |
| H2O | 0.81 | 0.08 | 0.22 | 1.03 | 1.03 | 0.00 | 1.03 | 82.74 | 1.12 | 1.19 |
| NH3 | 0.21 | 0.02 | 0.05 | 0.40 | 0.40 | 0.00 | 0.40 | 0.40 | | 0.40 |
| H2S | 0.09 | 0.01 | 0.02 | 0.09 | 0.09 | 0.00 | 0.09 | 0.09 | | 0.09 |
| H2 | 610.31 | 61.03 | 39.05 | 6.52 | 6.52 | 0.00 | 6.52 | 6.99 | 0.47 | 6.47 |
| C1 | 51.39 | 5.14 | 8.65 | 6.59 | 6.59 | 0.00 | 6.59 | 7.99 | 1.40 | 6.44 |
| C2 | 6.21 | 0.62 | 1.60 | 5.80 | 5.80 | 0.00 | 5.80 | 11.89 | 6.09 | 5.15 |
| C3 | 1.32 | 0.13 | 0.66 | 8.40 | 8.38 | 0.02 | 8.40 | 11.08 | 4.68 | 5.90 |
| C4 | 0.16 | 0.02 | 0.46 | 19.82 | 19.80 | 0.02 | 19.82 | 128.72 | 108.90 | 8.19 |
| C5 | 0.38 | 0.04 | 0.11 | 10.79 | 10.78 | 0.01 | 10.79 | 93.38 | 82.59 | 1.97 |
| 150 F NBP | 0.12 | 0.01 | 0.06 | 17.32 | 17.27 | 0.05 | 17.32 | 167.58 | 150.28 | 1.25 |
| 180 F NBP | 0.10 | 0.01 | 0.04 | 17.00 | 16 | 0.04 | 17.00 | 169.10 | 152.16 | 0.69 |
| 212.5 F NBP | 0.05 | 0.01 | 0.02 | 13.15 | 13.11 | 0.04 | 13.15 | 131.57 | 118.63 | 0.27 |
| 237.5 F NBP | 0.05 | 0.01 | 0.01 | 16.14 | 16.09 | 0.05 | 16.14 | 150.45 | 135.77 | 0.18 |
| 262.5 F NBP | 0.04 | | | 16.93 | 16.85 | 0.08 | 16.93 | 84.31 | 76.12 | 0.06 |
| 312.5 F NBP | 0.04 | | | 53.21 | 52.85 | 0.36 | 53.21 | 2.49 | 2.25 | |
| 387.5 F NBP | 0.01 | | | 59.10 | 58.42 | 0.68 | 59.10 | 1.04 | 0.94 | |
| 462.5 F NBP | | | | 64.26 | 62.93 | 1.33 | 64.26 | | | |
| 512.5 F NBP | | | | 19.73 | 19.11 | 0.62 | 19.73 | | | |
| 537.5 F NBP | | | | 19.66 | 18.91 | 0.75 | 19.66 | | | |
| 600 F NBP | | | | 30.03 | 28.11 | 1.92 | 30.03 | | | |
| 700 F NBP | | | | 17.20 | 14.46 | 2.74 | 17.20 | | | |
| 800 F NBP | | | | 9.79 | 6.34 | 3.45 | 9.79 | | | |
| 900 F NBP | | | | 5.78 | 2.05 | 3.73 | 5.78 | | | |
| HDS FEED | | | | | | 0.00 | 0.00 | | | |
| TOTAL FLOW, LBMOL/H | 671.29 | 67.13 | 50.95 | 418.74 | 402.85 | 15.89 | 418.74 | 1049.82 | 841.40 | 38.25 |
| LB/H | 2399.60 | 240.00 | 346.50 | 64546.00 | 59556.30 | 4989.70 | 64546.00 | 85484.70 | 74690.40 | 1389.20 |
| TEMPERATURE, DEG.F | 120.00 | 120.00 | 120.00 | 120.00 | 650.00 | 650.00 | 650.00 | 248.00 | 100.00 | 100.00 |
| PRESSURE, PSIG | 2335.00 | 2335.00 | 335.00 | 335.00 | 35.00 | 35.00 | 35.00 | 15.30 | 15.30 | 15.30 |
| MOLECULAR WEIGHT | 3.57 | 3.58 | 6.80 | 154.14 | 147.84 | 314.02 | 154.14 | 81.43 | 88.77 | 36.32 |
| GRAVITY, DEG. API | | | | 38.60 | | 26.30 | | | 67.50 | |
| VAPOR FLOW, MMSCFD | 6.11 | 0.61 | 0.46 | | 3.67 | | | 9.56 | | 0.35 |
| LIQUID FLOW, BPSD | | | | 5324.00 | | 381.81 | | | 7207.47 | |
| DENSITY AT P,T, LB/FT3 | 1.25 | 1.25 | 0.38 | 50.53 | 0.66 | 43.49 | | 1.32 | 43.06 | 0.19 |
| VISCOSITY AT P,T, CP | 0.01 | 0.01 | 0.01 | 1.12 | 0.01 | 0.27 | | 0.02 | 0.31 | 0.01 |
| VAPOR COMPRESSIBILITY | 1.08 | 1.08 | 1.00 | | 0.94 | | | 0.99 | | 0.98 |
| CONDUCTIVITY,BTU/H.F.FT | 0.07 | 0.07 | 0.07 | 0.07 | 0.03 | 0.04 | | 0.03 | 0.07 | 0.01 |
| SURFACE TENSION, DYNE/CM | | | | 24.18 | | 14.45 | | | | |
| VAPOR FLOW AT P,T, ACFM | 32.05 | 3.21 | 15.16 | | 1503.95 | | | 1078.54 | | 123.81 |
| LIQUID FLOW AT P,T, USGPM | | | | 159.42 | | 14.32 | | | 216.45 | |
| ENTHALPY, MMBTU/H | -0.92 | -0.09 | -0.03 | 0.43 | 24.77 | 1.58 | 26.34 | 16.83 | 0.50 | 0.25 |

JET FUEL STUDY
JOB 5571
MTL BAL AREAS
100, 200 300

DOE/AMOCO STUDY-05571
SECTION 200 - HDS/JP8 DISTILLA
MATERIAL BALANCE

| STREAM ID | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 230 | 231 |
|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | JP8 TWR O/H LIQ | JP8 STRP. FEED | JP8 STRP. S.STEAM | JP8 TWR S.STEAM | JP8 TWR BOTTOMS | STABILIS. O/H GAS | STABIL'D NAPHTHA | JP8 PRODUCT | MAKEUP H2 PSA FEED | PSA TAIL GAS |
| PHASE | LIQUID | LIQUID | VAPOR | VAPOR | LIQUID | VAPOR | LIQUID | LIQUID | VAPOR | VAPOR |
| COMPOSITION,LBMOLS/H | | | | | | | | | | |
| N2 | | | | | | | | | 5.97 | 5.97 |
| CO | | | | | | | | | 585.01 | 585.01 |
| CO2 | | | | | | | | | 46.52 | 46.52 |
| H2O | 0.12 | 0.18 | 51.71 | 30.00 | 0.83 | 0.01 | | | 0.32 | 0.32 |
| NH3 | | | | | | | | | | |
| H2S | | | | | | | | | | |
| H2 | 0.03 | 0.01 | | | | 0.05 | | | 1986.38 | 278.09 |
| C1 | 0.15 | 0.02 | | | | 0.15 | | | 509.56 | 509.56 |
| C2 | 0.65 | 0.04 | | | | 0.66 | | | 9.74 | 9.74 |
| C3 | 2.50 | 0.09 | | | | 0.40 | 0.16 | | | |
| C4 | 11.63 | 0.40 | | | | 0.60 | 11.29 | | | |
| C5 | 8.83 | 0.39 | | | | 0.08 | 10.45 | | | |
| 150 F NBP | 16.04 | 1.14 | | | | | 19.85 | 0.02 | | |
| 180 F NBP | 16.26 | 1.64 | | | | | 17.66 | 0.06 | | |
| 212.5 F NBP | 12.68 | 2.51 | | | | | 13.02 | 0.21 | | |
| 237.5 F NBP | 14.53 | 9.17 | | | | | 14.56 | 1.46 | | |
| 262.5 F NBP | 8.12 | 31.85 | | | 0.01 | | 8.14 | 8.73 | | |
| 312.5 F NBP | 0.27 | 95.67 | | | 0.08 | | 0.24 | 52.89 | | |
| 387.5 F NBP | | 70.75 | | | 0.66 | | 0.10 | 58.34 | | |
| 462.5 F NBP | | 62.96 | | | 5.45 | | | 58.82 | | |
| 512.5 F NBP | | 13.78 | | | 6.40 | | | 13.32 | | |
| 537.5 F NBP | | 8.87 | | | 11.00 | | | 8.66 | | |
| 600 F NBP | | 2.62 | | | 27.58 | | | 2.57 | | |
| 700 F NBP | | 0.01 | | | 17.19 | | | | | |
| 800 F NBP | | | | | 9.79 | | | | | |
| 900 F NBP | | | | | 5.78 | | | | | |
| HDS FEED | | | | | | | | | | |
| TOTAL FLOW, LBMOL/H | 91.81 | 302.10 | 51.71 | 30.00 | 84.77 | 1.95 | 95.47 | 205.08 | 3143.50 | 1435.22 |
| LB/H | 7981.30 | 44763.20 | 931.60 | 540.50 | 22680.00 | 80.80 | 8512.40 | 32500.00 | 31077.00 | 27634.89 |
| TEMPERATURE, DEG.F | 100.00 | 394.00 | 650.00 | 650.00 | 562.00 | 100.00 | 100.00 | 120.00 | 65.00 | 75.00 |
| PRESSURE, PSIG | 135.00 | 21.80 | 85.00 | 85.00 | 23.50 | 110.00 | 50.00 | 50.00 | 355.00 | 5.00 |
| MOLECULAR WEIGHT | 86.93 | 148.17 | 18.02 | 18.02 | 267.55 | 41.44 | 89.16 | 158.47 | 9.89 | 19.25 |
| GRAVITY, DEG. API | 67.50 | 40.10 | | | 22.90 | | 65.50 | 37.40 | | |
| VAPOR FLOW, MMSCFD | | | | | | 0.02 | | | 28.63 | 13.07 |
| LIQUID FLOW, BPSD | 770.18 | 3724.80 | | | 1698.07 | | 813.17 | 2661.81 | | |
| DENSITY AT P,T, LB/FT3 | 43.06 | 42.00 | 0.15 | 0.15 | 45.54 | 0.85 | 43.24 | 51.15 | 0.65 | 0.07 |
| VISCOSITY AT P,T, CP | 0.31 | 0.22 | 0.02 | 0.02 | 0.30 | 0.01 | 0.33 | 0.45 | | |
| VAPOR COMPRESSIBILITY | | | | | | 0.98 | | | 1.00 | 1.00 |
| CONDUCTIVITY,BTU/H.F.FT | 0.07 | 0.05 | 0.03 | 0.03 | 0.04 | 0.01 | 0.07 | 0.07 | | |
| SURFACE TENSION, DYNE/CM | 18.49 | 12.23 | | | 13.49 | | 18.20 | | | |
| VAPOR FLOW AT P,T, ACFM | | | 101.48 | 58.88 | | 1.59 | | | 796.92 | 6859.38 |
| LIQUID FLOW AT P,T, USGPM | 23.13 | 133.01 | | | 62.16 | | 24.57 | 79.30 | | |
| ENTHALPY, MMBTU/H | 0.05 | 6.90 | 1.26 | 0.73 | 5.61 | 0.01 | 0.06 | 0.11 | | |

JET FUEL STUDY
JOB 5571
MTL BAL AREAS
100, 200, 300

DOE/AMOCO STUDY-05571
SECTION 200 - HDS/JP8 DISTILLA
MATERIAL BALANCE

| STREAM ID | 232 |
|---|---|
| STREAM NAME | MAKEUP H2 TO LCF |
| PHASE | VAPOR |
| COMPOSITION,LBMOLS/H | |
| N2 | |
| CO | |
| CO2 | |
| H2O | |
| NH3 | |
| H2S | |
| H2 | 1117.22 |
| C1 | |
| C2 | |
| C3 | |
| C4 | |
| C5 | |
| 150 F NBP | |
| 180 F NBP | |
| 212.5 F NBP | |
| 237.5 F NBP | |
| 262.5 F NBP | |
| 312.5 F NBP | |
| 387.5 F NBP | |
| 462.5 F NBP | |
| 512.5 F NBP | |
| 537.5 F NBP | |
| 600 F NBP | |
| 700 F NBP | |
| 800 F NBP | |
| 900 F NBP | |
| HDS FEED | |
| TOTAL FLOW, LBMOL/H | 1117.22 |
| LB/H | 2251.19 |
| TEMPERATURE, DEG.F | 65.00 |
| PRESSURE, PSIG | 2505.00 |
| MOLECULAR WEIGHT | 2.02 |
| GRAVITY, DEG. API | |
| VAPOR FLOW, MMSCFD | 10.18 |
| LIQUID FLOW, BPSD | |
| DENSITY AT P,T, LB/FT3 | 0.97 |
| VISCOSITY AT P,T, CP | |
| VAPOR COMPRESSIBILITY | 1.08 |
| CONDUCTIVITY,BTU/H.F.FT | |
| SURFACE TENSION, DYNE/CM | |
| VAPOR FLOW AT P,T, ACFM | 38.50 |
| LIQUID FLOW AT P,T, USGPM | |
| ENTHALPY, MMBTU/H | |

JET FUEL STUDY
J.B 5571
MAT BAL AREAS
100 200 300

DOE/AMOCO STUDY - 05571
SECTIONS 100,200,300
YIELD SUMMARY

| | HYDROCRACKING YIELD | | | | | |
|---|---|---|---|---|---|---|
| | WT% | VOL% | API | SP.GR. | LB/H | BPSD |
| FEED | | | | | | |
| IBP-550 | | | | | | |
| 550+ | 100.00 | 100.00 | 22.89 | 0.92 | 22680.00 | 1697.98 |
| SOLIDS | | | | | | |
| | 100.00 | 100.00 | 22.89 | 0.92 | 22680.00 | 1697.98 |
| PRODUCTS | | | | | | |
| H2S | 0.00 | | | | 0.00 | |
| NH3 | 0.00 | | | | 0.00 | |
| H2O | 0.02 | | | | 4.54 | |
| C1 | 0.50 | | | | 113.40 | |
| C2 | 0.30 | | | | 68.04 | |
| C3 | 1.20 | | | | 272.16 | |
| C4 | 5.00 | 7.85 | | 0.58 | 1134.00 | 133.24 |
| C5 | 1.50 | 2.18 | | 0.63 | 340.20 | 36.98 |
| C6-200 | 8.50 | 10.98 | 68.00 | 0.71 | 1927.80 | 186.49 |
| 200-550 | 57.50 | 63.87 | 40.00 | 0.83 | 13041.00 | 1084.49 |
| 550+ | 27.34 | 27.71 | 25.00 | 0.90 | 6200.71 | 470.54 |
| SOLIDS | | | | | | |
| | 101.86 | 112.59 | | | 23101.85 | 1911.74 |
| C4+ | 99.84 | 112.59 | 42.61 | 0.81 | 22643.71 | 1911.74 |
| C5+ | 94.84 | 104.74 | 39.01 | 0.83 | 21509.71 | 1778.50 |
| C6+ | 93.34 | 102.56 | 38.15 | 0.83 | 21169.51 | 1741.52 |
| 200+ | 84.84 | 91.58 | 35.16 | 0.85 | 19241.71 | 1555.03 |

CHEMICAL H2 CONSUMPTION : 1122.42 SCF/BBL
CONVERSION (550+) : 72.66 WT%

JET FUEL STUDY
JOB 5571
MTL BAL AREAS
100, 200, 300
F

DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE
DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE

| STREAM ID | 301 | 302 | 303 | 304 | 305 | 306.1 | 306.2 | 306 | 307 | 308 |
|---|---|---|---|---|---|---|---|---|---|---|
| STREAM NAME | FRESH FEED | MAKE-UP HYDROGEN | TOT.GAS TO RX | REACTOR FEED | HYDROGEN QUENCH | RX EFFL. VAPOR | RX EFFL. LIQUID | REACTOR EFFLUENT | WASH WATER | HP/LT LIQUID |
| PHASE | LIQUID | VAPOR | VAPOR | MIXED | VAPOR | VAPOR | LIQUID | MIXED | LIQUID | LIQUID |
| COMPOSITION,LBMOLS/H | | | | | | | | | | |
| H2O | | | 0.92 | 0.92 | 0.85 | 2.02 | | 2.02 | 0.05 | 0.28 |
| NH3 | | | | | | | | | | |
| H2S | | | | | | | | | | |
| H2 | | 253.53 | 1192.49 | 1192.49 | 1106.27 | 2091.16 | 0.60 | 2091.76 | | 15.38 |
| C1 | | | 78.42 | 78.42 | 72.75 | 158.18 | 0.06 | 158.25 | | 4.73 |
| C2 | | | 7.86 | 7.86 | 7.29 | 17.40 | 0.01 | 17.41 | | 2.03 |
| C3 | | | 8.18 | 8.18 | 7.59 | 21.92 | 0.02 | 21.93 | | 5.93 |
| C4 | | | 9.47 | 9.47 | 8.78 | 37.72 | 0.04 | 37.76 | | 19.23 |
| C5 | | | 0.88 | 0.88 | 0.81 | 6.40 | 0.01 | 6.40 | | 4.69 |
| 150 F NBP | | | 0.92 | 0.92 | 0.86 | 14.07 | 0.02 | 14.10 | | 12.29 |
| 180 F NBP | | | 0.45 | 0.45 | 0.42 | 10.96 | 0.02 | 10.98 | | 10.10 |
| 212.5 F NBP | | | 0.17 | 0.17 | 0.16 | 7.19 | 0.01 | 7.20 | | 6.86 |
| 237.5 F NBP | | | 0.10 | 0.10 | 0.09 | 6.58 | 0.02 | 6.59 | | 6.40 |
| 262.5 F NBP | | | 0.06 | 0.06 | 0.05 | 6.09 | 0.02 | 6.11 | | 5.99 |
| 312.5 F NBP | | | 0.07 | 0.07 | 0.06 | 19.48 | 0.07 | 19.55 | | 19.41 |
| 387.5 F NBP | | | 0.01 | 0.01 | 0.01 | 18.38 | 0.10 | 18.48 | | 18.45 |
| 462.5 F NBP | | | | | | 21.12 | 0.18 | 21.30 | | 21.29 |
| 512.5 F NBP | | | | | | 5.93 | 0.07 | 6.00 | | 6.00 |
| 537.5 F NBP | | | | | | 2.79 | 0.04 | 2.83 | | 2.83 |
| 600 F NBP | | | | | | 9.38 | 0.21 | 9.60 | | 9.60 |
| 700 F NBP | | | | | | 4.88 | 0.25 | 5.13 | | 5.13 |
| 800 F NBP | | | | | | 3.14 | 0.39 | 3.53 | | 3.53 |
| 900 F NBP | | | | | | 1.37 | 0.46 | 1.83 | | 1.83 |
| HCR FEED | 84.77 | | | 84.77 | | | | | | |
| TOTAL FLOW, LBMOL/H | 84.77 | 253.53 | 1300.00 | 1384.77 | 1205.99 | 2466.16 | 2.60 | 2468.76 | 0.05 | 181.98 |
| LB/H | 22680.00 | 511.10 | 5051.80 | 27731.80 | 4686.60 | 31835.80 | 587.30 | 32418.40 | 0.90 | 23055.30 |
| TEMPERATURE, DEG.F | 300.00 | 100.00 | 118.00 | 650.00 | 118.00 | 670.00 | 670.00 | 670.00 | 120.00 | 120.00 |
| PRESSURE, PSIG | 35.00 | 1835.00 | 1835.00 | 1715.00 | 1835.00 | 1685.00 | 1685.00 | 1685.00 | 1686.00 | 1635.00 |
| MOLECULAR WEIGHT | 267.55 | 2.02 | 3.89 | 20.03 | 3.89 | 12.91 | 225.88 | 13.13 | 18.00 | 126.69 |
| GRAVITY, DEG.API | 22.90 | | | | | | 30.75 | | | 47.80 |
| VAPOR FLOW, MMSCFD | | 2.31 | 11.84 | | 10.98 | 22.46 | | | | |
| LIQUID FLOW, BPSD | 1698.07 | | | | | | 46.21 | | | 2004.55 |
| DENSITY AT P,T, LB/FT3 | 51.10 | 0.66 | 1.24 | | 1.24 | 1.73 | 40.26 | | 61.71 | 48.32 |
| VISCOSITY AT P,T, CP | 1.70 | 0.01 | 0.01 | | 0.01 | 0.02 | 0.22 | | 0.56 | 0.86 |
| VAPOR COMPRESSIBILITY | | 1.07 | 1.07 | | 1.07 | 1.05 | | | | |
| CONDUCTIVITY, BTU/H.F.FT | 0.06 | 0.09 | 0.06 | | 0.06 | 0.10 | 0.12 | | 0.37 | 0.07 |
| SURFACE TENSION, DYNE/CM | 23.05 | | | | | | | | 68.25 | 19.66 |
| VAPOR FLOW AT P,T, ACFM | | 12.83 | 67.79 | | 62.89 | 306.53 | | | | |
| LIQUID FLOW AT P,T, USGPM | 55.39 | | | | | | 1.82 | | | 59.55 |
| ENTHALPY, MMBTU/H | 2.38 | -0.47 | -1.73 | 11.21 | -1.60 | 16.78 | 0.21 | 16.98 | 0.00 | 0.36 |

JET FUEL STUDY
JOB 5591
MTL BAL AREA.
10C 200, 500

DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE
DOE/AMOCO STUDY-05571
SECTION 300 - HYDROCRACKING
MATERIAL BALANCE

| STREAM ID | 309 | 310 |
|---|---|---|
| STREAM NAME | MP/LT VAPOR | PURGE GASES |
| PHASE | VAPOR | VAPOR |
| COMPOSITION,LBMOLS/H | | |
| H2O | 1.80 | 0.03 |
| NH3 | | |
| H2S | | |
| H2 | 2076.38 | 31.15 |
| C1 | 153.52 | 2.30 |
| C2 | 15.38 | 0.23 |
| C3 | 16.00 | 0.24 |
| C4 | 18.53 | 0.28 |
| C5 | 1.72 | 0.03 |
| 150 F NBP | 1.81 | 0.03 |
| 180 F NBP | 0.88 | 0.01 |
| 212.5 F NBP | 0.34 | 0.01 |
| 237.5 F NBP | 0.20 | |
| 262.5 F NBP | 0.11 | |
| 312.5 F NBP | 0.14 | |
| 387.5 F NBP | 0.03 | |
| 462.5 F NBP | 0.01 | |
| 512.5 F NBP | | |
| 537.5 F NBP | | |
| 600 F NBP | | |
| 700 F NBP | | |
| 800 F NBP | | |
| 900 F NBP | | |
| HCR FEED | | |
| TOTAL FLOW, LBMOL/H | 2286.85 | 34.31 |
| LB/H | 9368.80 | 140.50 |
| TEMPERATURE, DEG.F | 120.00 | 120.00 |
| PRESSURE, PSIG | 1635.00 | 1635.00 |
| MOLECULAR WEIGHT | 4.10 | 4.10 |
| GRAVITY, DEG.API | | |
| VAPOR FLOW, MMSCFD | 20.83 | 0.31 |
| LIQUID FLOW, BPSD | | |
| DENSITY AT P,T, LB/FT3 | 1.03 | 1.03 |
| VISCOSITY AT P,T, CP | 0.01 | 0.01 |
| VAPOR COMPRESSIBILITY | 1.05 | 1.05 |
| CONDUCTIVITY, BTU/H.F.FT | 0.06 | 0.06 |
| SURFACE TENSION, DYNE/CM | | |
| VAPOR FLOW AT P,T, ACFM | 151.45 | 2.27 |
| LIQUID FLOW AT P,T, USGPM | | |
| ENTHALPY, MMBTU/H | -2.90 | -0.04 |

JET FUEL STUDY
JOB 5571
MTL BAL AREAS
100, 200, 300

## 2.2 Naphtha Stream

### 2.2.1 Naphtha Distillation & Hydrotreating (Area 600)

Operating conditions for the naphtha distillation and hydrotreater were provided to Lummus by Amoco and these conditions are presented in Table 2.1. The basic processing steps selected were a distillation to produce a 160°F+ feed stock and a fixed bed hydrotreater. Referring to drawing D5571-601 the flow is as follows:

- The crude naphtha is charged to the Naphtha Distillation Column DA-601 via Surge Drum FA-601 and Feed Pump GA-601.
- The column is reboiled with steam in EA-601 to produce a 160°F+ bottoms product.
- The 160°F- overheads are condensed in EA-602 and sent to fuel via GA-603.
- The 160°F+ Distillation Column bottoms is charged to the HDT Surge Drum FA-603 via GA-602.
- 160°F+ naphtha is charged into the hydrotreater from Surge Tank FA-603 by Charge Pumps GA-604 through Feed/Effluent Exchanger EA-603.
- The charge oil is combined with feed hydrogen gas from Heater EA-604 prior to entering the feed/effluent exchanger. The preheated mixture is then charged to the Reactor DC-601.
- The Reactor DC-601 operates adiabatically with an average bed temperature of 450°F.
- The effluent from DC-601 is cooled in EA-603 and flows through Exchangers EA-605 and EA-606. Process water is injected prior to EA-606 to convert the $H_2S$ and $NH_3$ in the gas to an aqueous $NH_4OH/NH_4HS$ solution.
- The cooled mixture then passes into the High Pressure/Low Temperature Separator FA-605 where hydrogen rich gas leaves overhead. A portion of this high pressure gas is purged to remove $H_2S$ and light gases from the loop and sent to the Rectisol Unit in the SNG plant to recover the hydrogen in the purge gas. The remaining gas is recirculated to Reactor DC-601.

- The water phase from Separator FA-606 goes to the PHOSAM Unit in the SNG plant to recover the $H_2S$ and $NH_3$.
- The hydrocarbon phase from Separator FA-606 is preheated in Exchanger EA-605 and charged to the HDT Naphtha Stabilizer DA-602 which is reboiled by MP Steam to stabilize the naphtha.
- Offgas from the Naphtha Stabilizer is sent to the SNG plant for fuel.
- The stabilized naphtha is cooled and sent to the Aromatics Recovery Unit (Area 700).

Table 2.1 Naphtha Hydrotreater Operating Conditions

| Naphtha Hydrotreater Conditions | |
|---|---|
| Feed Stock | 160°F+ Naphtha |
| Reactor Type | Fixed Bed |
| Number of Stages | 1 |
| LHSV $Hr^{-1}$ | 1.0 |
| Average Reactor Temperature | 450°F |
| Reactor Pressure | 500 psig $H_2$ Partial Pressure |
| H2 Recycle Rate | 2500 SCF/Bbl |
| Catalyst | Ni-Mo |
| Catalyst Replacement | 2 years @ $3/# |

2.2.2 Aromatics Recovery Unit (Area 700)

This unit is based on the Shell Sulfolane Process licensed by Universal Oil Products. Referring to Drawings D5571-701A and B the flow is as follows:

Stabilized Naphtha from the Naphtha Hydrotreater (Area 600) is charged to the Extraction Column DA-701 through Feed Surge Drum FA-701 by Feed Charge Pump GA-701. Lean solvent is charged to the top of Column DA-701. As the feed flows through the column, aromatic components are selectively dissolved in the solvent. Raffinate with very low aromatics content is withdrawn from the top of DA-701.

Rich solvent leaves the bottom of the extractor. After heat exchange in Lean/Rich Solvent Exchanger EA-702, the rich solvent is charged to the top of DA-703, Stripper.

The raffinate stream from the Extractor Column DA-701 overheads is cooled in Raffinate Cooler EA-701 and then contacted with wash water in Water Wash Column DA-702. Water removes any dissolved solvent from the raffinate. Raffinate leaving DA-702 overhead is pumped to Gasoline Blending Stock Storage. The solvent rich water form DA-702 flows to DA-705, Water Stripper.

Solvent accumulates in the bottom of Water Stripper DA-705 and is pumped back to the Recovery Column by Water Stripper Bottoms Pump GA-710. The rich water is returned to the Recovery Column DA-704 as stripping steam generated via the Water Stripper Reboiler EA-709 by exchange with the hot circulating lean solvent.

A solvent regeneration system is included to guard against excessive solvent degradation. In normal operation a slipstream of solvent is routed to the Solvent Regenerator DA-706. Degraded solvent is periodically withdrawn from the bottom of DA-706.

In the stripper, non-aromatic hydrocarbons, which are more volatile, are stripped from the solvent, removed overhead, condensed and recycled to the Extractor Column DA-701 for reuse.

The stripper bottoms consists of aromatics in the solvent. This stream is pumped to the Recovery Column DA-704 by Stripper Bottoms Pump GA-704.

In the Recovery Column DA-704, the aromatics are stripped from the solvent. Lean solvent leaves the column bottom and is returned to Extraction Column DA-701 by GA-707 Lean Solvent Pump after heat exchange in Water Stripper Reboiler EA-709 and Lean/Rich Solvent Exchanger EA-702.

The aromatic product recovered overhead from the Recovery Column is fractionated to recover benzene, toluene and xylene product streams.

The recovery column overhead is pumped by Recovery Column Overhead Pump GA-709 to Clay Tower Surge Tank FB-703. From FB-703 the aromatic stream is pumped by Clay Tower Feed Pump GA-715 through Clay Tower Feed/Effluent Exchanger EA-712, Clay Tower Feed Heater EA-713 and then into Clay Towers DA-707A/B. In the Clay Tower, trace amounts of unsaturates and residual non-hydrocarbon impurities are removed.

After heat exchange in the Clay Tower Feed/Effluent Exchanger, the extract flows to Benzene Column DA-708. Benzene product is withdrawn from a tray near the top of the tower. After cooling in Benzene Product Cooler EA-715, benzene flows to Benzene Day Tank FB-704. Product from FB-704 is pumped to product storage by Benzene Product Pump GA-719.

Any water that accumulates in Benzene Column Reflux Drum FA-708 is pumped to Waste Treatment by Benzene Column Water Pump GA-718.

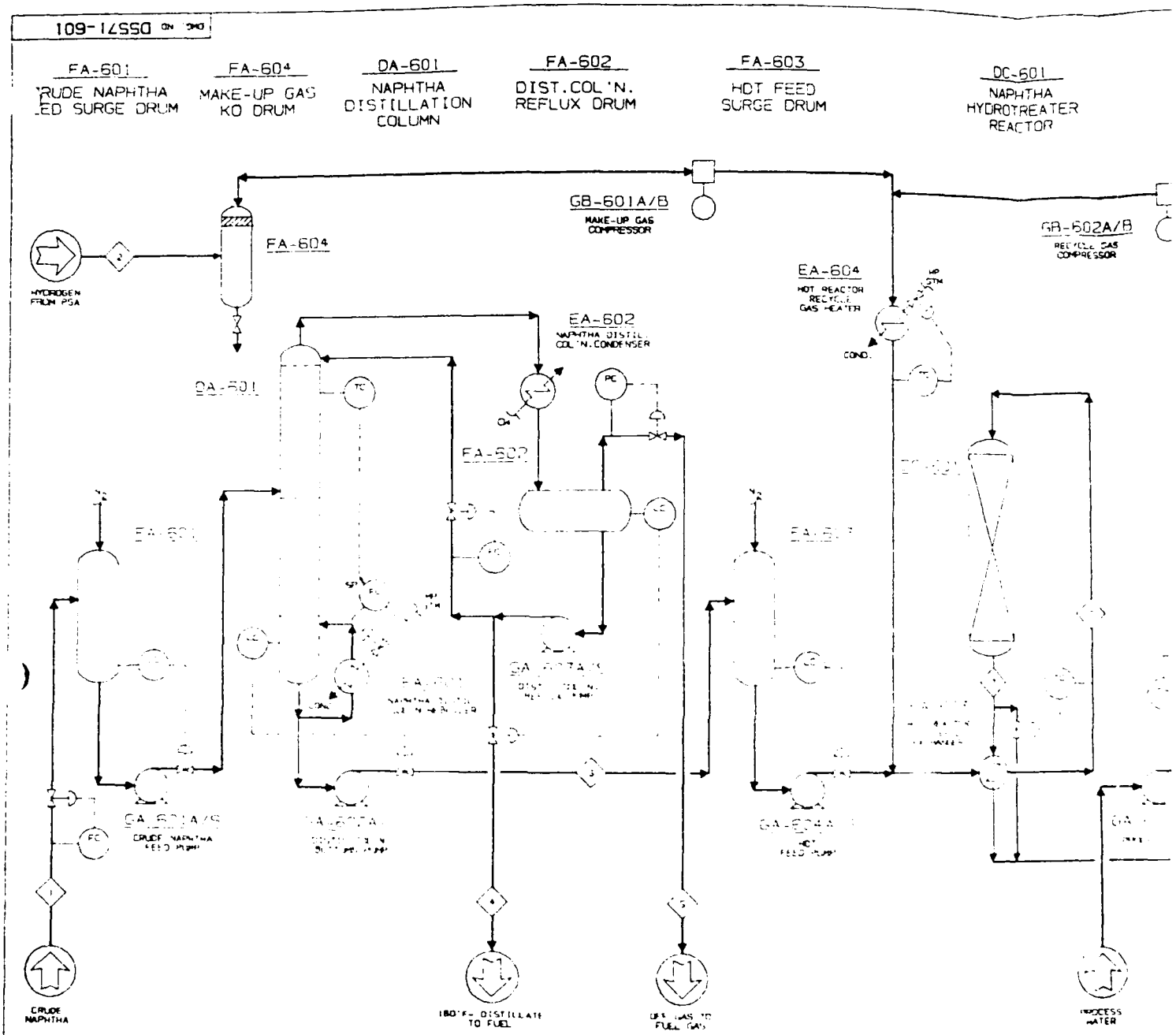
Benzene column bottoms are pumped by Benzene Column Bottoms Pump GA-716 to Toluene Column DA-709. The toluene product leaves overhead. Toluene is pumped from Toluene Column Reflux Drum FA-709 by Toluene Column Reflux Pump GA-721 through Toluene Product Cooler EA-720 to Toluene Day Tanks FB-706A/B. Toluene from FB-706A/B is pumped to storage by Toluene Product Pump GA-723.

Xylene is taken as bottoms product from Toluene Column DA-709. Xylene is pumped by Toluene Column Bottoms Pump GA-720 through Xylene Product Cooler EA-718 to Xylene Day Tank FB-705. Xylene from FB-705 is pumped to storage by Xylene Product Pump GA-722.

2.2 Naphtha Stream - cont'd

2.2.3 Process Flow Diagrams

| Dwg. | Title |
|---|---|
| E5571-601 | Naphtha Distillation and Hydrotreating |
| E5571-701A | Aromatics Recovery Unit Extraction Section |
| D5571-701B | Aromatics Recovery Unit Fractionation Section |


FA-601
CRUDE NAPHTHA FEED SURGE DRUM
FA-604
MAKE-UP GAS KO DRUM
DA-601
NAPHTHA DISTILLATION COLUMN
FA-602
DIST.COL'N. REFLUX DRUM
FA-603
HDT FEED SURGE DRUM
DC-601
NAPHTHA HYDROTREATER REACTOR
GB-601A/B
MAKE-UP GAS COMPRESSOR
GB-602A/B
RECYCLE GAS COMPRESSOR
EA-604
HOT REACTOR RECYCLE GAS HEATER
EA-602
NAPHTHA DISTIL. COL'N. CONDENSER
HYDROGEN FROM PSA
CRUDE NAPHTHA
180°F- DISTILLATE TO FUEL
PROCESS WATER

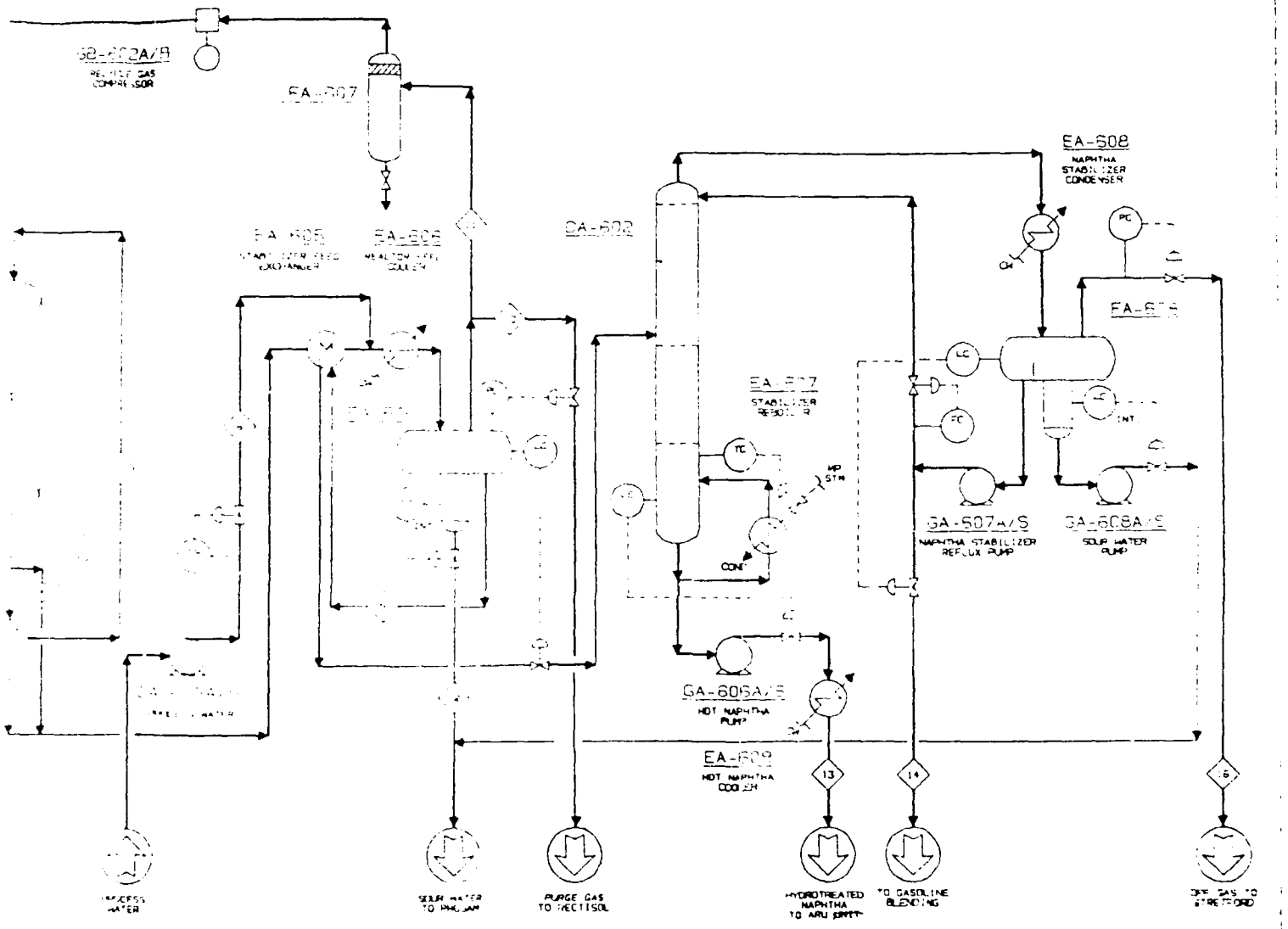
DC-501
NAPHTHA HDTREATER REACTOR

FA-607
RECYCLE GAS KO DRUM

FA-606
LT/HP SEPARATOR

DA-602
HDT NAPHTHA STABILIZER COLUMN

FA-608
NAPHTHA STABIL. REFLUX DRUM




| REV. | ISSUE DATE | DESCRIPTION | BY | CHKD | APP'D | ISSUE No. | LAB | RELEASED FOR CONST. |
|---|---|---|---|---|---|---|---|---|
| 0 | 6/16/89 | FOR TASK 4 | | | | | | |

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COMBUSTION ENGINEERING | LUMMUS CREST INC. Bloomfield, NJ

PROCESS FLOW DIAGRAM
NAPHTHA DISTILLATION
AND HYDROTREATING
AREA 600

E1466
A ISSUE 6/16/89 0

SCALE | DWG. NO. 05571-601

DWG. NO. D5571-701A

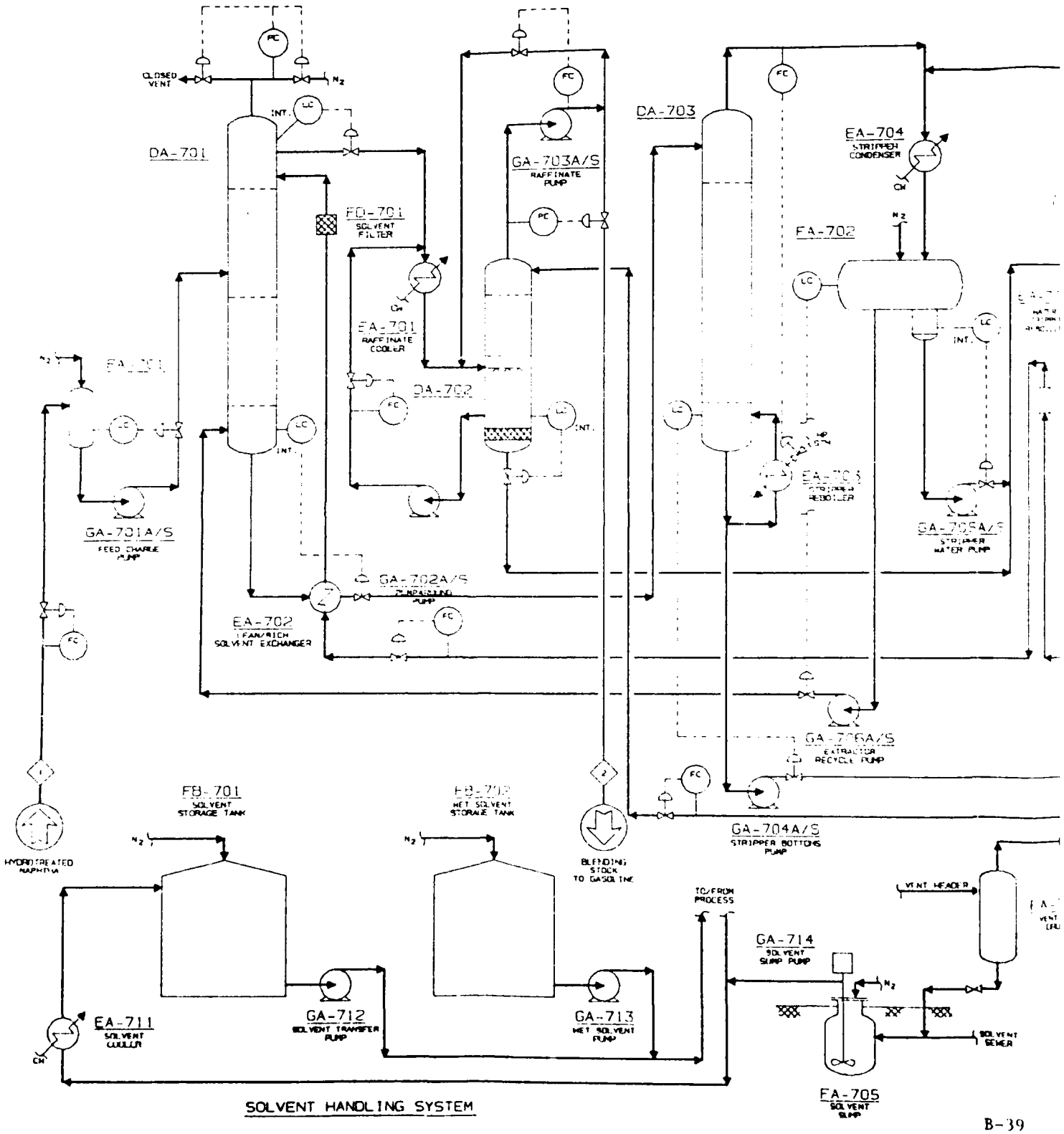
FA-701
FEED SURGE DRUM

DA-701
EXTRACTOR COLUMN

DA-702
RAFFINATE WATER WASH COLUMN

DA-703
STRIPPER

FA-702
STRIPPER REFLUX DRUM




SOLVENT HANDLING SYSTEM

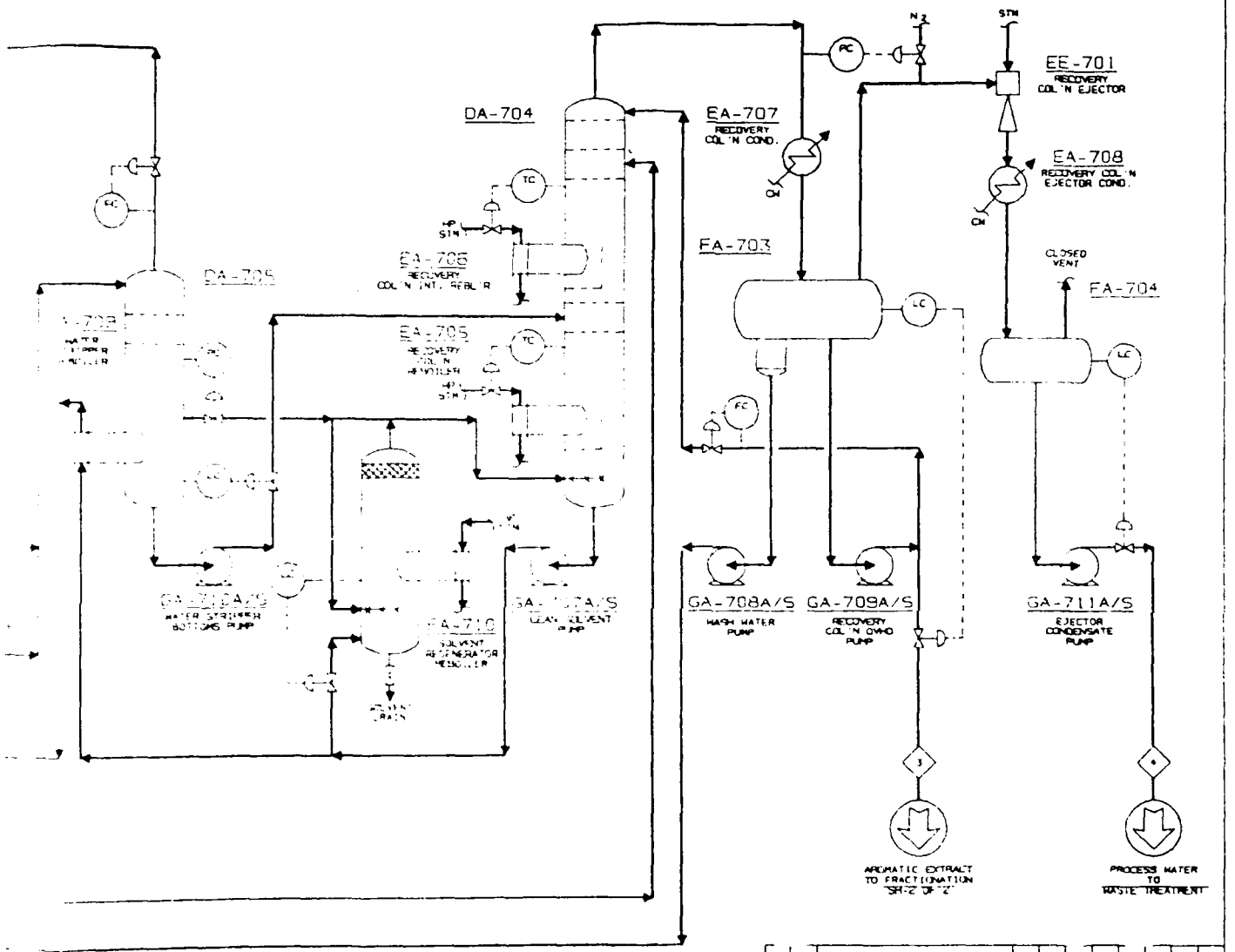
DA-705
WATER STRIPPER

DA-706
SOLVENT REGENERATOR

DA-704
RECOVERY COLUMN

FA-703
RECOVERY COLUMN REFLUX DRUM

FA-704
EJECTOR CONDENSATE DRUM




SHELL SULFOLANE PROCESS

| REV. | ISSUE DATE | DESCRIPTION | BM | DWG. | REG | CHKD. DATE | PM | LPE | PLANT DIR. | HEAD PLANT DIR. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4/15/89 | FOR TASK 4 | | | | ML | | | | |

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COMBUSTION ENGINEERING | LUMMUS CREST INC. Bloomfield, NJ

PROCESS FLOW DIAGRAM
AROMATICS RECOVERY UNIT
EXTRACTION SECTION
AREA 700

E1464
A ISSUE 4/15/89 0

SCALE | DWG. NO. D5571-701A

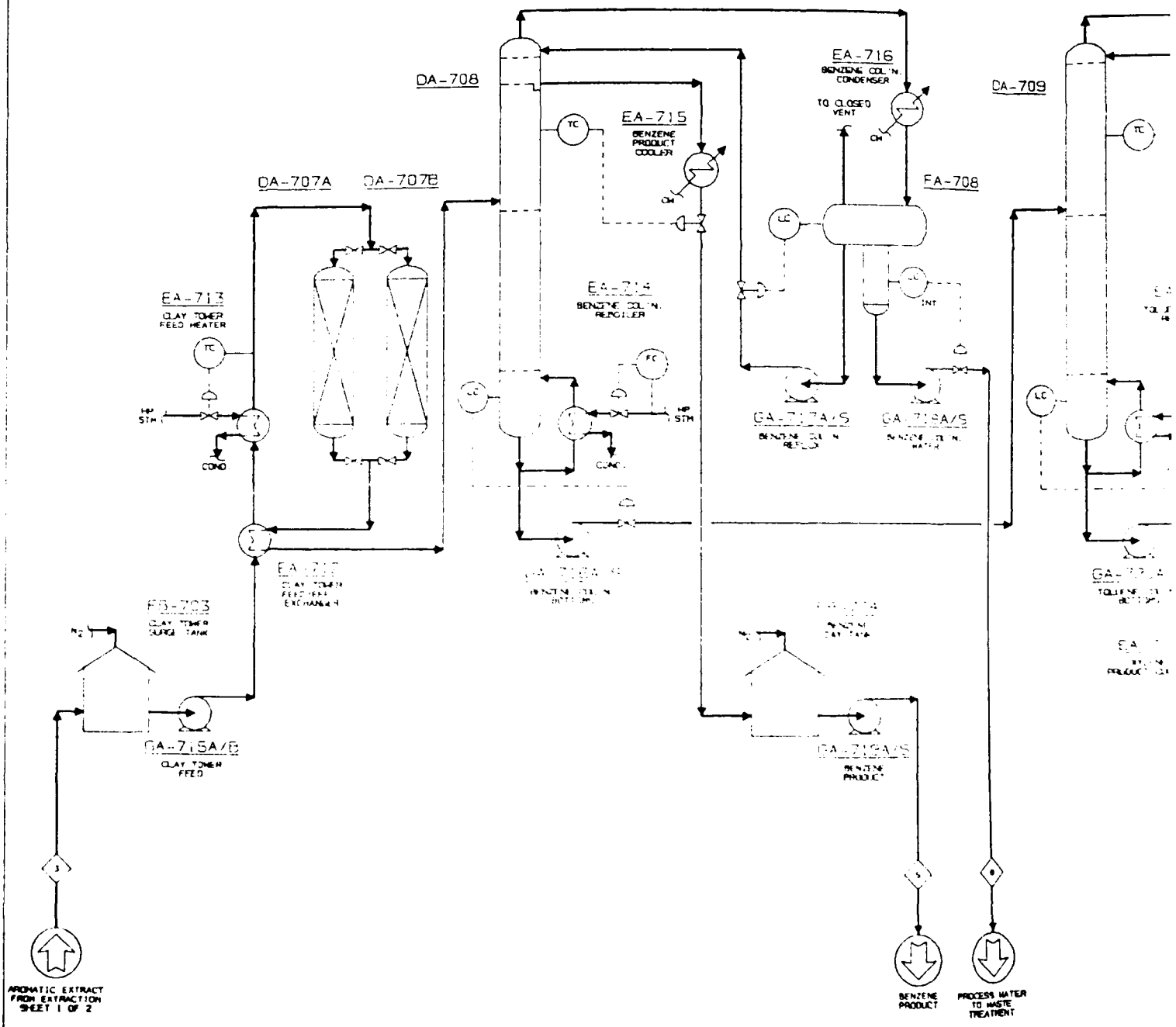
PLOT:132/ USER:D.RAPI 312 DR: IF2373 LOC: EXT: PAPER:W DATE: 04/21/89

DA-707A/B CLAY TOWERS

DA-708 BENZENE COLUMN

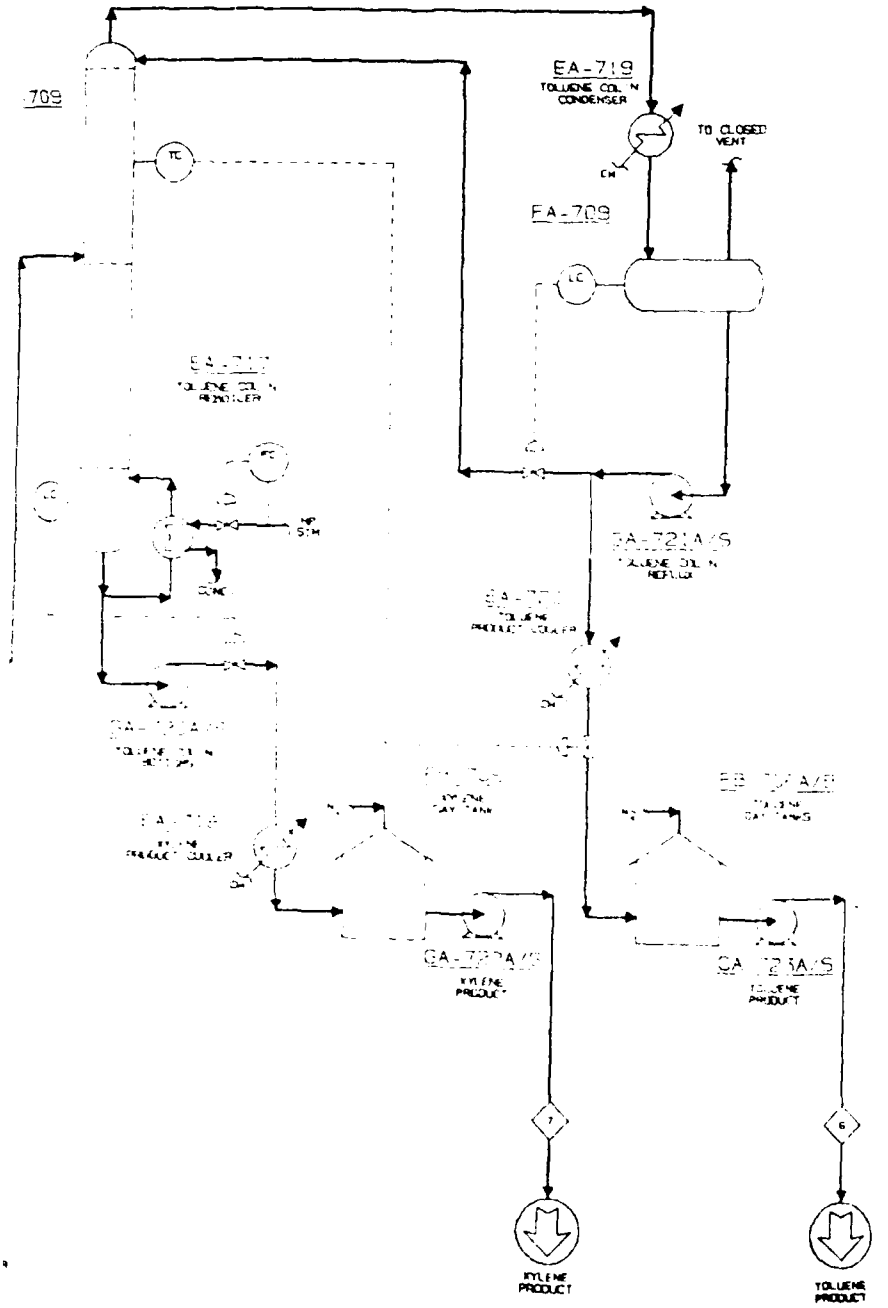
FA-708 BENZENE COLUMN REFLUX DRUM

DA-709 TOLUENE COLUMN



DA-709
TOLUENE COLUMN

FA-709
TOLUENE COLUMN
REFLUX DRUM




SHELL SULFOLANE PROCESS

| REV. | ISSUE DATE | DESCRIPTION | DRN | CHKD | APPR | APPR. DATE | PM | LPE | RELEASED FOR CONST. | RELEASED FOR PLANT DATE |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6/15/89 | FOR TASK 4 | | | | | | | | |

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COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

PROCESS FLOW DIAGRAM
AROMATICS RECOVERY UNIT
AROMATICS FRACTIONATION SECTION
AREA 700

SCALE

DWG. NO. 05571-7018

E1465

A ISSUE 6/15/89 0

## 2.2 Naphtha Stream

### 2.2.4 Material Balances

The following Material Balances were developed for Area 600.

VERSION 2.C1 TM
SIMULATION SCIENCES INC. PROCESS
PROJECT GP JET FUELS ML
PROBLEM NAPSTAB SOLUTION DEC 31 1987

AREA 600

NAPHTHA HDT PRODUCT STRIPPER

| STREAM ID. ..... | 12 | 13 | 15 | 17 |
|---|---|---|---|---|
| STREAM NAME..... | SOUR H2O | STAB PRD | STAB OFFGAS | STAB SOUR H2O |
| STREAM PHASE..... | LIQUID | LIQUID | VAPOR | LIQUID |
| TEMPERATURE, DEG F | 120.0000 | 287.5287 | 100.0000 | 100.0000 |
| PRESSURE, PSIA | 210.0000 | 70.0000 | 60.0000 | 60.0000 |
| RATE LB MOLS/HR | 147.1456 | 73.8262 | 8.4432 | 0.0309 |
| RATE LB /HR | 2661.4951 | 6135.1143 | 313.3105 | 0.5570 |
| ENTHALPY MM BTU /HR | 0.0780 | 0.6899 | 0.0653 | 0.0000 |
| ENTHALPY BTU /LB | 29.3213 | 112.4480 | 208.5772 | 67.9931 |
| MOLECULAR WEIGHT.... | 18.0873 | 83.0998 | 37.1079 | 18.0150 |
| *** VAPOR PHASE *** | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 313.3105 | 0.0000 |
| ACT.RATE FT3/SEC | 0.00 | 0.00 | 0.23 | 0.00 |
| STD.RATE MM FT3/DAY | 0.00 | 0.00 | 0.08 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.3973 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 37.1079 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.3844 | 0.0000 |
| COMPRESSIBILITY (Z). | 0.0000 | 0.0000 | 0.9645 | 0.0000 |
| *** LIQUID PHASE *** | | | | |
| RATE LB /HR | 2661.4951 | 6135.1143 | 0.0000 | 0.5570 |
| ACT.RATE BBL/DAY | 185.82 | 576.27 | 0.00 | 0.04 |
| STD. LV RATE BBL/HR | 7.66 | 20.33 | 0.00 | 0.00 |
| CP, BTU /LB F | 1.1616 | 0.4890 | 0.0000 | 0.9977 |
| MOLECULAR WEIGHT.... | 18.0873 | 83.0998 | 0.0000 | 18.0150 |
| ACT.DENS LB /FT3 | 61.2244 | 45.5081 | 0.0000 | 61.9843 |
| STD. API GRAVITY.... | 10.8946 | 32.5122 | 0.0000 | 10.0635 |
| *** DRY BASIS *** | | | | |
| RATE LB /HR | 37.6836 | 6135.1016 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 25.1254 | 83.1004 | 0.0000 | 0.0000 |
| UOP K ..... | 10.2499 | 10.0651 | 0.0000 | 0.0000 |
| FLASH POINT, DEG F | -5.3046 | 0.7399 | 0.0000 | 0.0000 |
| CRIT. TEMP, F | 214.9373 | 561.6288 | 0.0000 | 0.0000 |
| CRIT. PRES, PSIA | 1412.3528 | 667.3295 | 0.0000 | 0.0000 |
| *** VAPOR PHASE *** | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 310.9178 | 0.0000 |
| ACT.RATE FT3/SEC | 0.00 | 0.00 | 0.22 | 0.00 |
| STD.RATE MM FT3/HR | 0.00 | 0.00 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.3971 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 37.4130 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.3877 | 0.0000 |
| COMPRESSIBILITY (Z). | 0.0000 | 0.0000 | 0.9640 | 0.0000 |
| VISCOSITY, CP | 0.0000 | 0.0000 | 0.0102 | 0.0000 |
| *** LIQUID PHASE *** | | | | |
| RATE LB /HR | 37.6836 | 6135.1016 | 0.0000 | 0.0000 |
| ACT.RATE BBL/DAY | 4.07 | 576.27 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.8241 | 0.4890 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 25.1254 | 83.1004 | 0.0000 | 0.0000 |
| ACT.DENS LB /FT3 | 39.6032 | 45.5080 | 0.0000 | 0.0000 |
| STD. API GRAVITY.... | 68.7618 | 32.5122 | 0.0000 | 0.0000 |
| VISCOSITY, CP | 0.1646 | 1.1616 | 0.0000 | 0.0000 |

JET FUEL STUDY
JOB 5571

VERSION 2.01 TM
SIMULATION SCIENCES INC. PROCESS
PROJECT GP JET FUELS
PROBLEM NAPHOT SOLUTION ML DEC 31 1987

AREA 600

REFINERY PROCESSOR PROPERTIES SET

| STREAM ID. ..... | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|
| STREAM NAME..... | MAKE-UP GAS | REACTOR INLE | REACTOR EFFL | WASH WATER | COLD SEP LIQ | PURGE GAS | RECYCLE GAS |
| STREAM PHASE..... | VAPOR | VAPOR | VAPOR | LIQUID | LIQUID | VAPOR | VAPOR |
| TEMPERATURE, DEG F | 70.0000 | 425.0000 | 475.0000 | 100.0000 | 120.0000 | 120.0000 | 120.0000 |
| PRESSURE, PSIA | 340.0000 | 800.0000 | 775.0000 | 755.0000 | 710.0000 | 710.0000 | 710.0000 |
| RATE LB MOLS/HR | 31.0000 | 277.6176 | 264.3793 | 138.7732 | 82.9024 | 5.3009 | 168.4035 |
| RATE LB /HR | 62.5395 | 7324.1631 | 7321.4014 | 2499.9995 | 6446.4883 | 21.7711 | 691.6453 |
| ENTHALPY MM BTU /HR | -0.0644 | 2.2362 | 2.5851 | 0.1750 | 0.2584 | -0.0062 | -0.1984 |
| ENTHALPY BTU /LB | -1030.5195 | 305.3162 | 353.0820 | 69.9971 | 40.0906 | -286.8285 | -286.8286 |
| MOLECULAR WEIGHT.... | 2.0174 | 26.3822 | 27.6928 | 18.0150 | 78.3268 | 4.1071 | 4.1071 |
| *** VAPOR PHASE *** | | | | | | | |
| RATE LB /HR | 62.5395 | 7324.1631 | 7321.4014 | 0.0000 | 0.0000 | 21.7711 | 691.6453 |
| ACT.RATE FT3/SEC | 0.15 | 0.69 | 0.93 | 0.00 | 0.00 | 0.01 | 0.42 |
| STD.RATE MM FT3/DAY | 0.28 | 2.53 | 2.41 | 0.00 | 0.00 | 0.05 | 1.53 |
| CP, BTU /LB F | 3.4201 | 0.6138 | 0.6083 | 0.0000 | 0.0000 | 1.8091 | 1.8091 |
| MOLECULAR WEIGHT.... | 2.0174 | 26.3822 | 27.6928 | 0.0000 | 0.0000 | 4.1071 | 4.1071 |
| ACT.DENS LB /FT3 | 0.1189 | 2.2787 | 2.1894 | 0.0000 | 0.0000 | 0.4569 | 0.4569 |
| COMPRESSIBILITY (Z). | 1.0145 | 0.9757 | 0.9773 | 0.0000 | 0.0000 | 1.0260 | 1.0260 |
| *** LIQUID PHASE *** | | | | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 0.0000 | 2499.9995 | 6446.4883 | 0.0000 | 0.0000 |
| ACT.RATE BBL/DAY | 0.00 | 0.00 | 0.00 | 172.41 | 541.70 | 0.00 | 0.00 |
| STD. LV RATE BBL/HR | 0.00 | 0.00 | 0.00 | 7.15 | 21.83 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.0000 | 0.9941 | 0.4159 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 0.0000 | 18.0150 | 78.3268 | 0.0000 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.0000 | 61.9844 | 50.8694 | 0.0000 | 0.0000 |
| STD. API GRAVITY.... | 0.0000 | 0.0000 | 0.0000 | 10.0635 | 36.1255 | 0.0000 | 0.0000 |
| *** DRY BASIS *** | | | | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 6443.5264 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 78.4475 | 0.0000 | 0.0000 |
| UOP K ..... | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 10.1772 | 0.0000 | 0.0000 |
| FLASH POINT, DEG F | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -75.8712 | 0.0000 | 0.0000 |
| CRIT. TEMP, F | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 519.0099 | 0.0000 | 0.0000 |
| CRIT. PRES, PSIA | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 678.9440 | 0.0000 | 0.0000 |
| *** VAPOR PHASE *** | | | | | | | |
| RATE LB /HR | 62.5395 | 7316.9844 | 7187.2246 | 0.0000 | 0.0000 | 21.5452 | 684.4674 |
| ACT.RATE FT3/SEC | 0.15 | 0.89 | 0.90 | 0.00 | 0.00 | 0.01 | 0.42 |
| STD.RATE MM FT3/HR | 0.01 | 0.11 | 0.10 | 0.00 | 0.00 | 0.00 | 0.06 |
| CP, BTU /LB F | 3.4201 | 0.6139 | 0.6113 | 0.0000 | 0.0000 | 1.8233 | 1.8233 |
| MOLECULAR WEIGHT.... | 2.0174 | 26.3942 | 27.9733 | 0.0000 | 0.0000 | 4.0741 | 4.0741 |
| ACT.DENS LB /FT3 | 0.1189 | 2.2798 | 2.2128 | 0.0000 | 0.0000 | 0.4532 | 0.4532 |
| COMPRESSIBILITY (Z). | 1.0145 | 0.9756 | 0.9768 | 0.0000 | 0.0000 | 1.0261 | 1.0261 |
| VISCOSITY, CP | 0.0078 | 0.0185 | 0.0191 | 0.0000 | 0.0000 | 0.0106 | 0.0106 |
| *** LIQUID PHASE *** | | | | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 6443.5264 | 0.0000 | 0.0000 |
| ACT.RATE BBL/DAY | 0.00 | 0.00 | 0.00 | 0.00 | 541.49 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.4157 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 78.4475 | 0.0000 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 50.8653 | 0.0000 | 0.0000 |
| STD. API GRAVITY.... | | | | | | | |

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VERSION 2.01 TM
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AREA 600

NAPHTHA FRACTIONATION

| STREAM ID. ..... | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| STREAM NAME..... | RECTISOL NAP | 160 MINUS | 160 PLUS | DIST OFFGAS |
| STREAM PHASE..... | LIQUID | LIQUID | LIQUID | VAPOR |
| TEMPERATURE, DEG F | 33.0000 | 100.0000 | 272.4216 | 100.0000 |
| PRESSURE, PSIA | 46.9785 | 40.0000 | 47.9999 | 40.0000 |
| RATE LB MOLS/HR | 114.1908 | 35.9744 | 78.2163 | |
| RATE LB /HR | 8737.9805 | 2168.0786 | 6570.0576 | NORMALLY |
| ENTHALPY MM BTU /HR | -0.0349 | 0.0386 | 0.6911 | NO |
| ENTHALPY BTU /LB | -3.9967 | 17.8333 | 105.1917 | FLOW |
| MOLECULAR WEIGHT.... | 76.52C9 | 60.2673 | 83.9986 | |
| *** VAPOR PHASE *** | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ACT.RATE FT3/SEC | 0.00 | 0.00 | 0.00 | 0.00 |
| STD.RATE MM FT3/DAY | 0.00 | 0.00 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| COMPRESSIBILITY (Z). | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| *** LIQUID PHASE *** | | | | |
| RATE LB /HR | 8737.9805 | 2168.0786 | 6570.0576 | 0.0000 |
| ACT.RATE BBL/DAY | 713.18 | 208.33 | 607.62 | 0.00 |
| STD. LV RATE BBL/HR | 30.20 | 8.42 | 21.77 | 0.00 |
| CP, BTU /LB F | 0.4198 | 0.5621 | 0.4886 | 0.0000 |
| MOLECULAR WEIGHT.... | 76.52C9 | 60.2673 | 83.9986 | 0.0000 |
| ACT.DENS LB /FT3 | 52.3723 | 44.4841 | 46.2197 | 0.0000 |
| STD. API GRAVITY.... | 39.5750 | 60.6584 | 32.5314 | 0.0000 |
| *** DRY BASIS *** | | | | |
| RATE LB /HR | 8693.9824 | 2124.0786 | 6570.0576 | 0.0000 |
| MOLECULAR WEIGHT.... | 77.7996 | 63.3448 | 83.9986 | 0.0000 |
| UOP K ..... | 10.4363 | 11.4820 | 10.0981 | 0.0000 |
| FLASH POINT, DEG F | -11.2329 | -33.4546 | 19.7649 | 0.0000 |
| CRIT. TEMP, F | 530.7584 | 449.4239 | 565.6373 | 0.0000 |
| CRIT. PRES, PSIA | 665.3411 | 682.4471 | 658.0043 | 0.0000 |
| *** VAPOR PHASE *** | | | | |
| RATE LB /HR | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ACT.RATE FT3/SEC | 0.00 | 0.00 | 0.00 | 0.00 |
| STD.RATE MM FT3/HR | 0.00 | 0.00 | 0.00 | 0.00 |
| CP, BTU /LB F | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| MOLECULAR WEIGHT.... | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| ACT.DENS LB /FT3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| COMPRESSIBILITY (Z). | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| VISCOSITY, CP | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| *** LIQUID PHASE *** | | | | |
| RATE LB /HR | 8693.9824 | 2124.0786 | 6570.0576 | 0.0000 |
| ACT.RATE BBL/DAY | 710.17 | 205.30 | 607.62 | 0.00 |
| CP, BTU /LB F | 0.4169 | 0.5530 | 0.4886 | 0.0000 |
| MOLECULAR WEIGHT.... | 77.7996 | 63.3448 | 83.9986 | 0.0000 |
| ACT.DENS LB /FT3 | 52.3297 | 44.2255 | 46.2197 | 0.0000 |
| STD. API GRAVITY.... | 39.7.43 | 61.[illegible] | 32.5314 | 0.0000 |
| VISCOSITY | | | | |

JET FUEL STUDY
JOB 5571

## 2.3 Phenol Stream

The basic design data for processing the crude phenol stream were provided to LCI by the Dakota Gasification Co. (3).

The unit is divided into 3 sections:

- Area 800 - Phenol Extraction
- Area 850 - Cresylic Acid Extraction
- Area 900 - Cresylic Acid Distillation

### 2.3.1 Phenol Extraction ( Area 800)

Referring to Process Flow Diagram D5571-800 A,B and C the flow is as follows:

- Crude phenol from the Great Plains Plant is charged to the flash column DA-801 form the surge drum FA-806 through pump GA-801. The recycle phenol stream from the Phenol Column DA-803 overhead is also charged to Column DA-801. The overhead from DA-801 is condensed by a 2 step condensation. Phenol is first condensed and refluxed back to the column and then a light oil/water mixture with phenol is condensed and decanted in Light Ends Drum FA-809. The phenol/light oil phase with dissolved water is pumped by GA-806 to the Light Ends Column DA-805. In the Flash Column phenol rich cresylic acid is separated from the tar residue. Phenol rich cresylic acid is side withdrawn and tar residue is pumped from the bottom of the column to the tar wash section.

- The Flash Column overhead product enters the Light Ends Column DA-805. The overhead light ends product is sent to SNG plant fuel. Water condensed in the overhead drum is combined with the aqueous phase from the Light Ends Drum and sent to sour water treatment. The bottoms from the Light Ends Column are pumped and mixed with the phenol rich cresylic acid stream.

- The side drawoff stream from DA-801 and the bottoms stream from DA-805 are sent to the Thin Film Evaporator ED-801. This combined stream contains the phenol, cresylic acid and neutral oil. This material is flashed over sulfuric acid to remove pyridine type substances. The vapor phase from ED-801 is dried in drier column DA-802, top vapor from the Dryer Column is condensed, hydrocarbon phase is refluxed back, aqueous phase is combined with the other water effluents. Bottoms from the Dryer Column is sent to the Phenol Column DA-803. Bottoms of ED-801 is mixed with the other tar streams.

- Cresylic acid from the Dryer Column, and the recycled phenol stream from cresylic acid distillation (Area 900) are charged to the Phenol Column DA-803 to produce an overhead stream which is returned to the Flash Column DA-801, a side draw stream of crude phenol and a bottoms stream which is pumped to the cresylic acid extraction (Section 850).

- The crude phenol stream is stream stripped in a column to remove the impurities and produce a 99.8% pure phenol This section is a Lummus proprietary design.

- The combined tars are water washed in FD-8701/802, 1st and 2nd stage Water Wash Tanks, to remove acid materials and then routed to the Great Plains Fuel Pool.

2.3.2 Cresylic Acid Extraction (Area 850)

The basic processing step used in this section is a dual solvent extraction to recover the cresylic acid. Referring to Process Flow Diagram D5571-850 the flow is as follows:

- The dephenolized cresylic acid from DA-803 is fed to the cresylic acid extraction area where it is extracted with hexane and methanol/water in Extractor Column DA-851.

- Hexane enters the Extractor Column at the bottom and preferentially absorbs the oil components. The hexane/oil mixture exits the top of DA-851.

- A methanol/water solution enters the top of the extractor column and preferentially adsorbs the phenolic compounds. The methanol/water/phenolic mixture exits the bottom of DA-851.

- The oil components are stripped from the hexane in the Hexane Column DA-852. The hexane is recycled to Extractor Column DA-852. The oil is pumped by Hexane Column Bottoms Pump GA-852 through Neutral Oil Cooler EA-853 to the first stage Water Wash Tank FD-801.

- Make-up Hexane is added as needed from Hexane Storage Tank FB-851 by GA-854 Hexane Make-Up Pump.

- The phenolics are recovered from the methanol/water solution in Methanol Column DA-853. The methanol/water is condensed overhead and refluxed to the Methanol Column by Methanol Column Reflux Pump GA-856. Methanol Make-up Drum FA-854 receives the overhead product from the Methanol Column, the methanol/water make-up and the condensate from the Drying Column DA-854. The phenolics are pumped to Drying Column DA-808 by Methanol Column Bottoms Pump GA-855 through Methanol Column Bottoms Cooler EA-856.

- Drying Column DA-856 is reboiled to remove water carry-over from the phenolic product. The dry Crude Cresylic Acid leaves the bottom of DA-856. Product is pumped to either Cresylic Acid Distillation (Area 900) or through the Crude Cresylic Acid Cooler EA-861 to the Cresylic Acid Day Tank, FB-852 by Drying Column Bottoms Pump GA-858.

- Crude Cresylic Acid from Cresylic Acid Day Tank is pumped to storage by Crude Cresylic Acid Pump GA-859.

2.3.3 Cresylic Acid Distillation (Area 900)

A two run block operation is used to separate the cresols and xylenols in the crude cresylic acid. In each block operation a series of distillation columns are used to progressively recover the higher boiling products.

2.3.3.1 Block Operation #1

In this block operation, four distillation columns are used. Referring to Process Flow Diagram D5571-900A the flow is as follows:

Dry crude cresylic acid from Cresylic Acid Extraction (Area 850) is charged to Phenol/Ortho Column DA-901. The overhead liquid distillate from this column is fed to Phenol Column DA-902. DA-901 bottoms is pumped through Phenol/Ortho Column Feed-bottoms Interchanger EA-909 and is fed to M,P-cresol Column DA-903.

The overhead liquid distillate from the Phenol Column DA-902 is recycled to the Phenol Column DA-803 in the 800 Area. DA-902 bottoms is pumped through Phenol Column Bottoms Cooler EA-910 to O-Cresol Topping Feed Day Tank FB-901. The o-Cresol Topping Pump sends the o-Cresol to intermediate storage.

M,P-Cresol product is recovered overhead from M,P-Cresol Column DA-903. M,P-Cresol is pumped from M,P-Cresol Reflux Drum FA-903 through M,P-Cresol Product Cooler EA-912 to M,P-Cresol Product Cooler EA-912 to M,P-Cresol Day Tank FB-905. DA-903 bottoms is fed to Xylenol Topping Column DA-904.

The overhead liquid distillate from the Xylenol Topping Column DA-904 is recycled to M,P-Cresol Column DA-903. DA-904 bottoms is pumped through Xylenol Topping Bottoms Cooler EA-911 to Xylenol Intermediate Day Tank FB-902. From the day tank the xylenols are pumped to intermediate storage.

2.3.3.2 Block Operation #2

In this block operation, three distillation columns are used. Referring to Process Flow Diagram D5571-900B the flow is as follows:

O-Cresol from O-Cresol Topping Intermediate Storage FB-908 is charged to O-Cresol Topping Column DA-901. The overhead liquid distillate from this column is recycled to Crude Cresylic Acid Intermediate Storage FB-853. DA-901 bottoms is fed to O-Cresol Column DA-902.

O-Cresol product is recovered overhead from O-Cresol Column DA-902. O-Cresol is pumped from O-Cresol Reflux Drum FA-902 by O-Cresol Reflux Pump GA-904 through O-Cresol Product Cooler EA-914 to O-Cresol Day Tank FB-903. GA-913 pumps the O-Cresol product from FB-903 to O-Cresol Intermediate Storage FB-910. DA-902 bottoms is pumped by O-Cresol Bottoms Pump GA-903 through O-Cresol Column Bottoms Cooler EA-910 to Slop Cut Intermediate Storage FB-911.

Xylenols from Xylenol Intermediate Storage FB-909 are charged to 2,4/2,5 Xylenol Column DA-904. 2,4/2,5 Xylenol product is recovered overhead from DA-904. 2,4/2,5 Xylenol is pumped from 2,4/2,5 Xylenol Reflux Drum FA-904 by 2,4/2,5 Xylenol Reflux Pump GA-916 through 2,4/2,5 Xylenol Product Cooler EA-916 to 2,4/2,5 Xylenol Day Tank FB-906. GA-910 pumps the 2,4/2,5 Xylenol product from FB-906 to 2,4/2,5 Xylenol Storage FB-914. DA-904 bottoms contains Mixed Xylenols and is pumped by 2,4/2,5 Xylenol Bottoms Pump GA-915 through 2,4/2,5 Xylenol Column Feed-Bottoms Interchanger EA-915 and 2,4/2,5 Xylenol Column Bottoms Cooler EA-911 to Mixed Xylenols Day Tank FB-907, GA-908 pumps the Mixed Xylenols from FB-907 to Mixed Xylenols Storage FB-914.

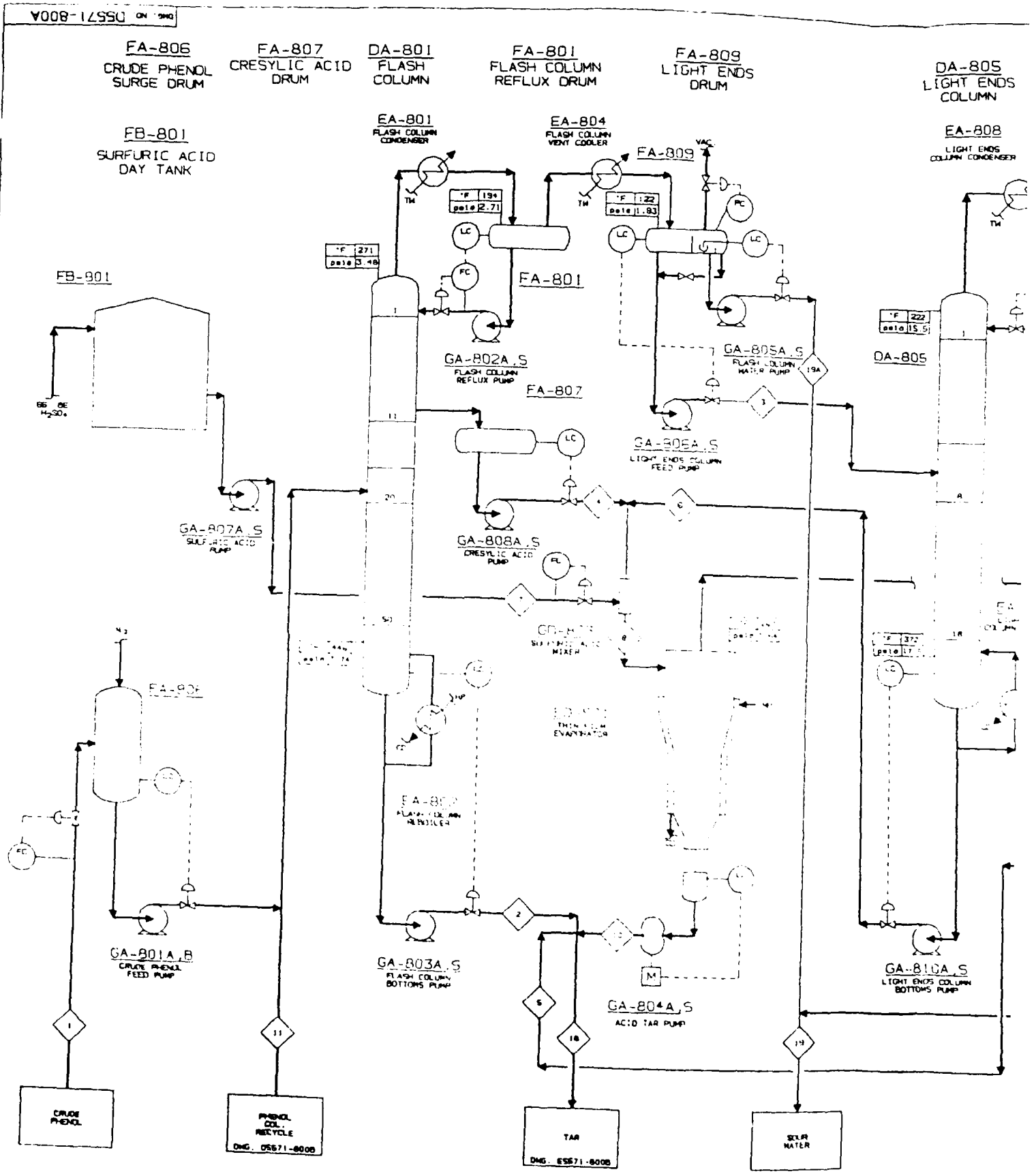
References

1) "Summary of Design Basis Data" dated January 16, 1989 (Sheets 1 to 10).
2) LCI letter G.L. Hamilton to Dr. M. W. Forlong dated January 30, 1989 "LC-Finer, Hydrotreater and Hydrotreater Basis of Design".
3) Minutes of Meeting "Crude Phenol Processing" dated August 25, 1988 and Dakota Gasification letter 9440-DHD-88-067.

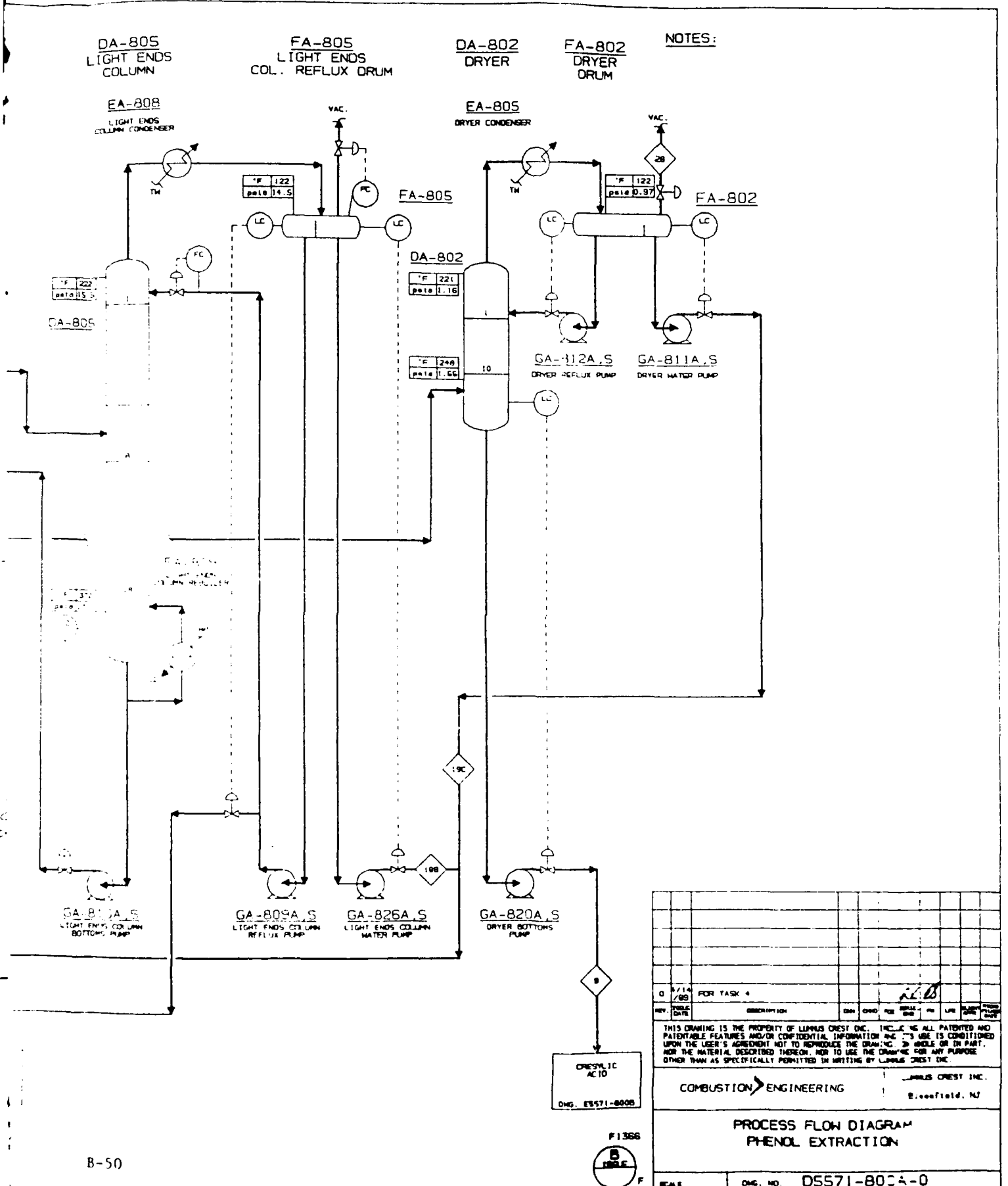
2.3 Phenol Stream - cont'd

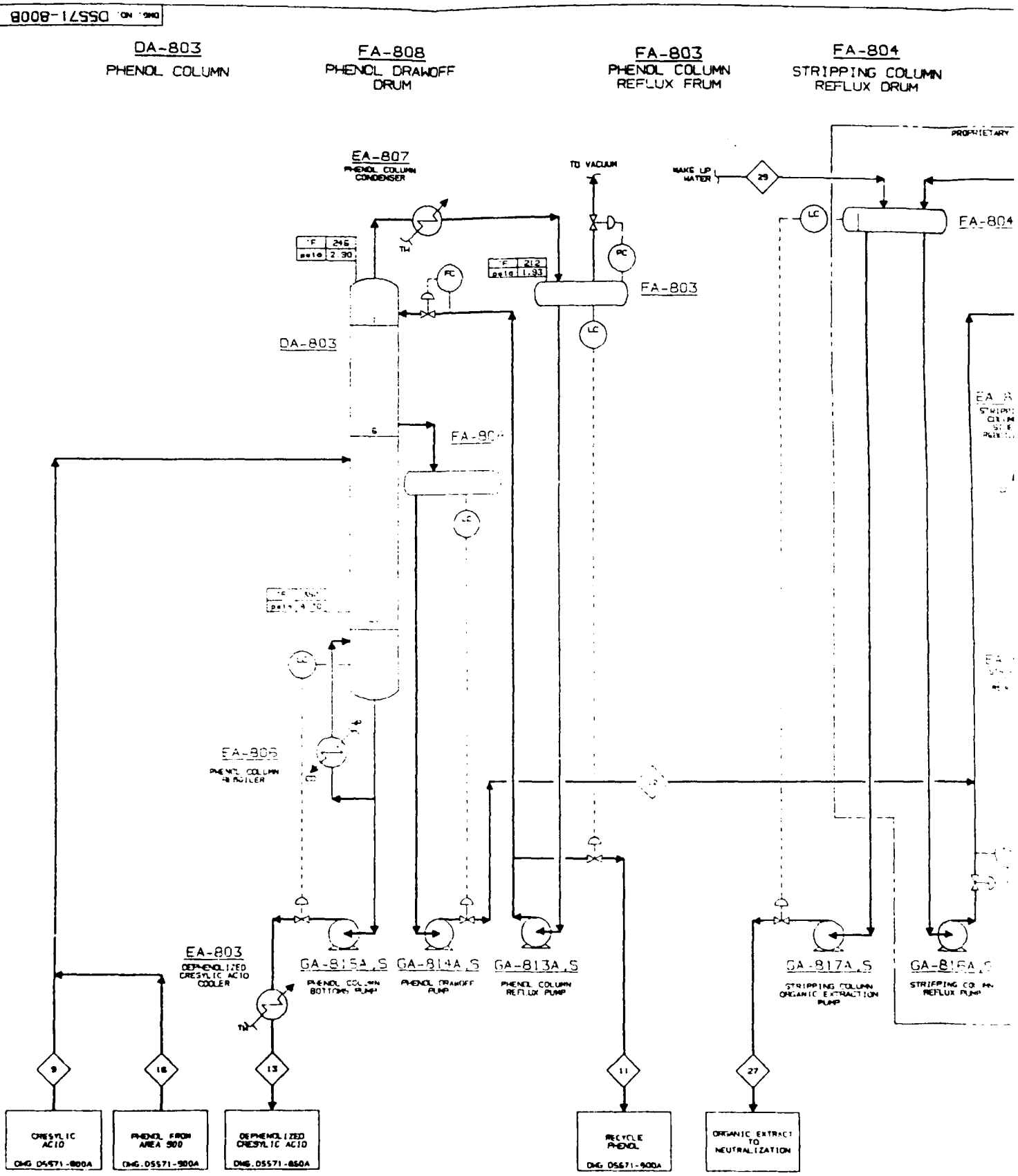
2.3.4 Process Flow Diagrams

| Dwg. | Title |
|---|---|
| E5571-800A | Phenol Extraction (Sheet 1 of 3) |
| E5571-800B | Phenol Extraction (Sheet 2 of 3) |
| E5571-800C | Phenol Extraction (Sheet 3 of 3) |
| E5571-850 | Cresylic Acid Extraction |
| E5571-900A | Crude Cresylic Distillation Block Operation #1 |
| E5571-900B | Crude Cresylic Distillation Block Operation #2 |




PLOT:0894 USER:D.COST 3:2 DR: 11366 :001 DATE: 04/13/89


DA-805
LIGHT ENDS
COLUMN
FA-805
LIGHT ENDS
COL. REFLUX DRUM
DA-802
DRYER
FA-802
DRYER
DRUM
NOTES:
EA-808
LIGHT ENDS
COLUMN CONDENSER
EA-805
DRYER CONDENSER
VAC.
TW
PC
LC
FC
FA-805
FA-802
DA-802
DA-805
GA-812A,S
DRYER REFLUX PUMP
GA-811A,S
DRYER WATER PUMP
GA-808A,S
LIGHT ENDS COLUMN
BOTTOMS PUMP
GA-809A,S
LIGHT ENDS COLUMN
REFLUX PUMP
GA-826A,S
LIGHT ENDS COLUMN
WATER PUMP
GA-820A,S
DRYER BOTTOMS
PUMP
CRESYLIC
ACID
DWG. D5571-8008
F1366
B
TABLE
F
B-50
0 9/14/89 FOR TASK 4
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PROCESS FLOW DIAGRAM
PHENOL EXTRACTION
SCALE
DWG. NO. D5571-8004-0

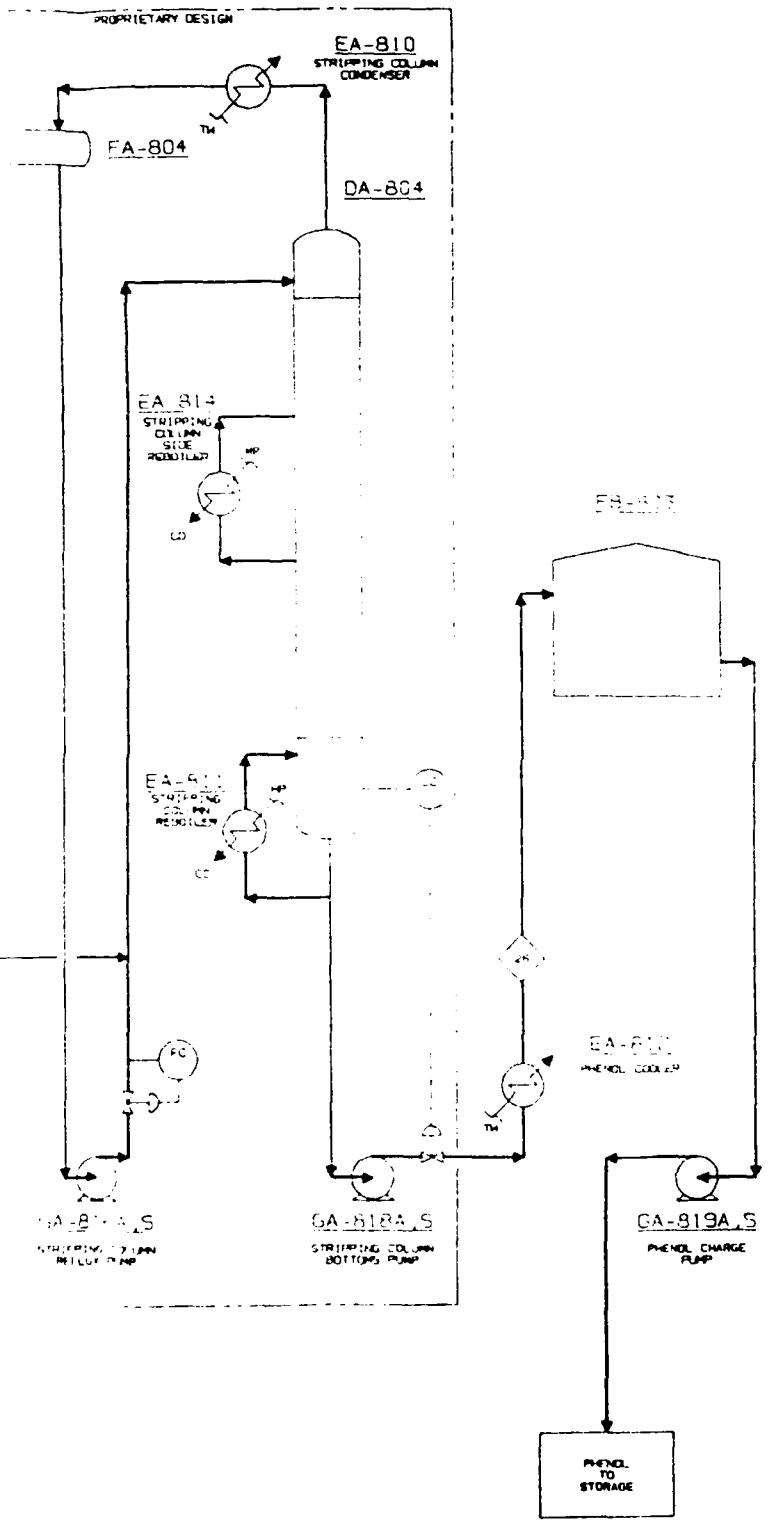

DA-803
PHENOL COLUMN
FA-808
PHENOL DRAWOFF DRUM
FA-803
PHENOL COLUMN REFLUX DRUM
FA-804
STRIPPING COLUMN REFLUX DRUM
PROPRIETARY
EA-807
PHENOL COLUMN CONDENSER
TO VACUUM
MAKE UP WATER
29
FA-804
FA-803
DA-803
FA-80
EA-805
PHENOL COLUMN REBOILER
EA-803
DEPHENOLIZED CRESYLIC ACID COOLER
GA-815A,S
PHENOL COLUMN BOTTOMS PUMP
GA-814A,S
PHENOL DRAWOFF PUMP
GA-813A,S
PHENOL COLUMN REFLUX PUMP
GA-817A,S
STRIPPING COLUMN ORGANIC EXTRACTION PUMP
GA-818A,S
STRIPPING COLUMN REFLUX PUMP
9
16
13
11
27
CRESYLIC ACID
DWG 05571-800A
PHENOL FROM AREA 900
DWG.05571-900A
DEPHENOLIZED CRESYLIC ACID
DWG.05571-850A
RECYCLE PHENOL
DWG 05671-900A
ORGANIC EXTRACT TO NEUTRALIZATION

DA-804
STRIPPING COLUMN

FB-803
PHENOL DAY TANK

NOTES:

1. FOR GENERAL NOTES, LEGEND AND SYMBOLS SEE DWG. NO.




| REV. | DATE | DESCRIPTION | DSN | CHKD | PRS | APPD. ENG. | PM | LAE | CLIENT APPR. | WORK PLACED DATE |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9/14/89 | FOR TASK 4 | | | | RK | | | | |

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COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

PHENOL EXTRACTION

SCALE

DWG. NO D5571-8008-0

F1367
A
ISSUE
E

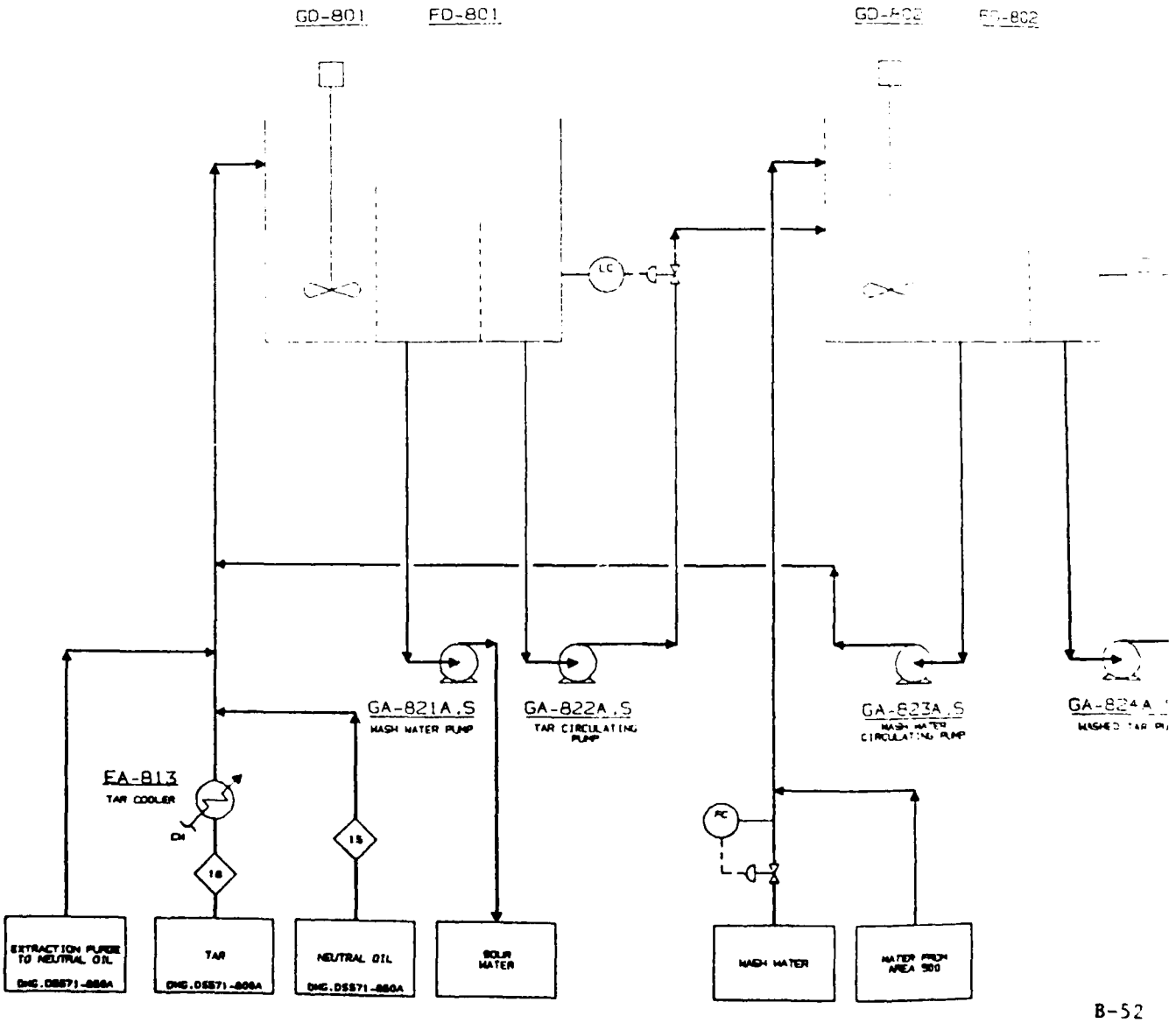
DWG NO. DSS71-800C

GD-801
FIRST STAGE MIXER

FD-801
FIRST STAGE WATER WASH TANK

GD-802
SECOND STAGE MIXER

FD-80
SECOND STAGE WASH TA






PLOT:0909 USER:D.COST 312 DR: IF1366 LCC: EXT: PAPER:W DATE: 04/13/89

FD-802

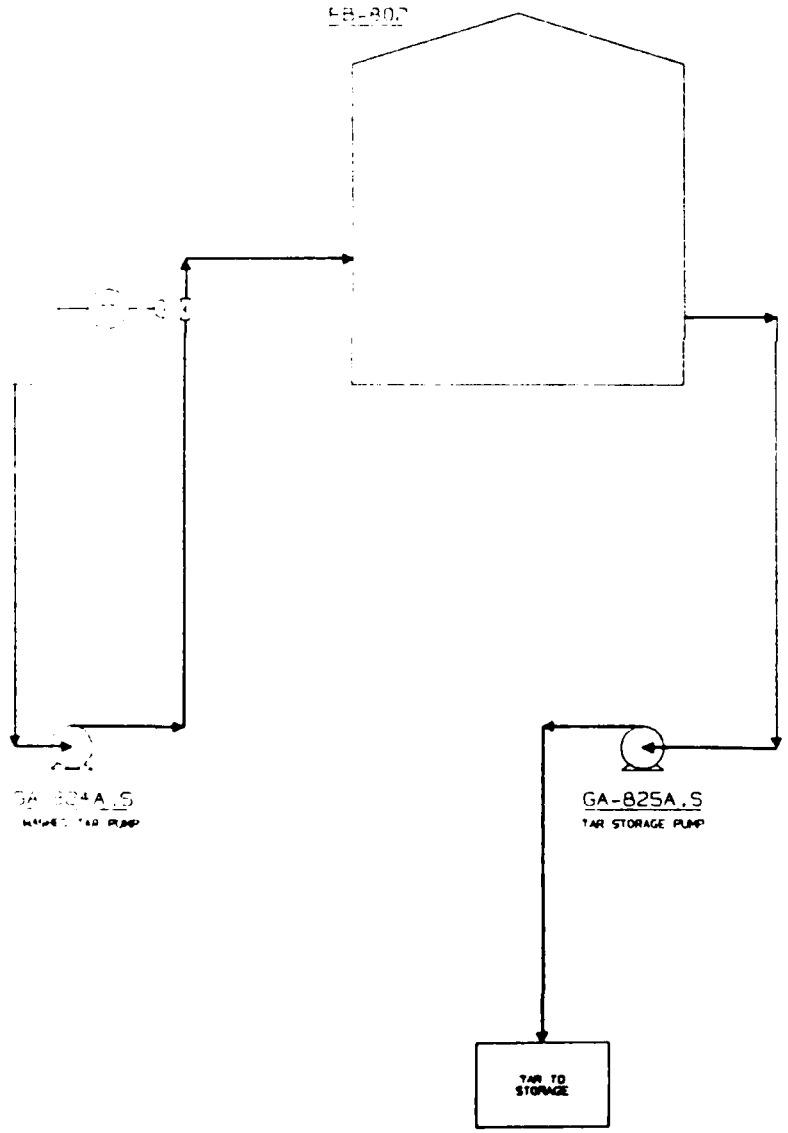
ECOND STAGE WATER WASH TANK

FB-802

TAR DAY TANK

NOTES:

1. FOR GENERAL NOTES, LEGEND AND SYMBOLS SEE DWG. NO.




| REV. | PUBLIC DATE | DESCRIPTION | DRAWN | CHKD | PCR | ENGR APPR. | PM | LPE | CLIENT APPR. | CLIENT APPR. DATE |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9/14/89 | FOR TASK 4 | | | | K.K. | | | | |

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COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

PHENOL EXTRACTION

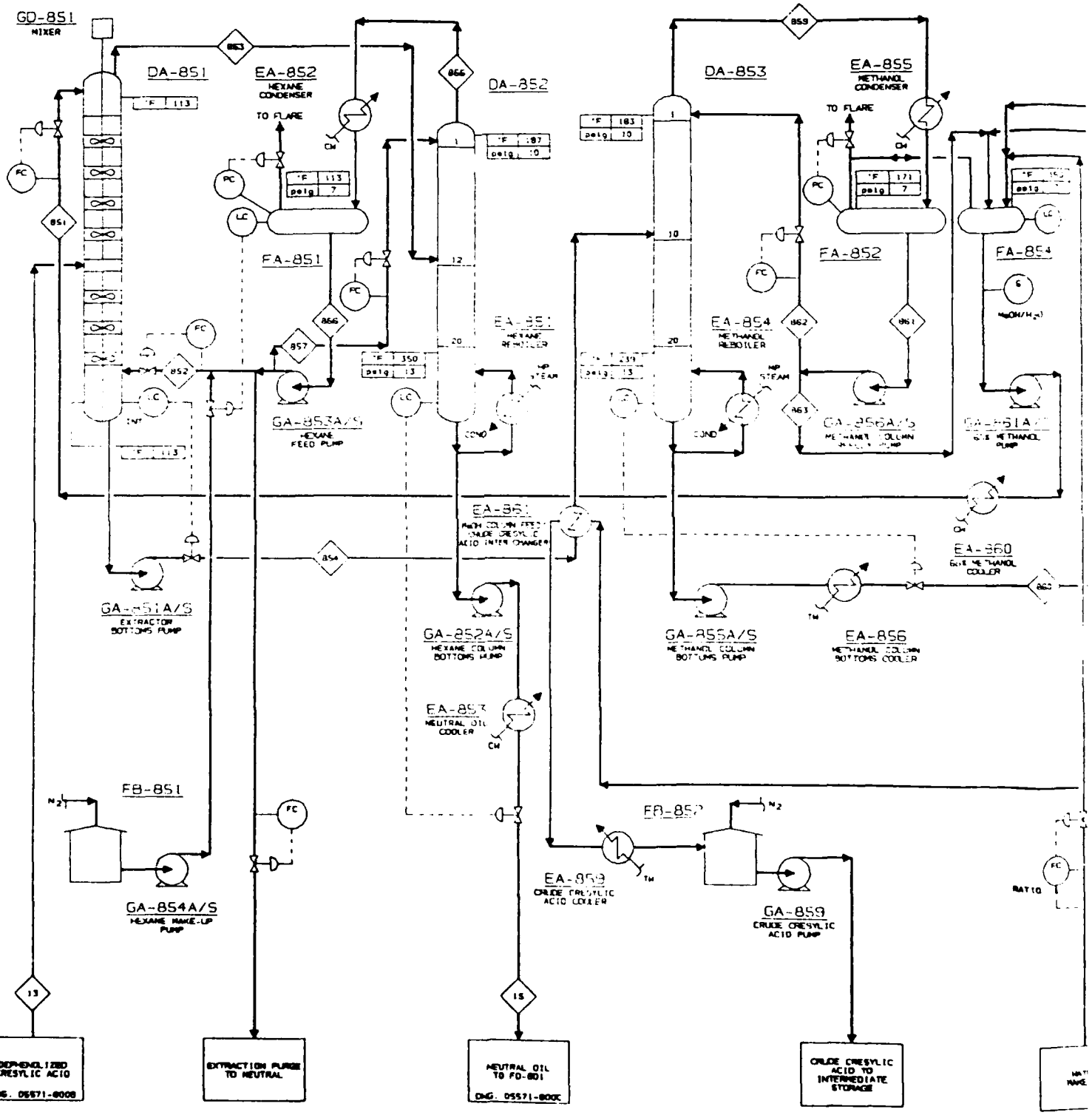
SCALE

DWG. NO. D5571-800C-0



F1376
A
ISSUE
0

| DA-851 | FB-851 | FA-851 | DA-852 | DA-853 | FA-852 | FA-854 |
|---|---|---|---|---|---|---|
| EXTRACTOR COLUMN | HEXANE STORAGE TANK | HEXANE REFLUX DRUM | HEXANE COLUMN | METHANOL COLUMN | METHANOL COLUMN REFLUX DRUM | METHANOL MAKE-UP DRUM |






PLOT: 0904 / D.COST 312 DR: IF1366 LOC: EXT: PAI W DATE: 04/13/89

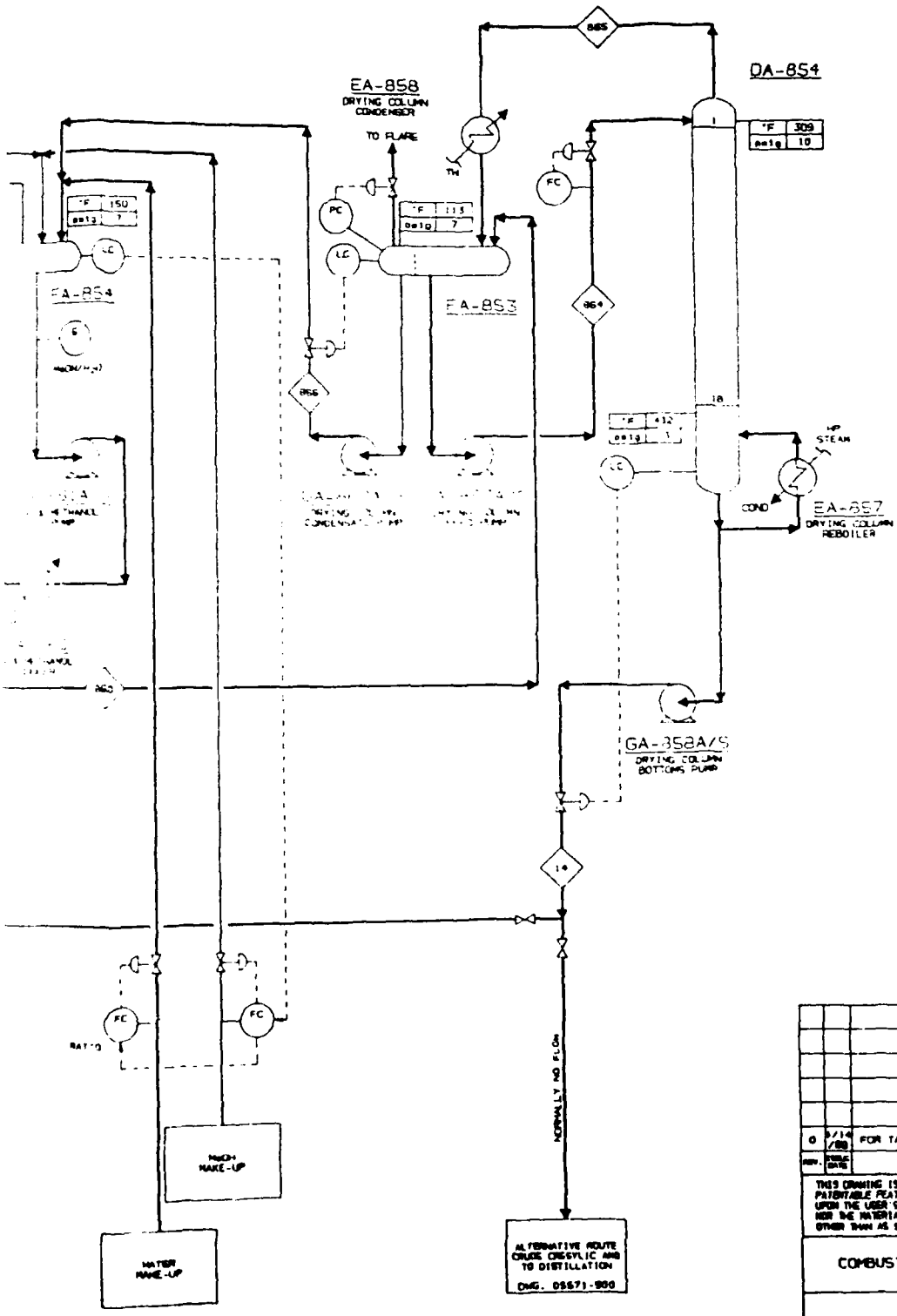
FA-854
METHANOL MAKE-UP DRUM

FB-852
CRUDE CRESYLIC ACID DAY TANK

FA-853
DRYING COLUMN REFLUX DRUM

DA-854
DRYING COLUMN

NOTES:
1. FOR GENERAL NOTES, LEGEND AND SYMBOLS SEE DWG. NO.




| REV. | ISSUE DATE | DESCRIPTION | DSN | CHKD | MGR | ENGR. APP. | PM | LPD | PLANT APP. | CLIENT APP. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5/14/88 | FOR TASK 4 | | | | | | | | |

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COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

# PROCESS FLOW DIAGRAM CRESYLIC ACID EXTRACTION

SCALE

DWG. NO. D5571-850-0

F1403
8 ISSUE C

DA-901
PHENOL/ORTHO COLUMN

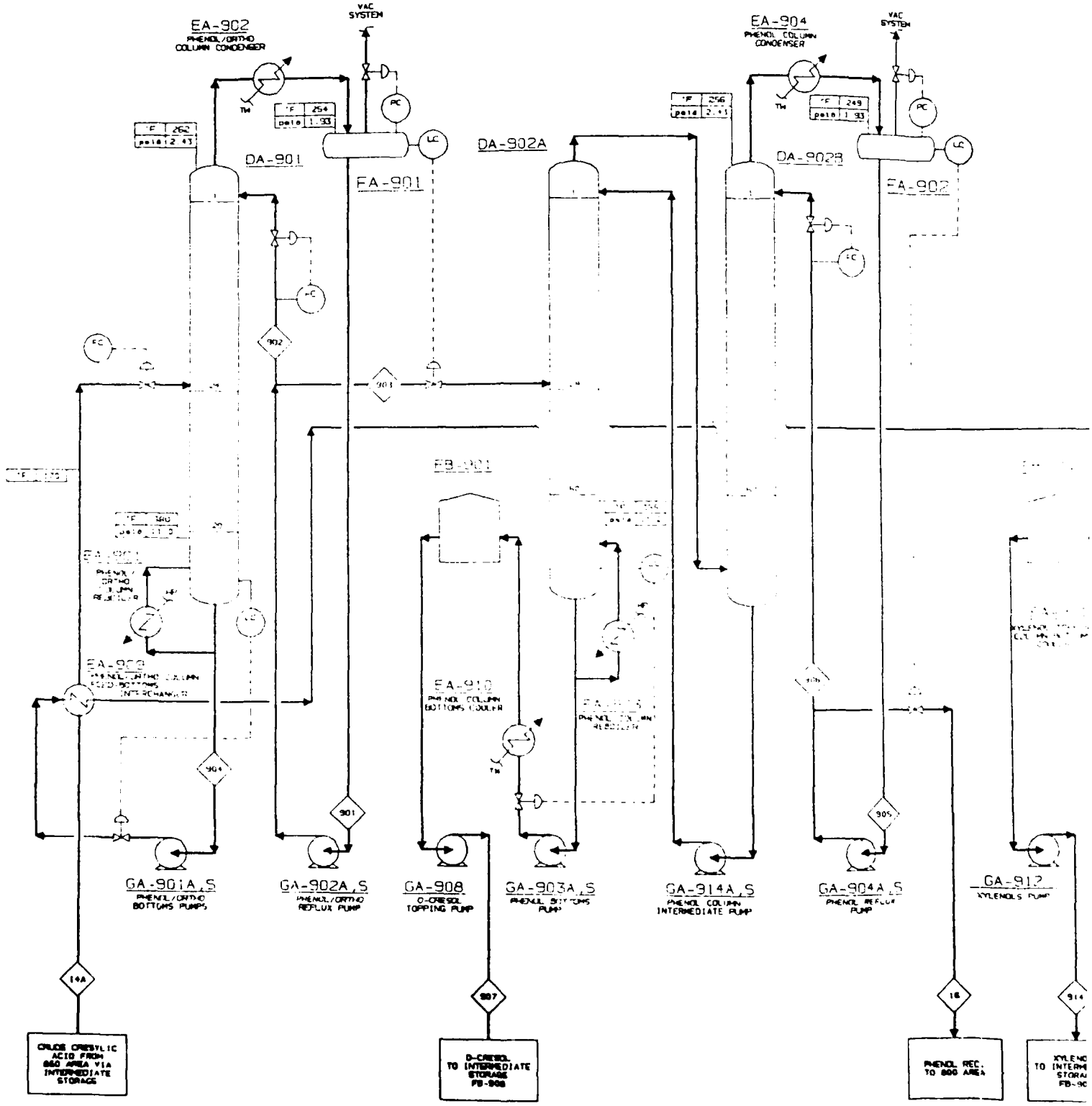
FA-901
PHENOL/ORTHO REFLUX DRUM

FB-901
O-CRESOL TOPPING FEED DAY TANK

DA-902A,B
PHENOL COLUMN

FA-902
PHENOL REFLUX DRUM

FB-902
XYLENOL INTERMEDIA DAY TANK






PLOT:0899 R:D.COST 312 GR: IF1366 LOC: EXT: BY: DATE: 04/13/89

FB-902
XYLENOL
INTERMEDIATE
DAY TANK

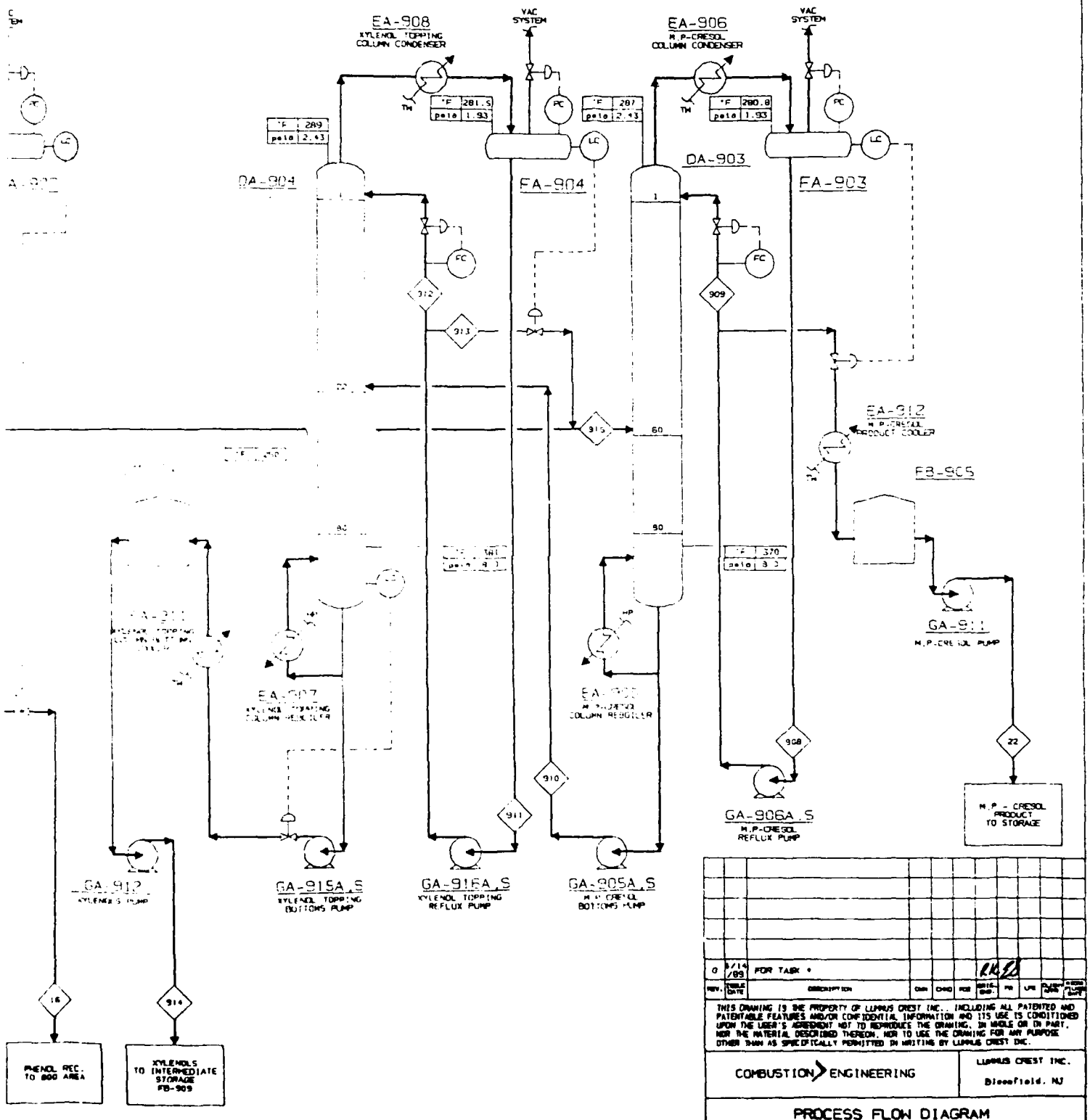
DA-904
XYLENOL
TOPPING
COLUMN

FA-904
XYLENOL TOPPING
REFLUX DRUM

DA-903
M,P-CRESOL
COLUMN

FA-903
M,P-CRESOL
REFLUX DRUM

FB-905
M,P-CRESOL
DAY TANK




| REV. | ISSUE DATE | DESCRIPTION | DWN | CHKD | RQE | SPEC-IND | PM | UPE | PLANT ENG | PROJ ENG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9/14/89 | FOR TASK 4 | | | | | | | | |

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COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

# PROCESS FLOW DIAGRAM
# CRUDE CRESYLIC DISTILLATION
# BLOCK OPERATION #1

SCALE

DWG. NO. D5571-900A-0

F1388

05571-9008

DA-901
O-CRESOL
TOPPING
COLUMN

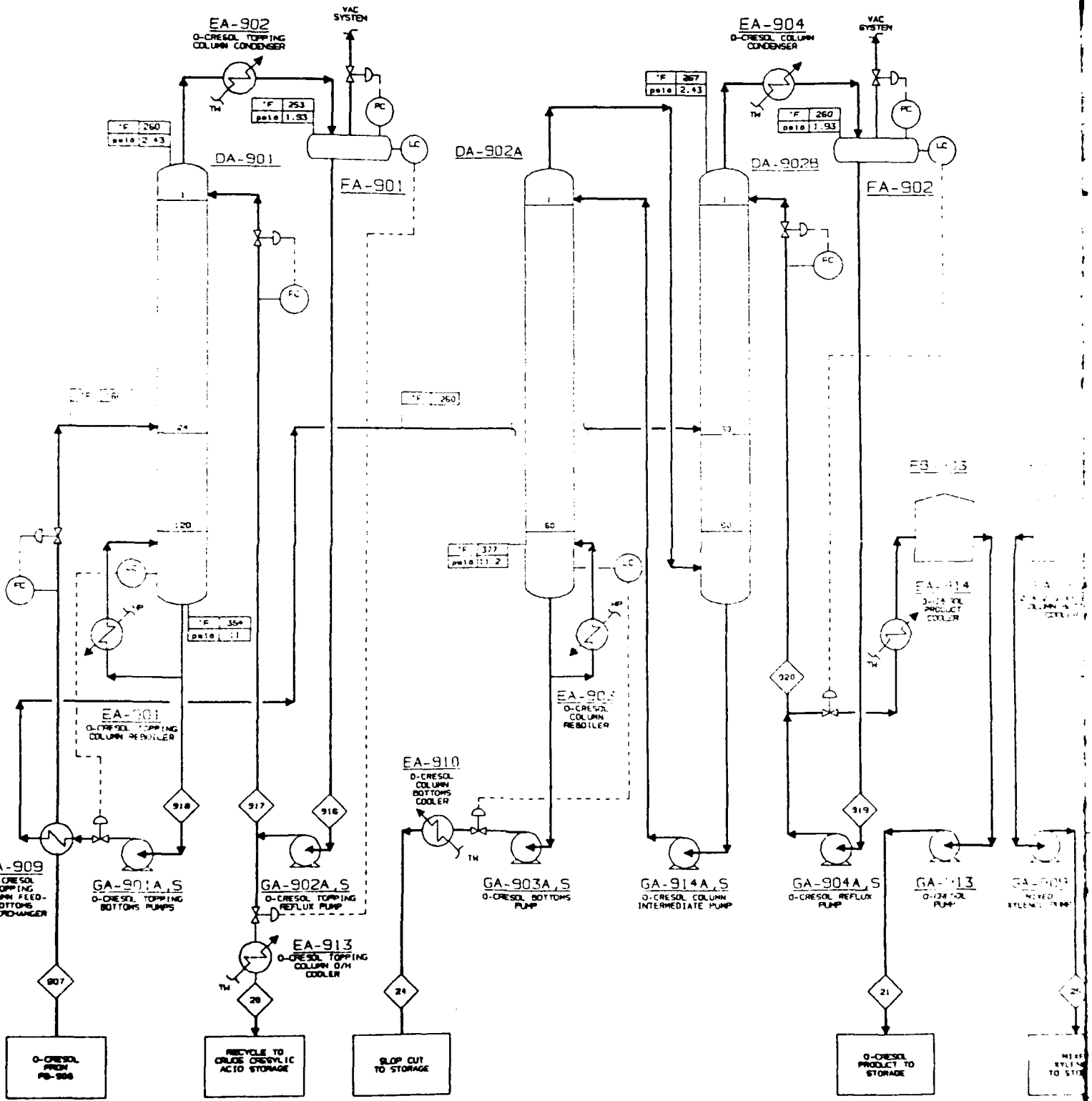
FA-901
O-CRESOL
TOPPING
REFLUX DRUM

DA-902A,B
O-CRESOL
COLUMN

FA-902
O-CRESOL
REFLUX
DRUM

FB-903
O-CRESOL
DAY TANK

FB-907
MIXED XYLENOLS
DAY TANK

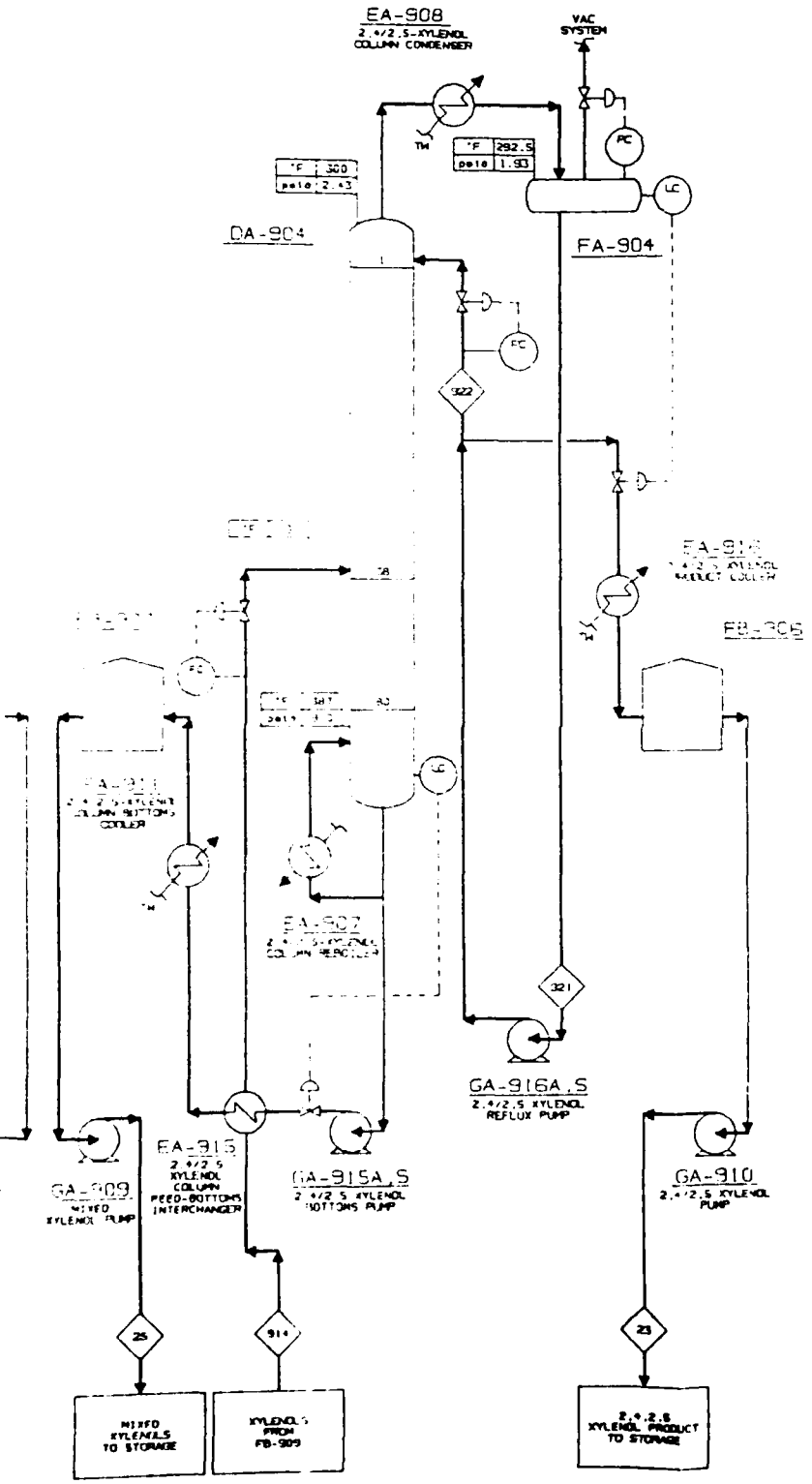


B-907
) XYLENOLS
AY TANK

DA-904
2.4/2.5 XYLENOL
COLUMN

FA-904
2.4/2.5 XYLENOL
REFLUX DRUM

FB-906
2.4/2.5 XYLENOL
DAY TANK




| REV. | ISSUE DATE | DESCRIPTION | DRAWN | CHKD. | RES. ENG. | PM | LPE | CLIENT APPR. | ENGRG APPR. |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 9/14/89 | FOR TASK 4 | | | RKB | | | | |

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COMBUSTION ENGINEERING | LUMMUS CRESTINC. Bloomfield, NJ

# PROCESS FLOW DIAGRAM
# CRUDE CRESYLIC DISTILLATION
# BLOCK OPERATION #2

SCALE | DWG. NO. D5571-9008-0

F1369
B ISSUE
F

2.3 Phenol Stream - cont'd

2.3.5 Material Balance

The following Material Balances were developed for Areas 800, 850 and 900.

| STRM | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| LBS HR | CRUDE PHENOL | BOTTOM DA801 | FEED DA805 | PHENOL DRAW | LIGHTEND PROD | BOTTOM DA805 | H2SO4 INJECTION | FEED T.F.E |
| LIGHTS | 244 | 0 | 244 | 4 | 244 | 0 | 0 | 4 |
| PYRIDIN | 141 | 141 | 0 | 0 | 0 | 0 | 0 | 0 |
| PHENOL | 3982 | 0 | 1156 | 3049 | 2 | 1154 | 0 | 4203 |
| NEUTRAL OIL | 411 | 0 | 39 | 373 | 0 | 39 | 0 | 412 |
| O CRESOL | 784 | 0 | 74 | 712 | 0 | 74 | 0 | 786 |
| M CRESOL | 1143 | 3 | 18 | 1122 | 0 | 18 | 0 | 1141 |
| P CRESOL | 809 | 2 | 13 | 795 | 0 | 13 | 0 | 808 |
| GUAIACOL | 103 | 0 | 2 | 101 | 0 | 2 | 0 | 103 |
| O-ETHYLPHENOL | 51 | 0 | 1 | 50 | 0 | 1 | 0 | 51 |
| 24XYLENOL | 141 | 4 | 1 | 136 | 0 | 1 | 0 | 137 |
| 25XYLENOL | 102 | 2 | 1 | 99 | 0 | 0 | 0 | 100 |
| 26XYLENOL | 51 | 2 | 0 | 48 | 0 | 0 | 0 | 49 |
| M-ETHYLPHENOL | 102 | 42 | 0 | 61 | 0 | 0 | 0 | 61 |
| P-ETYLPHENOL | 141 | 57 | 0 | 84 | 0 | 0 | 0 | 84 |
| 23XYLENOL | 51 | 21 | 0 | 31 | 0 | 0 | 0 | 31 |
| 34XYLENOL | 64 | 26 | 0 | 38 | 0 | 0 | 0 | 38 |
| 35XYLENOL | 141 | 57 | 0 | 84 | 0 | 0 | 0 | 84 |
| CATECHOL | 1451 | 1439 | 0 | 12 | 0 | 0 | 0 | 12 |
| RESIDUES | 2921 | 2921 | 0 | 0 | 0 | 0 | 0 | 0 |
| WATER | 705 | 0 | 285 | 1 | 0 | 0 | 1 | 4 |
| H2SO4 | 0 | 0 | 0 | 0 | 0 | 0 | 119 | 119 |
| HEXANE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| METHANOL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SULFUR DIOXIDE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL # HR | 13551 | 4728 | 1821 | 6800 | 248 | 1321 | 121 | 6226 |
| API | 2.2 | -1.9 | 5.9 | 2.7 | 39.8 | 0.4 | | 2.2 |
| SPGR | 1.06 | 1.09 | 1.02 | 1.05 | 0.83 | 1.02 | 1.83 | 1.06 |
| BSD | 876 | 293 | 122 | 445 | 19 | 83 | 5 | 533 |

JET FUEL PROJECT
AMOCO I.D.E. COKE PLANT WEGAS
JOB NO 5571
MATERIAL BALANCE - PROPOSED

| STRM<br>LBS/HR | 9<br>FEED<br>DAB[illegible] | 10<br>T.F.E<br>BOTTOM | 11<br>PHENOL<br>RECYCLE | 12<br>PHENOL<br>PRODUCT | 13<br>EXTRACT<br>FEED | 14<br>FEED<br>AREA900 | 15<br>NEUTRAL<br>OIL | 16<br>AREA9[illegible]<br>RECYCLE |
|---|---|---|---|---|---|---|---|---|
| LIGHTS | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| PYRIDIN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PHENOL | 3992 | 210 | 264 | 3651 | 679 | 605 | 74 | 60 |
| NEUTRAL OIL | 391 | 21 | 1 | 4 | 386 | 0 | 386 | 0 |
| O CRESOL | 747 | 39 | 2 | 1 | 745 | 685 | 60 | 1 |
| M CRESOL | 1084 | 57 | 1 | 1 | 1081 | 995 | 87 | 0 |
| P CRESOL | 767 | 40 | 1 | 0 | 766 | 705 | 61 | 0 |
| GUAIACOL | 98 | 5 | 0 | 0 | 98 | 90 | 8 | 0 |
| O-ETHYLPHENOL | 48 | 3 | 0 | 0 | 48 | 44 | 4 | 0 |
| 24XYLENOL | 130 | 7 | 0 | 0 | 130 | 119 | 11 | 0 |
| 25XYLENOL | 95 | 5 | 0 | 0 | 95 | 87 | 8 | 0 |
| 26XYLENOL | 46 | 2 | 0 | 0 | 46 | 43 | 3 | 0 |
| M-ETHYLPHENOL | 55 | 6 | 0 | 0 | 55 | 51 | 4 | 0 |
| P-ETHYLPHENOL | 76 | 8 | 0 | 0 | 76 | 70 | 6 | 0 |
| 23XYLENOL | 27 | 3 | 0 | 0 | 27 | 25 | 2 | 0 |
| 34XYLENOL | 34 | 4 | 0 | 0 | 34 | 32 | 2 | 0 |
| 35XYLENOL | 76 | 8 | 0 | 0 | 76 | 70 | 6 | 0 |
| CATECHOL | 12 | 1 | 0 | 0 | 12 | 11 | 1 | 0 |
| RESIDUES | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| WATER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H2SO4 | 0 | 98 | 0 | 0 | 0 | 0 | 0 | 0 |
| HEXANE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| METHANOL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SULFUR DIOXIDE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL # MP | 7682 | 515 | 272 | 3657 | 4255 | 3631 | 723 | 61[illegible] |
| API | 3.1 | -7.9 | -0.1 | -0.7 | 6.0 | 4.4 | 14.3 | -[illegible].7 |
| SPGR | 1.05 | 1.15 | 1.08 | 1.08 | 1.03 | 1.04 | 0.97 | 1.08 |
| BBL | 501 | 31 | 17 | 232 | 290 | 239 | 51 | 3[illegible] |



JET FUEL PROJECT
ANOCI LOGE - GRAND PLAINS GA F
JOB NO 05571
MATERIAL BALANCE . 800 AREA

| STRM<br>LBS/HR | 18<br>TAR | 19<br>SOUR WATER | 19A<br>AQU. PHASE OF FA-809 | 19B<br>AQU. PHASE OF FA-805 | 19C<br>SOUR WATR FR FA-802 |
|---|---|---|---|---|---|
| LIGHTS | 244 | 0 | 0 | 0 | 0 |
| PYRIDIN | 141 | 0 | 0 | 0 | 0 |
| PHENOL | 212 | 42 | 42 | 0 | 0 |
| NEUTRAL OIL | 21 | 0 | 0 | 0 | 0 |
| O CRESOL | 39 | 0 | 0 | 0 | 0 |
| M CRESOL | 60 | 0 | 0 | 0 | 0 |
| P CRESOL | 43 | 0 | 0 | 0 | 0 |
| GUAIACOL | 5 | 0 | 0 | 0 | 0 |
| O-ETHYLPHENOL | 3 | 0 | 0 | 0 | 0 |
| 24XYLENOL | 11 | 0 | 0 | 0 | 0 |
| 25XYLENOL | 8 | 0 | 0 | 0 | 0 |
| 26XYLENOL | 5 | 0 | 0 | 0 | 0 |
| M-ETHYLPHENOL | 48 | 0 | 0 | 0 | 0 |
| P-ETYLPHENOL | 65 | 0 | 0 | 0 | 0 |
| 23XYLENOL | 24 | 0 | 0 | 0 | 0 |
| 34XYLENOL | 30 | 0 | 0 | 0 | 0 |
| 35XYLENOL | 65 | 0 | 0 | 0 | 0 |
| CATECHOL | 1440 | 0 | 0 | 0 | 0 |
| RESIDUES | 2930 | 0 | 0 | 0 | 0 |
| WATER | 0 | 710 | 418 | 285 | 7 |
| H2SO4 | 98 | TRACE | 0 | 0 | TRACE |
| HEXANE | 0 | 0 | 0 | 0 | 0 |
| METHANOL | 0 | 0 | 0 | 0 | 0 |
| SULFUR DIOXIDE | 0 | 0 | 0 | 0 | 0 |
| TOTAL #/HR | 5493 | 752 | 460 | 285 | 7 |
| API | -1.0 | | | | |
| SPGR | 1.08 | 1.00 | 1.01 | 1.00 | 1.00 |
| BSD | 347 | 51 | 31 | 20 | 0 |

JET FUEL PROJECT
ARCO/DOE - GREAT FALLS, MT
JOB NO. 05571
MATERIAL BALANCE - 800 AREA

| STRM<br>LBS-HR | 26<br>PHENOL<br>PRODUCT | 27<br>ORGANIC<br>STREAM | 28<br>VENT GAS | 29<br>MAKE UP<br>WATER |
|---|---|---|---|---|
| LIGHTS | 0 | 0 | 0 | 0 |
| PYRIDIN | 0 | 0 | 0 | 0 |
| PHENOL | 3568 | 83 | 0 | 0 |
| NEUTRAL OIL | 4 | 0 | 0 | 0 |
| O CRESOL | 1 | 0 | 0 | 0 |
| M CRESOL | 1 | 0 | 0 | 0 |
| P CRESOL | 0 | 0 | 0 | 0 |
| GUAIACOL | 0 | 0 | 0 | 0 |
| O-ETHYLPHENOL | 0 | 0 | 0 | 0 |
| 24XYLENOL | 0 | 0 | 0 | 0 |
| 25XYLENOL | 0 | 0 | 0 | 0 |
| 26XYLENOL | 0 | 0 | 0 | 0 |
| M-ETHYLPHENOL | 0 | 0 | 0 | 0 |
| P-ETYLPHENOL | 0 | 0 | 0 | 0 |
| 23XYLENOL | 0 | 0 | 0 | 0 |
| 34XYLENOL | 0 | 0 | 0 | 0 |
| 35XYLENOL | 0 | 0 | 0 | 0 |
| CATECHOL | 0 | 0 | 0 | 0 |
| RESIDUES | 0 | 0 | 0 | 0 |
| WATER | 0 | 1 | 4 | 1 |
| H2SO4 | 0 | 0 | 0 | 0 |
| HEXANE | 0 | 0 | 0 | 0 |
| METHANOL | 0 | 0 | 0 | 0 |
| SULFUR DIOXIDE | 0 | 0 | 14 | 0 |
| TOTAL #/HR | 3574 | 84 | 18 | 1 |
| API | -9.7 | -9.6 | | |
| SPGR | 1.08 | 1.08 | | 1.00 |
| BSD | 226 | 5 | | |



JET FUEL PROJECT
AMOCO 100E - GREAT FALLS MT
JOB NO 05571
MATERIAL BALANCE SCHEDULE

| STREAM NO. | 17 CRUDE PHENOL | 851 METHANOL TO EXTRATR | 852 HEXANE TO EXTRATR | 853 HEXANE FR EXTRATR | 854 METHANOL FR EXTRATR | 855 VAPOR FR HEX. COL. | 856 COND. FR REF. DRUM | 857 REFLUX TO HEX. COL. | 15 NEUTRAL OIL |
|---|---|---|---|---|---|---|---|---|---|
| PHENOL | [illegible] | 13.3 | | 74.[illegible] | [illegible] | | | | 74.[illegible] |
| NEUTRAL OIL | 38[illegible] | [illegible] | 7.5 | 391.5 | [illegible] | 25.3 | 25.3 | 19.8 | 38[illegible] |
| O-CRESOL | 745. | [illegible] | | 60.0 | [illegible] | | | | 60.[illegible] |
| M-CRESOL | 1[illegible] | 7.5 | | 87.[illegible] | [illegible].5 | | | | 87.[illegible] |
| P-CRESOL | [illegible] | [illegible] | | 61.[illegible] | 71.[illegible] | | | | 61.[illegible] |
| [illegible] | [illegible] | [illegible] | | 8.0 | 90.7 | | | | 8.0 |
| [illegible] | 45. | [illegible] | | 4.0 | 44.[illegible] | | | | 4.0 |
| [illegible] | [illegible] | [illegible] | | [illegible] | 11[illegible] | | | | [illegible] |
| [illegible] XYLENOL | 95.[illegible] | [illegible] | | 5.[illegible] | 87.[illegible] | | | | 8.[illegible] |
| [illegible] | 4[illegible] | [illegible] | | [illegible] | 4[illegible] | | | | [illegible] |
| [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | | 4.[illegible] |
| [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | | [illegible] |
| [illegible] | [illegible] | [illegible] | | 2.[illegible] | 25.[illegible] | | | | [illegible] |
| [illegible] | [illegible] | [illegible] | | 2.[illegible] | 32.[illegible] | | | | [illegible] |
| [illegible] | 7[illegible] | [illegible] | | [illegible] | 70.[illegible] | | | | 6.[illegible] |
| CATECHOL | [illegible] | [illegible] | | [illegible] | [illegible] | | | | [illegible] |
| RESIDUES | | [illegible] | | [illegible] | [illegible] | | | | |
| WATER | | [illegible] | | [illegible] | [illegible] | | | | |
| HEXANE | | [illegible] | 845[illegible] | 845[illegible] | [illegible] | 3887[illegible] | 3887[illegible] | [illegible] | |
| METHANOL | | [illegible] | | [illegible] | [illegible] | | | | |
| TOTAL #/H | 4[illegible] | 554[illegible] | 845[illegible].5 | [illegible].5 | [illegible] | 38899.5 | 38899.5 | 30440.4 | [illegible] |
| TEMP., °F | [illegible] | [illegible] | [illegible] | 113 | 113 | 167 | 113 | [illegible] | [illegible] |
| DENSITY, LB/CF | [illegible] | [illegible] | [illegible] | 4[illegible] | 55.6 | | 35.7 | [illegible] | 57.[illegible] |
| GPM | 8.[illegible] | 13.2[illegible] | 26.56 | 26.19 | 20.50 | | 122.16 | 95.[illegible] | 1.5[illegible] |
| SP. GR. @60°F | 1.0[illegible] | | | | | | | | 0.9[illegible] |
| API | [illegible] | | | | | | | | 14.[illegible] |
| BSI | 25[illegible] | | | | | | | | 51 |

JET FUEL PROJECT

AMOCO/ADE-GREAT PLAINS GASIF CO

JOB NO. 05571

MATERIAL BALANCE - 850 AREA

| STREAM NO. | 85 VAPOR FR MEOH COL | 86v MEOH COL BOTTOMS | 8c1 COND. FR MEOH COL | 862 REFLUX TO MEOH COL | 863 COND. TO MEOH MAKE UP DRUM | 864 FEED TO DRYING COL | 865 VAPOR FR DRYING COL | 866 DECANTED WATR TO MEOH MAKE UP DRUM | 14 CRUDE CRESYLIC |
|---|---|---|---|---|---|---|---|---|---|
| PHENOL | | 622.8 | | | | 1009.9 | 404.9 | 18.9 | 605.0 |
| NEUTRAL O | | | | | | | | 0.0 | 0.0 |
| O-CRESOL | | 650.9 | | | | 911.2 | 226.2 | 5.9 | 685.0 |
| M-CRESOL | | 1[illegible].5 | | | | 1162.8 | 167.9 | 7.5 | 995.0 |
| P-CRESOL | | [illegible] | | | | [illegible] | 119.[illegible] | 5.3 | [illegible] |
| 2,4 XYLENOL | | 90.7 | | | | 105.2 | 15.2 | 0.7 | 90.[illegible] |
| 3-ETH PHE | | 44.2 | | | | 51.4 | 7.4 | 0.3 | 44.[illegible] |
| 2,4 XYLENOL | | 114.3 | | | | 132.2 | 13.1 | 0.3 | 114.[illegible] |
| 2,5-XYLENOL | | 27.2 | | | | 96.7 | 9.7 | 0.2 | 87.[illegible] |
| 2,6-XYLENOL | | 40.1 | | | | 47.8 | 4.8 | [illegible] | 43.[illegible] |
| 4-ETHYLPH | | 51.2 | | | | 55.6 | 4.[illegible] | [illegible] | 51.[illegible] |
| P-ETHYLPH | | [illegible] | | | | 75.4 | 5.4 | [illegible] | [illegible] |
| 2,3 XYLENOL | | 25.[illegible] | | | | 26.9 | 1.9 | [illegible] | 25.[illegible] |
| 3,4-XYLENOL | | 34.[illegible] | | | | 34.5 | 2.5 | [illegible] | 32.[illegible] |
| 3,5-XYLENOL | | 75.[illegible] | | | | 75.4 | 5.4 | [illegible] | 70.[illegible] |
| CATECHOL | | 10.[illegible] | | | | 11.4 | 0.4 | [illegible] | 11.[illegible] |
| RESIDUES | | [illegible] | | | | | | | |
| WATER | 975.4 | 1547.9 | 978.4 | [illegible] | 37[illegible] | 675.[illegible] | 675.[illegible] | 1547.9 | |
| HEXANE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| METHANOL | [illegible] | 4.0 | [illegible] | [illegible] | [illegible] | 5.2 | 8.2 | 4.0 | |
| TOTAL # H | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TEMP., DF | 161 | [illegible] | 171 | 171 | 171 | 112 | 3[illegible] | 113 | 421 |
| DENSITY, # CF | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| GPM | | 10.38 | 27.22 | [illegible] | [illegible] | 10.44 | | 3.22 | [illegible] |
| S. G. @ [illegible] | | | | | | | | | 1.04 |
| API | | | | | | | | | 4.4 |
| ESD | | | | | | | | | 235 |

JET FUEL PROJECT
AMOCO/BOE - GREAT PLAINS GASIF. PROJ
JOB NO. 8571
MATERIAL BALANCE - 300 AREA

| STREAM NO. | 14 CRUDE CRESYLIC ACID | 14A FEED TO PHENOL-ORTHO COLUMN | 901 COND. FROM PHENOL-ORTHO REFLUX DRUM | 902 REFLUX TO PHENOL-ORTHO COLUMN | 903 FEED TO PHENOL COL. | 904 PHENOL-ORTHO COL. BTMS. | 905 COND. FROM PHENOL COL. REFLUX DRUM | 906 REFLUX TO PHENOL COL. |
|---|---|---|---|---|---|---|---|---|
| PHENOL | 605.0 | 710.0 | 6106.0 | 5396.0 | 710.0 | 0.0 | 6622.0 | 6020.0 |
| NEUTRAL O | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O CRESOL | 685.0 | 775.0 | 6665.0 | 5890.0 | 775.0 | 0.0 | 11.0 | 10.0 |
| M-CRESOL | 995.0 | 995.0 | 25.8 | 22.8 | 3.0 | 992.0 | 0.0 | 0.0 |
| P CRESOL | 705.0 | 705.0 | 17.2 | 15.2 | 2.0 | 703.0 | 0.0 | 0.0 |
| GUAIACOL | 90.0 | 90.0 | 0.0 | 0.0 | 0.0 | 90.0 | 0.0 | 0.0 |
| O-ETHYLPH | 44.0 | 44.0 | 0.0 | 0.0 | 0.0 | 44.0 | 0.0 | 0.0 |
| 24XYLENOL | 119.0 | 119.0 | 0.0 | 0.0 | 0.0 | 119.0 | 0.0 | 0.0 |
| 25XYLENOL | 87.0 | 87.0 | 0.0 | 0.0 | 0.0 | 87.0 | 0.0 | 0.0 |
| 26XYLENOL | 43.0 | 43.0 | 34.4 | 30.4 | 4.0 | 39.0 | 0.0 | 0.0 |
| M-ETHYLPH | 51.0 | 51.0 | 8.6 | 7.6 | 1.0 | 50.0 | 0.0 | 0.0 |
| P-ETHYLPH | 70.0 | 70.0 | 0.0 | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 |
| 23XYLENOL | 25.0 | 25.0 | 0.0 | 0.0 | 0.0 | 25.0 | 0.0 | 0.0 |
| 34XYLENOL | 32.0 | 32.0 | 0.0 | 0.0 | 0.0 | 32.0 | 0.0 | 0.0 |
| 35XYLENOL | 70.0 | 70.0 | 0.0 | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 |
| CATECHOL | 11.0 | 11.0 | 0.0 | 0.0 | 0.0 | 11.0 | 0.0 | 0.0 |
| RESIDUES | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| WATER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HEXANE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| THANOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL #/H | 3632.0 | 3827.0 | 12857.0 | 11362.0 | 1495.0 | 2332.0 | 6633.0 | 6030.0 |
| TEMP., oF | 77.0 | 77.0 | 253.4 | 253.4 | 253.4 | 379.6 | 249.0 | 249.0 |
| DENSITY,#/CF | 63.5 | 63.5 | 60.4 | 60.4 | 60.4 | 53.9 | 61.4 | 61.4 |
| GPM | 7.1 | 7.5 | 26.5 | 23.5 | 3.1 | 5.4 | 13.5 | 12.2 |
| S.G. @60/60 | 1.04 | 1.04 | 1.06 | 1.06 | 1.06 | 1.02 | 1.08 | 1.08 |
| API | 4.4 | 4.4 | 2.0 | 2.0 | 2.0 | 7.2 | -0.7 | -0.7 |
| BSD | 239.3 | 252.1 | 831.1 | 734.4 | 96.6 | 156.6 | 420.8 | 382.6 |

JET FUEL PROJECT
AMOCO IDOE - UREA PLANT CASE
JOB NO 05571
MATERIAL BALANCE - 900 AREA

| STREAM NO. | 16<br>PHENOL RECYCLE<br>TO 800 AREA | 907<br>FEED TO<br>O-CRESOL<br>TOPPING COL. | 915<br>FEED TO<br>M,P-CRESOL<br>COLUMN | 908<br>COND. FROM<br>M,P-CRESOL<br>REFLUX DRUM | 909<br>REFLUX TO<br>M,P-CRESOL<br>COLUMN | 22<br>M,P-CRESOL<br>PRODUCT | 910<br>FEED TO<br>XYLENOL<br>TOPP. COL. | 911<br>COND. FROM<br>XYLENOL TOPP.<br>REFLUX DRUM |
|---|---|---|---|---|---|---|---|---|
| PHENOL | 602.0 | 108.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NEUTRAL O | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O CRESOL | 1.0 | 774.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-CRESOL | 0.0 | 3.0 | 1180.7 | 7432.5 | 6441.5 | 991.0 | 189.7 | 3207.9 |
| P CRESOL | 0.0 | 2.0 | 836.7 | 5265.0 | 4563.0 | 702.0 | 134.7 | 2272.9 |
| GUAIACOL | 0.0 | 0.0 | 107.0 | 675.0 | 585.0 | 90.0 | 17.0 | 289.0 |
| O-ETHYLPH | 0.0 | 0.0 | 52.4 | 330.0 | 286.0 | 44.0 | 8.4 | 142.8 |
| 24XYLENOL | 0.0 | 0.0 | 137.5 | 37.5 | 32.5 | 5.0 | 132.5 | 314.5 |
| 25XYLENOL | 0.0 | 0.0 | 100.5 | 30.0 | 26.0 | 4.0 | 96.5 | 229.5 |
| 26XYLENOL | 0.0 | 4.0 | 41.4 | 292.5 | 253.5 | 39.0 | 2.4 | 40.8 |
| M-ETHYLPH | 0.0 | 1.0 | 50.0 | 0.0 | 0.0 | 0.0 | 50.0 | 0.0 |
| P-ETHYLPH | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 | 0.0 | 70.0 | 0.0 |
| 23XYLENOL | 0.0 | 0.0 | 25.0 | 0.0 | 0.0 | 0.0 | 25.0 | 0.0 |
| 34XYLENOL | 0.0 | 0.0 | 32.0 | 0.0 | 0.0 | 0.0 | 32.0 | 0.0 |
| 35XYLENOL | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 | 0.0 | 70.0 | 0.0 |
| CATECHOL | 0.0 | 0.0 | 11.0 | 0.0 | 0.0 | 0.0 | 11.0 | 0.0 |
| RESIDUES | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| WATER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HEXANE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ETHANOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL #/H | 603.0 | 892.0 | 2714.2 | 14062.5 | 12187.5 | 1875.0 | 839.2 | 6497.4 |
| TEMP., oF | 249.0 | 113.0 | 253.0 | 281.0 | 281.0 | 113.0 | 369.0 | 281.0 |
| DENSITY,#/CF | 61.4 | 64.4 | 58.1 | 58.0 | 58.0 | 63.3 | 53.2 | 57.8 |
| GPM | 1.2 | 1.7 | 5.8 | 30.2 | 26.2 | 3.7 | 2.0 | 14.0 |
| S.G. 860/60 | 1.08 | 1.04 | 1.02 | 1.04 | 1.04 | 1.04 | 0.99 | 1.03 |
| API | -0.7 | 5.1 | 7.2 | 5.1 | 5.1 | 5.1 | 11.4 | 5.9 |
| BSD | 38.3 | 58.8 | 182.3 | 926.5 | 802.9 | 123.5 | 58.1 | 432.2 |

JET FUEL PROJECT
ANSCHUTZ - GREAT PLAINS GAS
JOB NO 05571
MATERIAL BALANCE - 900 AREA

| STREAM NO. | 912 REFLUX TO XYLENOL TOPP COLUMN | 913 RECYCLE TO M,P-CRESOL COLUMN | 914 FEED TO XYLENOL COL. | 916 COND. FROM O-CRESOL TOPP. COL. | 917 REFLUX TO O-CRESOL TOPP. COL. | 20 REC. TO CRUDE CRES ACID STORAGE | 918 FEED TO O-CRESOL COL | 919 COND. FROM O-CRESOL COL |
|---|---|---|---|---|---|---|---|---|
| PHENOL | 0.0 | 0.0 | 0.0 | 1575.0 | 1470.0 | 105.0 | 3.0 | 33.0 |
| NEUTRAL O | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O CRESOL | 0.0 | 0.0 | 0.0 | 1350.0 | 1260.0 | 90.0 | 684.0 | 7513.0 |
| M-CRESOL | 3019.2 | 188.7 | 1.0 | 0.0 | 0.0 | 0.0 | 3.0 | 0.0 |
| P CRESOL | 2139.2 | 133.7 | 1.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 |
| GUAIACOL | 272.0 | 17.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-ETHYLPH | 134.4 | 8.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24XYLENOL | 296.0 | 18.5 | 114.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25XYLENOL | 216.0 | 13.5 | 83.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26XYLENOL | 38.4 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | 4.0 | 11.0 |
| M-ETHYLPH | 0.0 | 0.0 | 50.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 |
| P-ETHYLPH | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 23XYLENOL | 0.0 | 0.0 | 25.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 34XYLENOL | 0.0 | 0.0 | 32.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 35XYLENOL | 0.0 | 0.0 | 70.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| CATECHOL | 0.0 | 0.0 | 11.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| RESIDUES | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| WATER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HEXANE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| THANOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL #/H | 6115.2 | 382.2 | 457.0 | 2925.0 | 2730.0 | 195.0 | 697.0 | 7557.0 |
| TEMP., oF | 281.0 | 281.0 | 113.0 | 253.0 | 253.0 | 113.0 | 354.0 | 260.4 |
| DENSITY,#/CF | 57.8 | 57.8 | 59.5 | 60.5 | 60.5 | 64.8 | 56.1 | 59.3 |
| GPM | 13.2 | 0.8 | 1.0 | 6.0 | 5.6 | 0.4 | 1.5 | 15.9 |
| S.G. @60/60 | 1.03 | 1.03 | 0.97 | 1.07 | 1.07 | 1.07 | 1.05 | 1.05 |
| API | 5.9 | 5.9 | 14.4 | 0.7 | 0.7 | 0.7 | 3.3 | 3.4 |
| BSD | 406.8 | 25.4 | 32.3 | 187.3 | 174.8 | 12.5 | 45.5 | 493.1 |

DOE FUEL PROJECT
ARGONNE - GREAT PLAINS COAL
JOB NO 05571
MATERIAL BALANCE - GOOARCO

| STREAM NO. | 920<br>REFLUX TO<br>O-CRESOL COL | 21<br>O-CRESOL<br>PRODUCT | 24<br>SLOP CUT | 921<br>COND FROM<br>XYLENOL<br>REFLUX DRUM | 922<br>REFLUX TO<br>XYLENOL COL | 23<br>2,4/2,5-XYL<br>PRODUCT | 25<br>MIXED<br>XYLENOLS |
|---|---|---|---|---|---|---|---|
| PHENOL | 30.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| NEUTRAL O | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O CRESOL | 6830.0 | 683.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-CRESOL | 0.0 | 0.0 | 3.0 | 16.0 | 15.0 | 1.0 | 0.0 |
| P CRESOL | 0.0 | 0.0 | 2.0 | 16.0 | 15.0 | 1.0 | 0.0 |
| GUAIACOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| O-ETHYLPH | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 24XYLENOL | 0.0 | 0.0 | 0.0 | 1680.0 | 1575.0 | 105.0 | 9.0 |
| 25XYLENOL | 0.0 | 0.0 | 0.0 | 1232.0 | 1155.0 | 77.0 | 6.0 |
| 26XYLENOL | 10.0 | 1.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| M-ETHYLPH | 0.0 | 0.0 | 1.0 | 16.0 | 15.0 | 1.0 | 49.0 |
| P-ETHYLPH | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 70.0 |
| 23XYLENOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 25.0 |
| 34XYLENOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 32.0 |
| 35XYLENOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 70.0 |
| CATECHOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 |
| RESIDUES | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| WATER | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HEXANE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| ETHANOL | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL #/H | 6870.0 | 687.0 | 10.0 | 2960.0 | 2775.0 | 185.0 | 272.0 |
| TEMP., oF | 260.4 | 113.0 | 113.0 | 292.5 | 292.5 | 113.0 | 113.0 |
| DENSITY,#/CF | 59.3 | 63.9 | 62.2 | 54.6 | 54.6 | 59.3 | 59.2 |
| GPM | 14.4 | 1.3 | 0.02 | 6.8 | 6.3 | 0.4 | 0.6 |
| S.G. 60/60 | 1.05 | 1.05 | 1.02 | 0.97 | 0.97 | 0.97 | 1.03 |
| API | 3.4 | 3.4 | 7.9 | 15.1 | 15.1 | 15.1 | 5.7 |
| BSD | 448.3 | 44.8 | 0.7 | 209.1 | 196.0 | 13.1 | 18.1 |

JET FUEL PROJECT
AMOCO 100E - GREAT PLAINS CASE
JOB NO. 05571
MATERIAL BALANCE - 900 BBLS

APPENDIX C

LCI Report on "Profitable JP-8" Design:
Capital Costs

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists

AREA 100 - HYDROTREATER

| TAG NO. | DESCRIPTION |
|---|---|
| BA-101 | Preflash Heater |
| BA-102 | Feed Heater |
| DA-101 | Preflash Tower |
| DA-102 | Atmospheric Tower |
| DA-103 | Vacumm Tower |
| DC-101 | Hydrotreater Reactor |
| DC-102 | Hydrotreater Reactor |
| DC-103 | Hydrotreater Reactor |
| EA-101 | HVGO Condenser/BFW Exchanger |
| EA-102 | LVGO Condenser |
| EA-103 | Hot H.P. Separator Vapor/Steam Generator |
| EA-104 | Hot L.P. Separator Vapor/BFW Exchanger |
| EA-105 | Atmospheric Tower Reboiler |
| EA-106 | Atmospheric Tower Overhead Condenser |
| EA-107 | Fuel Gas Cooler |
| EA-108 | Recycle Compressor Circulation Cooler |
| EC-101 | Recycle Gas Cooler |
| EC-102 | Preflash Tower Overhead Condenser |
| FA-101 | Feed Surge Drum |
| FA-102 | Hot H.P. Separator |
| FA-103 | Hot L.P. Separator |
| FA-104 | Interm. L.P. Separator |
| FA-105 | Cold L.P. Separator |
| FA-106 | HVGO Accumulator |
| FA-107 | LVGO Accumulator |
| FA-108 | Vacuum Hotwell |
| FA-109 | Atmospheric Tower Feed Surge Drum |
| FA-110 | Atmospheric Tower Overhead Accumulator |
| FA-111 | Wash Water Surge Drum |
| FA-112 | Water Seal Pot |
| FA-113 | Water Collection Pot |
| FA-114 | Fuel Gas K.O. Drum |
| FA-115 | Recycle Compressor K.O. Drum |
| FA-116 | Preflash Tower Overhead Drum |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREA 100 - HYDROTREATER

| TAG NO. | DESCRIPTION |
|---|---|
| GA-101A/S | Feed Pump and Spare |
| GA-102A/S | Naphtha Quench Pump and Spare |
| GA-103A/S | HVGO Pump and Spare |
| GA-104A/S | LVGO Pump and Spare |
| GA-105 | Slop Oil Pump |
| GA-106A/S | Sour Water Pump and Spare |
| GA-107A/S | Atmospheric Tower Overhead Pump and Spare |
| GA-108A/S | Vacuum Tower Bottoms Pump and Spare |
| GA-109 | Reactor (DC-101) Recycle Pump |
| GA-110 | Reactor (DC-102) Recycle Pump |
| GA-111 | Reactor (DC-103) Recycle Pump |
| GA-112A/S | Wash Water Pump and Spare |
| GA-113A/S | HDS Feed Pump and Spare |
| GA-114A/S | Fresh Feed Pump and Spare |
| GA-115A/S | Preflash Tower Overhead Pump and Spare |
| GB-101A/S | Recycle Compressor and Spare |
| GB-102A/S | Fuel Gas Compressor and Spare |
| PA-101 | Vacuum Ejector Package |
| PA-102A/S | Flame Arrester and Spare |
| PA-103 | Corrosion Inhibitor Package |
| PA-104 | Recycle Gas PSA Unit |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREA 200 HDS and JP8 PRODUCTION

| TAG NO. | DESCRIPTION |
|---|---|
| BA-201 | HDS Feed Heater |
| BA-202 | JP8 Tower Feed Heater |
| DA-201 | JP8 Tower |
| DA-202 | JP8 Product Stripper |
| DA-203 | Naphtha Stabilizer |
| DC-201 | HDS Reactor |
| EA-201 | HDS Reactor Feed/Effluent Exchanger |
| EA-202 | JP8 Tower Feed/Bottoms Exchanger |
| EA-203 | JP8 Tower Overhead Condenser |
| EA-204 | Naphtha Stabilizer Feed/Bottoms Exchanger |
| EA-205 | Naphtha Stabilizer Reboiler |
| EA-206 | Naphtha Stabilizer Overhead Condenser |
| EA-207 | Stabilized Naphtha Cooler |
| EA-208 | Make-Up Hydrogen Compressor Circulation Cooler |
| EA-209 | PSA Tail Gas Compressor After Cooler |
| EA-210 | HDS Recycle Gas Compressor Circulation Cooler |
| EC-201 | HDS Reactor Effluent Condenser |
| EC-202 | JP8 Product Cooler |
| FA-201 | HDS Feed Surge Drum |
| FA-202 | HDS Reactor Effluent HP/LT Separator |
| FA-203 | HDS Recycle Gas Compressor Suction K.O. Drum |
| FA-204 | JP8 Tower Feed Surge Drum |
| FA-205 | JP8 Tower Overhead Reflux/Product Drum |
| FA-206 | Naphtha Stabilizer Overhead Reflux Drum |
| FA-207 | PSA Feed Gas K.O. Drum |
| FA-208 | Make-Up Hydrogen Compressor Suction K.O. Drum |
| FA-209 | PSA Tail Gas K.O. Drum |
| GA-201A/S | HDS Feed Pump and Spare |
| GA-202A/S | JP8 Tower Overhead Reflux/Product Pump and Spare |
| GA-203A/S | JP8 Product Pump and Spare |
| GA-204A/S | JP8 Tower Bottoms and Spare |
| GA-205A/S | Naphtha Stabilizer Reflux Pump and Spare |
| GA-206A/S | HP Wash Water and Spare |
| GB-201A/S | HDS Recycle Gas Compressor and Spare |
| GB-202A/S | Make-Up Hydrogen Compressor and Spare |
| GB-203A/S | PSA Tail Gas Compressor and Spare |
| PA-201 | Make-Up Hydrogen PSA Unit |

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 300 HYDROCRACKING ($525^{o}F^{+}$ FEED)

| TAG NO. | DESCRIPTION |
|---|---|
| BA-301 | HCR Feed Heater |
| DC-301 | HCR Reactor |
| EA-301 | HCR Reactor Feed/Effluent Exchanger |
| EA-302 | HCR Recycle Gas Compressor Circulation Cooler |
| EC-301 | HCR Reactor Effluent Condenser |
| FA-301 | HCR Feed Surge Drum |
| FA-302 | HCR Reactor Effluent HP/LT Separator |
| FA-303 | HCR Recycle Gas Compressor K.O. Drum |
| GA-301A/S | HCR Feed Pump and Spare |
| GB-301A/S | HCR Recycle Gas Compressor and Spare |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREA 400 STORAGE AREA

| TAG NO. | DESCRIPTION |
|---|---|
| FB-401 | JP-8 Jet Fuel Storage Tank |
| FB-402 | Stabilized Naphtha Storage Tank |
| FB-403 | Fuel Oil Storage Tank |
| FB-404 | 300°F - Lt. Ends Storage |
| FB-405 | Benzene Storage |
| FB-406 | Toluene Storage |
| FB-407 | Xylene Storage |
| FB-408 | Gasoline Blend Storage |
| FB-409 | Gasoline Storage |
| FB-804 | Tar Product Storage |
| FB-805 | Phenol Product Storage |
| FB-910 | O-Cresol Storage |
| FB-912 | M,P Cresol Storage |
| FB-913 | 2,4/2,5 Xylenol Storage |
| FB-914 | Mixed Xylenol Storage |
| GA-401A/S | Tar/Tar Oil Feed Pump |
| GA-402A/S | Crude Phenol Feed Pump |
| GA-403A/S | Fuel Oil Transfer Pump |
| GA-404A/S | Stabilized Naphtha Transfer Pump |
| GA-405A/S | Crude Naphtha Transfer Pump |
| GA-406A/S | Gasoline Blending Stock Pump |
| GA-407A/S | Benzene Transfer Pump |
| GA-408A/S | Toluene Transfer Pump |
| GA-409A/S | Xylene Transfer Pump |
| GA-410A/S | JP-8 Transfer Pump |
| GA-411A/S | Gasoline Transfer Pump |
| GA-413A/S | 300°F - Lt. Ends Transfer Pump |
| GA-414A/S | Tar Transfer Pump |
| GA-415A/S | Phenol Transfer Pump |
| GA-416A/S | O-Cresol Transfer Pump |
| GA-417A/S | M,P Cresol Transfer Pump |
| GA-418A/S | 2,4/2,5 Xylenol Transfer Pump |
| GA-419A/S | Mixed Xylenol Transfer Pump |
| PA-401 | Gasoline Blending Package |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

| AREA 500 | CATALYST HANDLING |
|---|---|
| TAG NO. | DESCRIPTION |
| FA-501 | Catalyst Oil Drum |
| FA-502 | Catalyst Storage Hopper |
| FA-503 | Catalyst Transfer Vessel |
| FA-504 | Spent Catalyst Vessels |
| FL-501 | Catalyst Screen |
| GA-501A/S | Catalyst Transfer Pump |
| GA-502A/S | Catalyst Oil Pump |

| AREA 600 | NAPHTHA DISTILLATION & HDT |
|---|---|
| EA-601 | Naphtha Distillation Column Reboiler |
| EA-602 | Naphtha Distillation Column Condenser |
| EA-603 | HDT Reactor Feed/Effl. Exchanger |
| EA-604 | HDT Reactor Recycle Gas Heater |
| EA-605 | Stabilizer Feed Exchanger |
| EA-606 | Reactor Effl. Cooler |
| EA-607 | Stabilizer Reboiler |
| EA-608 | Naphtha Stabilizer Condenser |
| EA-609 | HDT Naphtha Cooler |
| FA-601 | Crude Naphtha Feed Surge Drum |
| FA-602 | Distillation Col'n Reflux Drum |
| FA-603 | HDT Feed Surge Drum |
| FA-604 | Make-Up Gas K.O. Drum |
| FA-606 | LT/HP Separator |
| FA-607 | Recycle Gas K.O. Drum |
| FA-608 | Naphtha Stabilizer Reflux Drum |
| GA-601A/S | Crude Naphtha Feed Pump |
| GA-602A/S | Distillation Col'n Bottoms Pump |
| GA-603A/S | Distillation Col'n Reflux Pump |
| GA-604A/S | HDT Feed Pump |
| GA-605A/S | Process Water Pump |
| GA-606A/S | HDT Naphtha Pump |
| GA-607A/S | Naphtha Stabilizer Reflux Pump |
| GA-608A/S | Sour Water Pump |
| GB-601A/B | Make-Up Gas Compressor |
| GB-602A/B | Recycle Gas Compressor |

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

| AREA 700 | AROMATICS RECOVERY |
|---|---|
| TAG NO. | DESCRIPTION |
| DA-701 | Extractor Column |
| DA-702 | Raffinate Water Wash Column |
| DA-703 | Stripper |
| DA-704 | Recovery Column |
| DA-705 | Water Stripper |
| DA-706 | Solvent Regenerator |
| DA-707A/B | Clay Tower |
| DA-708 | Benzene Column |
| DA-709 | Toluene Column |
| EA-701 | Raffinate Cooler |
| EA-702 | Lean/Rich Solvent Exchanger |
| EA-703 | Stripper Reboiler |
| EA-704 | Stripper Condenser |
| EA-705 | Recovery Column Reboiler |
| EA-706 | Recovery Column Intermediate Reboiler |
| EA-707 | Recovery Column Condenser |
| EA-708 | Recovery Column Ejector Condenser |
| EA-709 | Water Stripper Reboiler |
| EA-710 | Solvent Regenerator Reboiler |
| EA-711 | Solvent Cooler |
| EA-712 | Clay Tower Feed/Effl. Exchanger |
| EA-713 | Clay Tower Feed Heater |
| EA-714 | Benzene Column Reboiler |
| EA-715 | Benzene Product Cooler |
| EA-716 | Benzene Column Condenser |
| EA-717 | Toluene Column Reboiler |
| EA-718 | Xylene Product Cooler |
| EA-719 | Toluene Column Condenser |
| EA-720 | Toluene Product Cooler |
| EE-701 | Recovery Column Ejector |
| FA-701 | Feed Surge Drum |
| FA-702 | Stripper Reflux Drum |
| FA-703 | Recovery Column Reflux Drum |
| FA-704 | Ejector Condensate Drum |
| FA-705 | Solvent Sump |
| FA-706 | Vent K.O. Drum |
| FA-708 | Benzene Column Reflux Drum |
| FA-709 | Toluene Column Reflux Drum |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREA 700

| | |
|---|---|
| FB-701 | Solvent Storage Tank |
| FB-702 | Wet Solvent Storage Tank |
| FB-703 | Clay Tower Surge Tank |
| FB-704 | Benzene Day Tank |
| FB-705 | Xylene Day Tank |
| FB-706A/B | Toluene Day Tanks |
| FD-701 | Solvent Filter |
| GA-701A/S | Feed Charge Pump |
| GA-702A/S | Pumparound Pump |
| GA-703A/S | Raffinate Pump |
| GA-704A/S | Stripper Bottoms Pump |
| GA-705A/S | Stripper Water Pump |
| GA-706A/S | Extractor Recycle Pump |
| GA-707A/S | Lean Solvent Pump |
| GA-708A/S | Wash Water Pump |
| GA-709A/S | Recovery Column Overhead Pump |
| GA-710A/S | Water Stripper Bottoms Pump |
| GA-711A/S | Ejector Condensate Pump |
| GA-712 | Solvent Transfer Pump |
| GA-713 | Wet Solvent Pump |
| GA-714A/S | Solvent Sump Pump (Warehouse Spare) |
| GA-715A/S | Clay Tower Feed Pump |
| GA-716A/S | Benzene Column Bottoms Pump |
| GA-717A/S | Benzene Column Reflux Pump |
| GA-718A/S | Benzene Column Water Pump |
| GA-719A/S | Benzene Product Pump |
| GA-720A/S | Toluene Column Bottoms Pump |
| GA-721A/S | Toluene Column Reflux Pump |
| GA-722A/S | Xylene Product Pump |
| GA-723A/S | Toluene Product Pump |
| PA-701 | Clay Handling Equipment |

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREAS 800 & 850 PHENOL AND CRESYLIC ACID EXTRACTION

| TAG NO. | DESCRIPTION |
|---|---|
| DA-801 | Flash Column |
| DA-802 | Drier Column |
| DA-803 | Phenol Column |
| DA-804 | Stripping Column |
| DA-805 | Light Ends Column |
| DA-851 | Extractor Column |
| DA-852 | Hexane Column |
| DA-853 | Methanol Column |
| DA-854 | Drying Column |
| EA-801 | Flash Column Condenser |
| EA-802 | Flash Column Reboiler |
| EA-803 | Dephenolized Cresylic Acid Cooler |
| EA-804 | Flash Column Trim Cooler |
| EA-805 | Dryer Condenser |
| EA-806 | Phenol Column Reboiler |
| EA-807 | Phenol Column Condenser |
| EA-808 | Light Ends Column Condenser |
| EA-809 | Light Ends Column Reboiler |
| EA-810 | Stripping Column Condenser |
| EA-811 | Stripping Column Reboiler |
| EA-812 | Phenol Cooler |
| EA-813 | Tar Cooler |
| EA-814 | Stripping Column Side Reboiler |
| EA-851 | Hexane Reboiler |
| EA-852 | Hexane Condenser |
| EA-853 | Neutral Oil Cooler |
| EA-854 | Methanol Reboiler |
| EA-855 | Methanol Condenser |
| EA-856 | Methanol Column Bottoms Cooler |
| EA-857 | Drying Column Reboiler |
| EA-858 | Drying Column Condenser |
| EA-859 | Crude Cresylic Acid Cooler |
| EA-860 | 65% Methanol Cooler |
| EA-861 | Methanol Column Feed/Crude Cresylic Acid Interchanger |
| ED-801 | Thin Film Evaporator |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREAS 800 & 850 PHENOL AND CRESYLIC ACID EXTRACTION

| TAG NO. | DESCRIPTION |
|---|---|
| FA-801 | Flash Column Reflux Drum |
| FA-802 | Dryer Drum |
| FA-803 | Phenol Column Reflux Drum |
| FA-804 | Stripping Column Reflux Drum |
| FA-805 | Light Ends Column Reflux Drum |
| FA-806 | Crude Phenol Surge Drum |
| FA-807 | Cresylic Acid Drum |
| FA-808 | Phenol Drawoff Drum |
| FA-809 | Light Ends Drum |
| FA-851 | Hexane Reflux Drum |
| FA-852 | Methanol Column Reflux Drum |
| FA-853 | Drying Column Reflux Drum |
| FA-854 | Methanol Make-Up Drum |
| FB-801 | Sulfuric Acid Day Tank |
| FB-802 | Tar Day Tank |
| FB-803 | Phenol Day Tank |
| FB-851 | Hexane Storage Tank |
| FB-852 | Crude Cresylic Acid Day Tank |
| FB-853A/B | Crude Cresylic Acid Month Storage Tank |
| FD-801 | 1st Stage Water Wash Tank |
| FD-802 | 2nd Stage Water Wash Tank |
| GA-801A/S | Crude Phenol Feed Pump |
| GA-802A/S | Flash Column Reflux Pump |
| GA-803A/S | Flash Column Bottoms Pump |
| GA-804A/S | Acid Tar Pump |
| GA-805A/S | Flash Column Water Pump |
| GA-806A/S | Light Ends Column Feed Pump |
| GA-807A/S | Sulfuric Acid Pump |
| GA-808A/S | Cresylic Acid Pump |
| GA-809A/S | Light Ends Column Reflux Pump |
| GA-810A/S | Light Ends Column Bottoms Pump |
| GA-811A/S | Dryer Water Pump |
| GA-812A/S | Dryer Reflux Pump |
| GA-813A/S | Phenol Column Reflux Pump |
| GA-814A/S | Phenol Drawoff Pump |
| GA-815A/S | Phenol Column Bottoms Pump |
| GA-816A/S | Stripping Column Reflux Pump |
| GA-817A/S | Stripping Column Organic Extraction Pump |
| GA-818A/S | Stripping Column Bottoms Pump |
| GA-819A/S | Phenol Charge Pump |
| GA-820A/S | Dryer Column Bottoms Pump |

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

| AREAS 800 & 850 | PHENOL AND CRESYLIC ACID EXTRACTION |
|---|---|
| GA-821A/S | Wash Water Pump |
| GA-822A/S | Tar Circulating Pump |
| GA-823A/S | Wash Water Circulating Pump |
| GA-824A/S | Tar Pump |
| GA-825A/S | Tar Storage Pump |
| GA-826A/S | Light Ends Column Water Pump |
| GA-851A/S | Extractor Bottoms Pump |
| GA-852A/S | Hexane Column Bottoms Pump |
| GA-853A/S | Hexane Feed Pump |
| GA-854A/S | Hexane Make-Up Pump |
| GA-855A/S | Methanol Column Bottoms Pump |
| GA-856A/S | Methanol Column Reflux Pump |
| GA-857A/S | Drying Column Feed Pump |
| GA-858A/S | Drying Column Bottoms Pump |
| GA-859 | Crude Cresylic Acid Pump |
| GA-860A/S | Drying Column Condensate Pump |
| GA-861A/S | 65% Methanol Pump |
| GA-862A/S | Crude Cresylic Acid Supply Pump |
| GD-801 | 1st Stage Wash Tank Mixer |
| GD-802 | 2nd Stage Wash Tank Mixer |
| GD-803 | Sulfuric Acid Mixer |
| GD-851 | Extractor Mixer |
| PA-801 | Vacuum System |

## 3.0 CAPITAL COSTS

### 3.1 Equipment Lists (cont'd)

AREA 900 CRESYLIC ACID DISTILLATION

| TAG NO. | DESCRIPTION | |
|---|---|---|
| | BLOCK OPERATION 1 | BLOCK OPERATION 2 |
| DA-901 | Phenol/Ortho Column | O-Cres. Top. Column |
| DA-902A/B | Phenol Column | O-Cres. Column |
| DA-903 | M,P Cresol Column | --- |
| DA-904 | Xylenol Top. Column | 2,4/2,5-Xylenol Col. |
| EA-901 | Phenol/Ortho Col. Reb. | O-Cres. Top Col. Reb. |
| EA-902 | Phenol/Ortho Condenser | O-Cres. Top Condenser |
| EA-903 | Phenol Column Reb. | O-Cres. Col. Reboiler |
| EA-904 | Phenol Column Cond. | O-Cres. Col. Condenser |
| EA-905 | M,P Cres. Col. Reb. | --- |
| EA-906 | M,P Cres. Col. Cond. | --- |
| EA-907 | Xylenol Top. Col. Reb. | 2,4/2,5-Xyl. Col. Reb. |
| EA-908 | Xylenol Top. Col. Cond. | 2,4/2,5-Xyl. Col. Cond |
| EA-909 | Phen./Ortho Col. Feed. Btms. Interchanger | O-Cres. Top. Column Feed-Btms. Interchanger |
| EA-910 | Phenol Col. Btms Cool. | O-Cres. Col. Btms. Cool. |
| EA-911 | Xyl. Top. Col. Btms Cool. | 2,4/2,5 Xyl. Col Btms Cool |
| EA-912 | M,P Cres. Prod. Cool. | --- |
| EA-913 | --- | O-Cres. Top. Col O/H Cool |
| EA-914 | --- | O-Cres. Product Cooler |
| EA-915 | --- | Xyl. Col. Feed Btms Intchg. |
| EA-916 | --- | 2,4/2,5-Xyl. Prod. Cool. |
| FA-901 | Phen/Ortho Reflux Drum | O-Cres. Top. Reflux Drum |
| FA-902 | Phenol Reflux Drum | O-Cres. Reflux Drum |
| FA-903 | M,P Cres. Reflux Drum | --- |
| FA-904 | Xyl. Top. Reflux Drum | 2,4/2,5 Xyl. Ref. Drum |
| FB-901 | O-Cresol Top. Feed Day Tank | --- --- |
| FB-902 | Xyl. Intermed. Day Tank | --- |
| FB-903 | --- | O-Cres. Day Tank |
| FB-905 | M,P Cresol Day Tank | --- |
| FB-906 | --- | 2,4/2,5 Xyl. Day Tank |
| FB-907 | --- | Mixed Xylenol Day Tank |
| FB-908 | O-Cresol Topping Feed Month Storage | |
| FB-909 | Xylenol Intermediate Month Storage | |
| FB-910 | O-Cresol Month Storage | |
| FB-911 | Slop Cut Month Storage | |
| FB-912 | M,P Cresol Month Storage | |
| FB-913 | 2,4/2,5 Xylenol Month Storage | |
| FB-914 | Mixed Xylenol Month Storage | |

3.0 CAPITAL COSTS

3.1 Equipment Lists (cont'd)

AREA 900 CRESYLIC ACID DISTILLATION

| TAG NO. | DESCRIPTION | |
|---|---|---|
| | BLOCK OPERATION 1 | BLOCK OPERATION 2 |
| GA-901A/S | Phenol/Ortho Btms Pump | O-Cres. Top. Bottoms Pump |
| GA-902A/S | Phenol/Ortho Reflux Pump | O-Cres. Top. Reflux Pump |
| GA-903A/S | Phenol Bottoms Pump | O-Cres. Bottoms Pump |
| GA-904A/S | Phenol Reflux Pump | O-Cres. Reflux Pump |
| GA-905A/S | M,P Cres. Btms. Pump | --- |
| GA-906A/S | M,P Cres. Reflux Pump | --- |
| GA-908 | O-Cres. Topping Pump | --- |
| GA-909 | --- | Mixed Xylenol Pump |
| GA-910 | --- | 2,4/2,5 Xylenol Pump |
| GA-911 | M,P Cresol Pump | --- |
| GA-912 | Xylenol Pump | --- |
| GA-913 | --- | O-Cresol Pump |
| GA-914A/S | Phen Col Intermed. Pump | O-Cres. Col. Inter. Pump |
| GA-915A/S | Xyl. Top. Btms. Pump | 2,4/2,5 Xyl. Btms. Pump |
| GA-916/A/S | Xyl. Top Return Pump | 2,4/2,5 Xyl. Rflx.Pump |
| GA-917A/S | --- | O-Cres. Top. Col. Feed |
| GA-918A/S | --- | Xylenol Col. Feed Pump |
| PA-901 | Vacuum Package | |

## 3.2 Cost Estimate

### 3.2.1 Basis of Estimate

The estimates for all areas are equipment factored estimates. Data was developed for the equipment based on the processing schemes and then priced using in-house return cost data for similar equipment items. This equipment value was then used to establish the cost of materials and labor using historical ratio's of such costs. Engineering was calculated based on the number of equipment items. Contingency was added at 20% of the total costs. For Areas 500, 600 and 700 the Task 1.2 previous estimates are used, and escalated.

Excluded from this estimate are:

Spare Parts
Start-Up
Insurances & Taxes
Permits
Royalties on Processing Technology Knowhow

### 3.2.2 Estimate Summary

| | (Thousands of $) |
|---|---|
| Area 100 Hydrotreater | $ 25,992 |
| Area 200 HDS & JP-8 | 34,761 |
| Area 300 HDC | 5,803 |
| Area 400 OSBL | 12,802 |
| Area 500 Catalyst Handling | 1,409 |
| Area 600 Naph. Dist & HDT | 5,403 |
| Area 700 ARU | 10,338 |
| Area 800 Phenol Ext. | 11,909 |
| Area 850 Cresylic Acid Ext. | 5,361 |
| Area 900 Cresylic Acid Dist | 7,508 |
| | $121,287 |
| Area 700 ARU Solvent Invent. | 110 |
| Total | $121,397 |

3.2 Cost Estimate (cont'd)

3.2.3 ESTIMATE BREAKDOWN

The following pages show the estimate breakdown for each Area. The backup for the estimate can be found in Section 6 along with the equipment data.

AREA 100

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89 03:31 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 2 | $485 | 80% | $388 |
| TOWERS | 3 | $80 | 110% | $88 |
| INTERNALS | | $16 | | |
| REACTORS | 3 | $2,100 | 60% | $1,260 |
| EXCHANGERS | 8 | $84 | 120% | $101 |
| AIR COOLERS | 2 | $116 | 90% | $104 |
| VESSELS | 16 | $266 | 100% | $266 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 30 | $900 | 100% | $900 |
| COMPRESSORS | 4 | $1,700 | 60% | $1,020 |
| PACKAGE UNITS | 4 | $45 | 60% | $27 |
| | | | | |
| TOTAL | 72 | $5,792 | | $4,154 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $5,792 | |
| COMMODITIES | $4,154 | |
| LABOR | $3,072 | (10% EQUIP,60% COMM) |
| INDIRECTS | $3,072 | (100% LABOR) |
| ENGINEERING | $4,320 | (1000/PC X $60) |
| SUBTOTAL | $20,410 | |
| CONTINGENCY | $4,082 | (20%) |
| TOTAL | $24,492 | |
| PSA | $1,500 | PSA 5MM X 1.5 TIC |
| TOTAL | $25,992 | |

AREA 200

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89 03:36 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 2 | $370 | 60% | $222 |
| TOWERS | 3 | $81 | 110% | $89 |
| INTERNALS | | $19 | | |
| REACTORS | 1 | $900 | 70% | $630 |
| EXCHANGERS | 10 | $376 | 90% | $338 |
| AIR COOLERS | 2 | $88 | 90% | $79 |
| VESSELS | 9 | $266 | 100% | $266 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 12 | $315 | 100% | $315 |
| COMPRESSORS | 6 | $5,100 | 60% | $3,060 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 45 | $7,515 | | $5,000 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $7,515 | |
| COMMODITIES | $5,000 | |
| LABOR | $3,751 | (10% EQUIP,60% COMM) |
| INDIRECTS | $3,751 | (100% LABOR) |
| ENGINEERING | $2,700 | (1000/PC X $60) |
| SUBTOTAL | $22,717 | |
| CONTINGENCY | $4,543 | (20%) |
| TOTAL | $27,261 | |
| PSA | $7,500 | PSA 5MM X 1.5 TIC |
| TOTAL | $34,761 | |

AREA 300

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
PAGE:1
DATE/BY: 21-Apr-89 03:05 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 1 | $60 | 100% | $60 |
| TOWERS | | | 110% | |
| INTERNALS | | | | |
| REACTORS | 1 | $560 | 70% | $392 |
| EXCHANGERS | 2 | $85 | 100% | $85 |
| AIR COOLERS | 1 | $70 | 100% | $70 |
| VESSELS | 3 | $85 | 120% | $102 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 2 | $100 | 100% | $100 |
| COMPRESSORS | 2 | $400 | 80% | $320 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 12 | $1,360 | | $1,129 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,360 | |
| COMMODITIES | $1,129 | |
| LABOR | $813 | (10% EQUIP,60% COMM) |
| INDIRECTS | $813 | (100% LABOR) |
| ENGINEERING | $720 | (1000/PC X $60) |
| SUBTOTAL | $4,836 | |
| CONTINGENCY | $967 | (20%) |
| TOTAL | $5,803 | |

LCI PROJECT 5571
TASK 4.0

AREA 400

# *OSBL ESTIMATE*

| | | |
|---|---|---|
| **PIPING** | | |
| 600 TONS X 1.1 FOR FITTINGS & FLANGES X $200/TON | | $1,320,000 |
| 2000 GALV. @ $25/FT | | $50,000 |
| LABOR @ .6 HRS/FT. X $55/HR (80000 FT) | | $2,640,000 |
| TRACING 16200 LF @ $20/FT | | $324,000 |
| **INSULATION** | | |
| FROM BACK UP | | $420,000 |
| **PIPERACK** | | |
| 3000LF @ $300/FT | | $900,000 |
| CONCRETE 1500 Y3 X $350/ | | $525,000 |
| TOTAL INTERCONNECTIONS | | $6,179,000 |
| EQUIPMENT | | $1,846,000 |
| INSTALLATION MATERIALS FOR EQUIPMENT @ 25% | | $461,500 |
| LABOR FOR EQUIPMENT & MATERIALS | | $461,500 |
| | S/T | $8,948,000 |
| ENGINEERING @ 10 % | | $900,000 |
| | S/T | $9,848,000 |
| CONTINGENCY @ 30% | | $2,954,400 |
| | TOTAL | $12,802,400 |

AREA 500

LCI PROJE' 5571
TASK 4.0

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | | | | |
| INTERNALS | | | | |
| REACTORS | | | | |
| EXCHANGERS | | | | |
| AIR COOLERS | | | | |
| VESSELS | 4 | $105 | 120% | $126 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 4 | $48 | 120% | $58 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 8 | $153 | | $184 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $153 | |
| COMMODITIES | $184 | |
| LABOR | $125 | (10% EQUIP,60% COMM) |
| INDIRECTS | $125 | (100% LABOR) |
| ENGINEERING | $480 | (1000/PC X $60) |
| SUBTOTAL | $1,068 | |
| CONTINGENCY | $214 | (20%) |
| TOTAL | $1,281 | |
| ESCALATION | $128 | 10% |
| TOTAL | $1,409 | |

AREA 600

LCI PROJECT 5571
TASK 4.0

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 2 | $48 | 140% | $67 |
| INTERNALS | | $8 | | |
| REACTORS | | | | |
| EXCHANGERS | 1 | $125 | 85% | $106 |
| AIR COOLERS | | | | |
| VESSELS | 9 | $123 | 100% | $123 |
| TANKS | 7 | $89 | 100% | $89 |
| FILTERS | | | | |
| PUMPS | 16 | $68 | 100% | $68 |
| COMPRESSORS | 4 | $230 | 60% | $138 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 39 | $691 | | $591 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $691 | |
| COMMODITIES | $591 | |
| LABOR | $424 | (10% EQUIP,60% COMM) |
| INDIRECTS | $424 | (100% LABOR) |
| ENGINEERING | $1,872 | (800/PC X $60) |
| SUBTOTAL | $4,002 | |
| CONTINGENCY | $800 | (20%) |
| TOTAL | $4,803 | |
| ESCALATION | $600 | 12.5% |
| TOTAL | $5,403 | |

AREA 700

LCI PROJECT 5571
TASK 4.0

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 10 | $350 | 140% | $490 |
| INTERNALS | | $66 | | |
| REACTORS | | | | |
| EXCHANGERS | 20 | $113 | 100% | $113 |
| AIR COOLERS | | | | |
| VESSELS | 9 | $65 | 120% | $78 |
| TANKS | 7 | $117 | 100% | $117 |
| FILTERS | | | | |
| PUMPS | 44 | $180 | 120% | $216 |
| COMPRESSORS | | | 60% | |
| PACKAGE UNITS | 3 | $20 | 100% | $20 |
| | | | | |
| TOTAL | 93 | $911 | | $1,034 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $911 | |
| COMMODITIES | $1,034 | |
| LABOR | $712 | (10% EQUIP,60% COMM) |
| INDIRECTS | $712 | (100% LABOR) |
| ENGINEERING | $4,464 | (800/PC X $60) |
| SUBTOTAL | $7,832 | |
| CONTINGENCY | $1,566 | (20%) |
| TOTAL | $9,398 | |
| ESCALATION | $940 | 10.0% |
| TOTAL | $10,338 | |

AREA 800

LCI PROJECT 5571
TASK 4.0

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 5 | $776 | 100% | $776 |
| INTERNALS | | $143 | 0% | $0 |
| REACTORS | | | 90% | $0 |
| EXCHANGERS | 14 | $332 | 100% | $332 |
| VESSELS | 9 | $73 | 120% | $88 |
| TANKS | 3 | $53 | 80% | $42 |
| FILTERS | | | | $0 |
| PUMPS | 52 | $440 | 100% | $440 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | 7 | $165 | 70% | $115 |
| | | | | |
| TOTAL | 90 | $1,982 | | $1,794 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,982 | |
| COMMODITIES | $1,794 | |
| LABOR | $1,274 | (10% EQUIP,60% COMM) |
| INDIRECTS | $1,274 | (100% LABOR) |
| ENGINEERING | $3,600 | (800/PC X $50) |
| SUBTOTAL | $9,924 | |
| CONTINGENCY | $1,985 | (20%) |
| TOTAL | $11,909 | |

LCI PROJECT 5571
TASK 4.0

AREA 850

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 4 | $115 | 100% | $115 |
| INTERNALS | | $281 | | |
| REACTORS | | | | |
| EXCHANGERS | 11 | $167 | 120% | $200 |
| VESSELS | 9 | $25 | 120% | $30 |
| TANKS | 3 | $127 | 80% | $102 |
| FILTERS | | | | |
| PUMPS | 23 | $173 | 110% | $190 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 50 | $888 | | $637 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $888 | |
| COMMODITIES | $637 | |
| LABOR | $471 | (10% EQUIP,60% COMM) |
| INDIRECTS | $471 | (100% LABOR) |
| ENGINEERING | $2,000 | (800/PC X $50) |
| SUBTOTAL | $4,468 | |
| CONTINGENCY | $894 | (20%) |
| TOTAL | $5,361 | |

AREA 900

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 5 | $453 | 100% | $453 |
| INTERNALS | | $218 | | |
| REACTORS | | | | |
| EXCHANGERS | 16 | $220 | 110% | $242 |
| VESSELS | 4 | $19 | 120% | $23 |
| TANKS | 6 | $69 | 80% | $55 |
| FILTERS | | | | |
| PUMPS | 28 | $210 | 110% | $231 |
| COMPRESSORS | 2 | $50 | 110% | $55 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 61 | $1,239 | | $1,059 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,239 | |
| COMMODITIES | $1,059 | |
| LABOR | $759 | (10% EQUIP,60% COMM) |
| INDIRECTS | $759 | (100% LABOR) |
| ENGINEERING | $2,440 | (800/PC X $50) |
| SUBTOTAL | $6,257 | |
| CONTINGENCY | $1,251 | (20%) |
| TOTAL | $7,508 | |

## 4.0 OPERATING COSTS

### 4.1 Operating Labor

It is estimated that it will require 17 men/shift to operate the plant broken down as follows:

| | |
|---|---|
| Foreman | 2 |
| Control Room | 2 |
| HDT Operator | 2 |
| HDS & JP-8 Operator | 2 |
| HCR Operator | 1 |
| Naph. Distill. & HDT Operator | 2 |
| ARU | 2 |
| Phenol Extraction | 1 |
| Cresylic Acid Extraction | 1 |
| Cresylic Acid Distillation | 1 |
| Relief Man | 1 |
| Shift Positions | 17 |

Maintenance will be integrated with the existing SNG Plant Maintenance Shop. The existing maintenance department will most likely be expanded by about 10 people.

The total additional people (assuming 6 & 2 operation for the process units) are as follows:

| | | | |
|---|---|---|---|
| Shift Personnel | 17 Positions X 4 People/Position | = | 68 |
| Supervisor & Admin. | | | 6 |
| QC Technician | | | 2 |
| Maintenance | | | 10 |
| Other (Stores or Janitorial) | | | 1 |
| Total | | | 87 |

## 4.2 Utilities

The following utility requirements have been developed:

| UTILITY | CONSUMPTION | COST | | $/CD |
|---|---|---|---|---|
| #6 Fuel Oil | 3904 BPCD | $16/BBL | (a) | 62464 |
| SNG Equivalent of SYN Gas & Purge Gas | 3.76 MMSCFD | $3.80/MM BTU | (b) | 14000 |
| Cooling Water | 8063 GPM | $0.155/MGAL | (c) | 1800 |
| Power | 7230 KW | $0.04/KWH | (c) | 6940 |
| Process Water | 90 GPM | $0.45/MGAL | (c) | 58 |
| HP Steam (550#) | 63700 #/H | $5/M LBS. | (c) | 7644 |
| MP Steam (100#) | 31400 #/H | $2.50/MLBS | (c) | 1884 |
| LP Steam (40#) | (13732 #/H) | $2.50/MLBS | (c) | (824) |
| BFW | 11800 #/H | $2.66/MGAL | (c) | 91 |
| Condensate Return | (92360 #/H) | $1.87/MGAL | (c) | (495) |

(a) Cost of 1% sulfur #6 oil in Minnesota on 11/24/87 as per Platts Oilgram.

(b) Memo from D. Daley of Burns & Roe to L. Lorenzo of DOE dated October 20, 1987 reference DPD-87-863.

(c) ANG utility cost information dated 5/87.

4.2 Utilities - cont'd

4.3 Catalyst & Chemicals

The catalyst and chemicals cost is as follows:

| Catalyst & Chem. | Use | Cost | $/CD |
|---|---|---|---|
| Nap. HDT Cat. | 0.021 #/Bbl | $3.00/# | 30 |
| HDT Cat. | 0.2 #/Bbl | $3.00/# | 1671 |
| HDS Cat. | 0.038 #/Bbl | $3.30/# | 368 |
| HCR Cat. | 0.053 #/Bbl | $6.00/# | 491 |
| Inhibitors | 50 PPM | $10/Gal. | 60 |
| ARU Solvent | 24 #/D | $2.10/# | 60 |
| $H_2SO_4$ | 2650 #/D | $0.04/# | 106 |
| | | | 2786 |

4.4 Maintenance Supplies

Maintenance supplies for hydrotreating operations typically cost between 1.5-2.0% of the installed cost per year. For a daily cost we would estimate the cost of maintenance supplies to be 0.005% of the total installed cost of the process units (excluding the ARU solvent inventory). On this basis the maintenance supplies would be:

$$\frac{0.02}{365} (121,287,000) (0.91) = \$6048/CD.$$

APPENDIX E

LCI Report on "Profitable JP-8" Design:
Plot Plan and Tie-ins

## 5.0 PLOT PLAN AND UNIT TIE-INS

### 5.1 Plot Plan

The process units required for the production of JP-8 and by-product chemicals are proposed to be located to the east of the Rectisol Unit of the existing gasification plant as indicated on the markup of the overall Process Area Plot Plan, LCI Dwg E7102-00010A. This area approximately 400 x 600' will be surrounded by an access road and will be divided by two central east-west roads. Areas 100, 200 and 300 will be located to the north and Areas 800, 850 and 900 south of Area 100, and then Areas 600 and 700. The 500 Area equipment is located within Area 100. Adjacent to the 700 Area is a intermediate storage tank area that is utilized with the blocked operation of Area 900 Cresylic Acid Distillation.

A diked storage tank area approximately 375' x 425' will be required for product and fuel oil storage and is proposed to be located to the south of the existing tankage area adjacent to the railcar loading spurs.

### 5.2 Unit Tie-Ins

Approximately 3000 ft of new interconnecting pipe rack will be required to connect the new process area with the main yard rack of the gasification plant, the product storage area and flare.

New storm, oily water and sanitary sewer lines will be run from the new process units south to their respective collection systems.

A summary of the interconnecting lines is shown in Table 5.1.

TABLE 5.1

INTERCONNECTING PIPING

I. TAR OIL STREAM

| EST. SIZE | SERVICE | TO/FROM |
|---|---|---|
| 4" | Tar/Tar Oil (Elec. Tr.) | Storage |
| 3" | JP-8 Product | Storage |
| 2" | Stabil. Naph. Product | Storage |
| 8" | Synthesis Gas | PSA/Rectisol |
| 6" | Purge Gas | Methanation/PSA |
| 2" | Waste Water | Phosam/HDT, HDC |
| 1 1/2" | 300°F Lt. Ends | Storage |
| 1 1/2" | Vac. Twr. Btms. & Slop | Fuel |
| 4" | Off Gas | Fuel Gas |
| 3" | Off Gas | LP. Fuel. |

TABLE 5.1 - cont'd

INTERCONNECTING PIPING

II. NAPHTHA STREAM

| EST. SIZE | SERVICE | TO/FROM |
|---|---|---|
| 1 1/2" | Crude Naphtha | Storage |
| 1 1/2" | 160°F - Distillate | Storage/Dist. |
| 1 1/2" | Blending Stock | Storage/ARU |
| 1 1/2" | Benzene | Storage/ARU |
| 1 1/2" | Toluene | Storage/ARU |
| 1 1/2" | Xylene | Storage/ARU |
| 1 1/2" | Butane | Storage |
| 3" | Gasoline | Storage |
| 3" | Purge Gas | Fuel Gas/PSA & HDT |
| 1 1/2" | Off Gas | Rectisol/HDT |
| 2" | Waste Water | Phosam/HDT |

TABLE 5.1

INTERCONNECTING PIPING

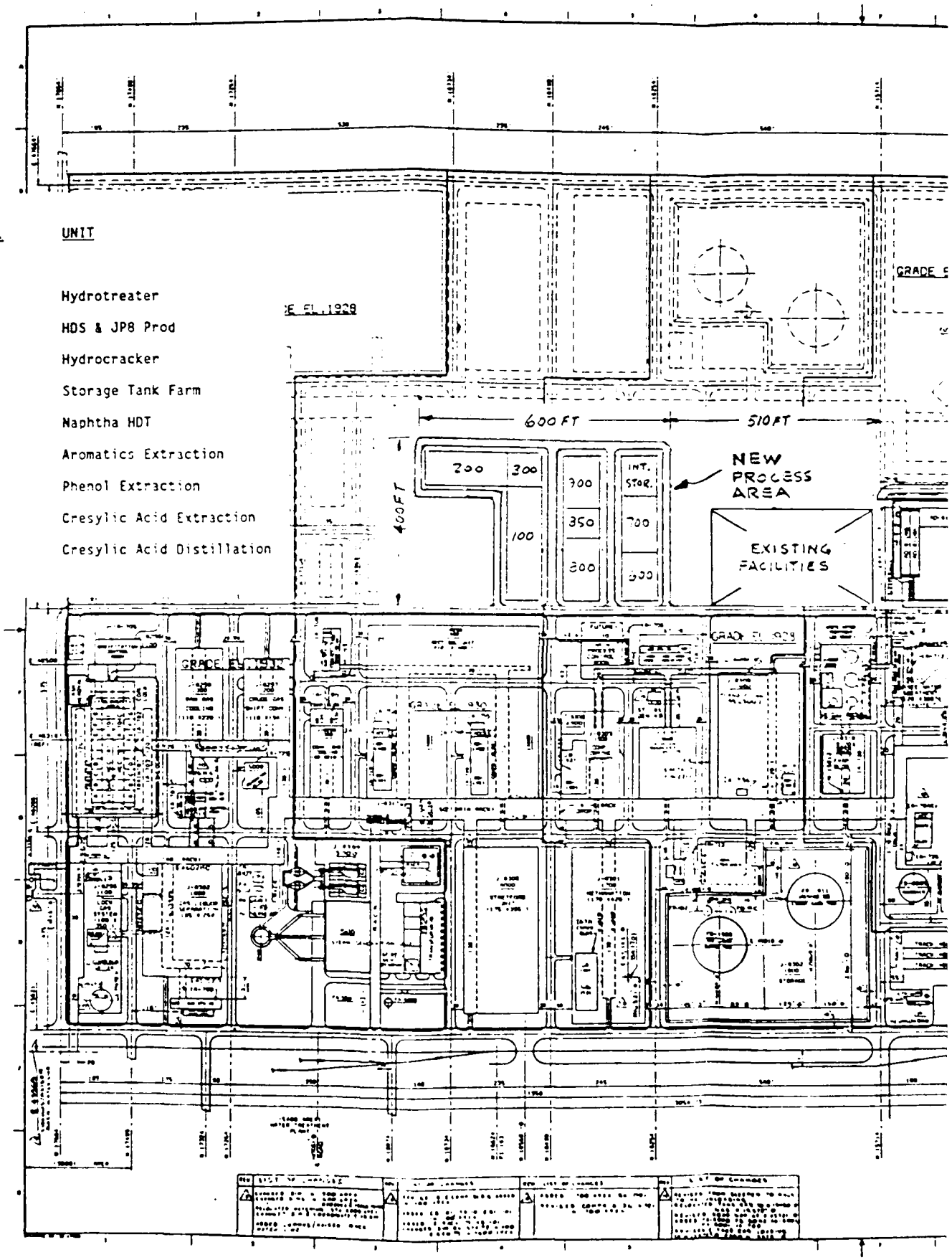
III. PHENOL STREAM

| EST. SIZE | SERVICE | TO/FROM |
|---|---|---|
| 2" | Crude Phenol (Elec. Tr.) | Storage |
| 2" | Tar Product | Storage |
| 3" | Phenol Product (Elec. Tr.) | Storage |
| 2" | Crude Cresylic Acid (Elec. Tr.) | Int. Storage & Return |
| 2" | Crude O-Cresol (Elec. Tr.) | Int. Storage & Return |
| 1 1/2" | Crude Xylenol (Elec. Tr.) | Int. Storage & Return |
| 1 1/2" | Crude Cresylic Acid (Elec. Tr.) | Int. Storage & Return |
| 1 1/2" | Slop (Elec. Tr.) | Int. Storage & Return |
| 1 1/2" | Extraction Purge | Fuel/Ph. Ext. |
| 1 1/2" | O-Cresol (Elec. Tr.) | Storage |
| 3" | M,P-Cresol (Elec. Tr.) | Storage |
| 1 1/2" | 2,4/2,5 Xylenol Product (Elec. Tr.) | Storage |
| 1 1/2" | Mixed Xylenol Prod. (Elec. Tr.) | Storage |
| 1 1/2" | Methanol Make-Up | Ph. Ext./MeoH Unit |
| 1 1/2" | Sulfuric Acid (Elec Tr.) | Ph. Ext./Storage |
| 3" | Wash Water (Elec. Tr.) | Treatment/Ph. Ext. |
| 1 1/2" | Waste Water (Elec. Tr.) | Phenosolvan/Ph. Ext. |
| 2" | Off Gas | LP Fuel Gas |

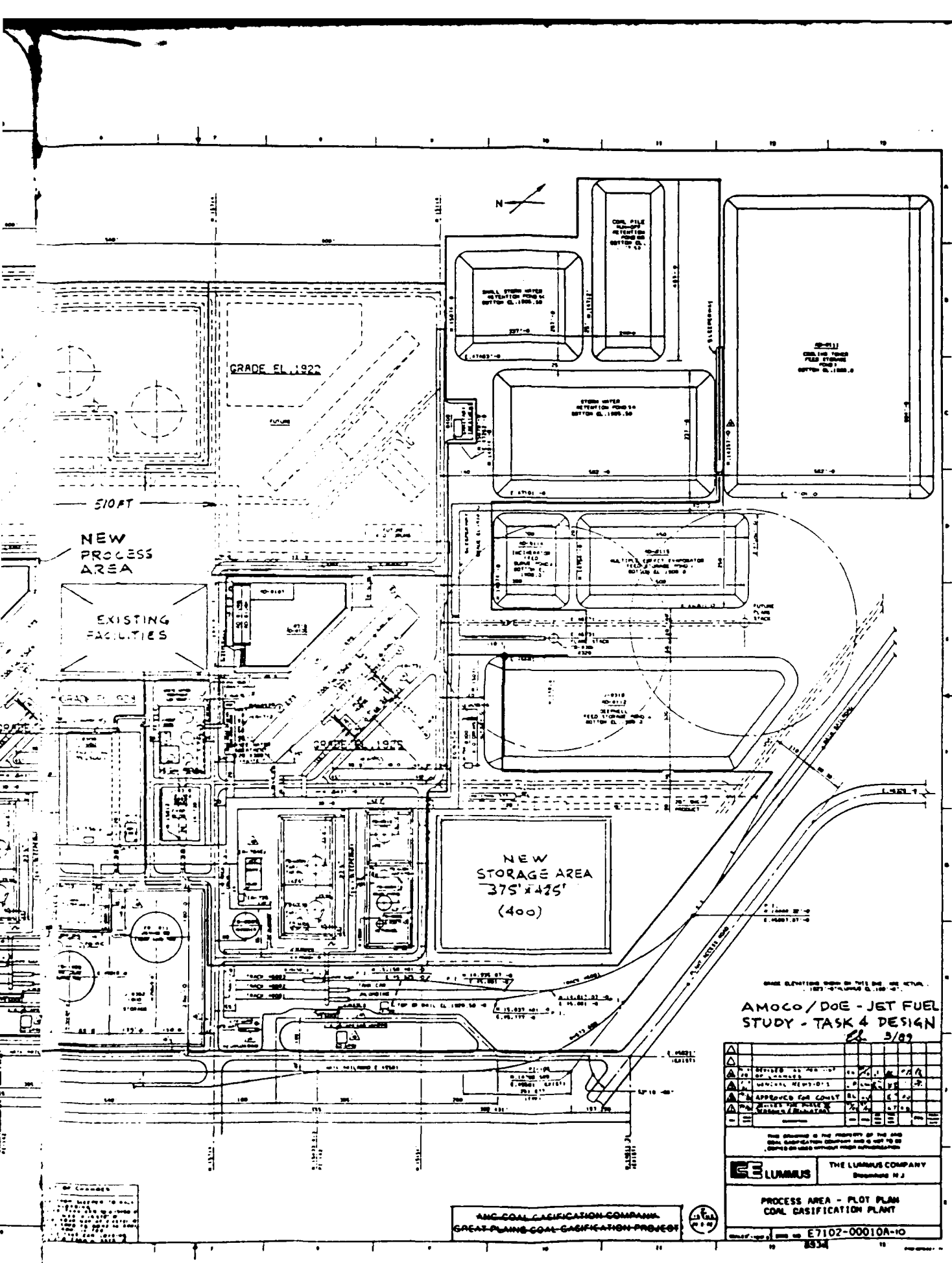
IV. COLUMN LINES

| EST. SIZE | SERVICE | TO/FROM |
|---|---|---|
| 30" | Wet Flare (Trace) | Flare |
| 3" | Nitrogen | Main Rack |
| 3" | Plant Air | Main Rack |
| 3" | Instr. Air | Main Rack |
| 2" | Raw Water (Elec. Trace) | Main Rack |
| 8" | HP Steam | Main Rack |
| 8" | MP Steam | Main Rack |
| 20" | C. W. Supply and Return | Main Rack |
| 2" | BFW | Main Rack |
| 4" | Cond. Return | Main Rack |
| 1 1/2" | Boiler B.D. | Main Rack |
| 26" | Storm Sewer (8' Deep) | Storm Basin/ Process Units |
| 15" | Oily Water Sewer (8' Deep) | 8100/Process Units |
| 6" | Sanitary Sewer (9' Deep) | 8400/Process Units |
| 10" | Fire Water | Rins Header |
| 4" | Fuel Oil (Elec. Trace) | Day Tank/Storage |

RR5571-5.TXT




| AREA NO. | UNIT |
|---|---|
| 100 | Hydrotreater |
| 200 | HDS & JP8 Prod |
| 300 | Hydrocracker |
| 400 | Storage Tank Farm |
| 600 | Naphtha HDT |
| 700 | Aromatics Extraction |
| 800 | Phenol Extraction |
| 850 | Cresylic Acid Extraction |
| 900 | Cresylic Acid Distillation |


N
GRADE EL. 1922
510 FT
NEW
PROCESS
AREA
EXISTING
FACILITIES
NEW
STORAGE AREA
375' x 475'
(400)
AMOCO / DOE - JET FUEL
STUDY - TASK 4 DESIGN
THE LUMMUS COMPANY
PROCESS AREA - PLOT PLAN
COAL GASIFICATION PLANT
E7102-00010A-10

APPENDIX F

LCI Report on "Profitable JP-8" Design:
Equipment Data and Estimate Sheets

# 6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

## 6.1 Tar Oil Stream

6.1.1 AREA 100

6.1.2 AREA 200

6.1.3 AREA 300

6.1.4 AREA 500

AREA 100

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89 03:31 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 2 | $485 | 80% | $388 |
| TOWERS | 3 | $80 | 110% | $88 |
| INTERNALS | | $16 | | |
| REACTORS | 3 | $2,100 | 60% | $1,260 |
| EXCHANGERS | 8 | $84 | 120% | $101 |
| AIR COOLERS | 2 | $116 | 90% | $104 |
| VESSELS | 16 | $266 | 100% | $266 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 30 | $900 | 100% | $900 |
| COMPRESSORS | 4 | $1,700 | 60% | $1,020 |
| PACKAGE UNITS | 4 | $45 | 60% | $27 |
| | | | | |
| TOTAL | 72 | $5,792 | | $4,154 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $5,792 | |
| COMMODITIES | $4,154 | |
| LABOR | $3,072 | (10% EQUIP,60% COMM) |
| INDIRECTS | $3,072 | (100% LABOR) |
| ENGINEERING | $4,320 | (1000/PC X $60) |
| SUBTOTAL | $20,410 | |
| CONTINGENCY | $4,082 | (20%) |
| TOTAL | $24,492 | |
| PSA | $1,500 | PSA 5MM X 1.5 TIC |
| TOTAL | $25,992 | |

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BA- 101 FRESH FEED HEATER (LIQUID ONLY) | | | | | 1 | | | | | | |
| 2 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | 125 000 | | | |
| 3 | MM Btu/h | | | 8.4 | | | | | | | | |
| 4 | kW | | | | | | | | | | | |
| 5 | DES PRESS | 750 PSIG | kPa kg/cm² | PSIG | kPa kg/cm² | | | | | | | |
| 6 | DES TEMP | 850 °F | °C | °F | °C | | | | | | | |
| 7 | MAT TUBES | 5Cr ½ Mo | | | | | | | | | | |
| 8 | TYPE | VERTICAL CYLINDRICAL | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | PREHEATER ☐ ECONOMIZER ☐ | | | | ERECT WT | | TONS | | | | | |
| 11 | BA- 102 FEED HEATER (MIXED PHASE) | | | | | 1 | | | | | | |
| 12 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | 360 000 | | | |
| 13 | MM Btu/h | | | 12.0 | | | | | | | | |
| 14 | kW | | | | | | | | | | | |
| 15 | DES PRESS | 2350 PSIG | kPa kg/cm² | PSIG | kPa kg/cm² | | | | | | | |
| 16 | DES TEMP | 750 °F | °C | °F | °C | | | | | | | |
| 17 | MAT TUBES | 5Cr ½ Mo | | | | | | | | | | |
| 18 | TYPE | VERTICAL CYLINDRICAL | | | | | | | | | | |
| 19 | | | | | | | | | | | | |
| 20 | PREHEATER ☐ ECONOMIZER ☐ | | | | ERECT. WT. | | TONS | | | | | |
| 21 | BA- | | | | | | | | | | | |
| 22 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | | |
| 23 | MM Btu/h | | | | | | | | | | | |
| 24 | kW | | | | | | | | | | | |
| 25 | DES PRESS | PSIG | kPa kg/cm² | PSIG | kPa kg/cm² | | | | | | | |
| 26 | DES TEMP | °F | °C | °F | °C | | | | | | | |
| 27 | MAT TUBES | | | | | | | | | | | |
| 28 | TYPE | | | | | | | | | | | |
| 29 | | | | | | | | | | | | |
| 30 | PREHEATER ☐ ECONOMIZER ☐ | | | | ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2/15/89
REV. 1
JOB EST NO. 5571
ACCT RA

A127 1091 2 REV 2

F-4

AREA 100

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA-101 PREFLASH TOWER | 1 | | | | | | |
| 2 | 3'-0" ϕ 5'-0" ID 55'-0" TT TK SKIRT HT | | 11000 LBS | 2- | 22 000 | | | |
| 3 | m ☐ mm ☐ (3'-0" = 39' + 15' = 5'-0") | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 550 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS TRAYS - INSTALLED SHOP ☐ FIELD ☒ 18 VALVE TRAYS | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 11 | DA 102 ATMOSPHERIC TOWER | 1 | | | | | | |
| 12 | 3'-0" ID 53'-0" TT TK SKIRT HT | | 11000 LBS | 3- | 33 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS + 11/13Cr 6' BELT CLAD ☒ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS (2D MISSECTION) 75 PSIG DES TEMP 460 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS - INSTALLED SHOP ☐ FIELD ☒ 20 VALVE TRAYS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 21 | DA-103 VACUUM TOWER | 1 | | | | | | |
| 22 | 3'-6" ID 20'-0" TT TK SKIRT HT | | 7000 LBS | 3- | 25 000 | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CS + 11/13 CLAD ☒ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS 75 PSIG & FULL VACUUM PSIG DES TEMP 800 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS' TRAYS - INSTALLED SHOP ☐ FIELD ☒ GRID (GLITSCH) | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT Amoco/POE-GREAT PLAINS GASIF. PLANT | PROD FACT | | LOC M H | | BY GS | JOB EST NO. 5571 | ACCT DA |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 2/16/89 | | |
| PROJECT JET FUEL FROM COAD DERIVED LIQUIDS | WAGE RATE | | LAB COST | | REV 2 | | |

F-5

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB 101 PREFLASH TOWER TRAYS | | | | | 1 | | | | | | |
| 2 | TYPE | DIA | DIA m \| \|mm \| \| | MAT | NO PASSES | | | | | | | | |
| 3 | VALVE (18) | 9'-0" | | 410 SS | ONE | | | 300 | 5 400 | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | OTHER INTERNALS | | | | | | | | | | | |
| 10 | | | | | ERECT WT | | TONS | | | | | |
| 11 | DB 102 ATMOSPHERIC TOWER TRAYS | | | | | 1 | | | | | | |
| 12 | TYPE | DIA | DIA m \| \|mm \| \| | MAT | NO PASSES | | | | | | | | |
| 13 | VALVE (20) | 3'-0" | | 410 SS | TWO | | | 300 | 6 000 | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | OTHER INTERNALS | | | | | | | | | | | |
| 20 | | | | | ERECT WT | | TONS | | | | | |
| 21 | DB 103 VACUUM TOWER PACKING | | | | | | | | | | | |
| 22 | TYPE | DIA | DIA m \| \|mm \| \| | MAT | NO PASSES | 1 | | | | | | | |
| 23 | GLITSCHGRID (9'-0") | 3' 6" | | 410 SS | - | | 83 FT² | 40 | 3 300 | | | |
| 24 | | | | | | | +2 | 400 | 800 | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | OTHER INTERNALS SUPPORT, DISTRIBUTOR | | | | | | | | | | | |
| 30 | | | | | ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT AMOCO/DOE GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC MH
LAB COST

BY GS
DATE 2/15/89
REV 1

JOB NO 5571
EST
ACCT DB

AREA 100

LUMMUS Bloomfield

## ESTIMATE WORKSHEET

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS. | STD. LABOR MH UNIT | STD. LABOR MH TOTAL (1) | LOCATION LABOR COST (1) x (2) x (3) | UNIT COST | MATERIAL COST | SUB-CONTRACT COST | TOTAL COST M + L + S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DC - 101, 102 & 103 HYDROTREATING REACTOR | 3 | No. | | | | | | | |
| 2 | 6'-0" ID 30'-0" T/T tk SKIRT HT | 140,000 | lbs. ea. | | | | | 700,000 | | |
| 3 | | | | | | | | X3 | | |
| 4 | MAT'L 2¼Cr-1Mo CLAD SS (347 or 304) CA | | | | | | | 2,100,000 | | |
| 5 | DES PRESS 2500 PSIG DES TEMP 890 °F | | | | | | | | | |
| 6 | X-RAY X STRESS REL X FAB SHOP/FIELD | | | | | | | | | |
| 7 | HORIZONTAL VERTICAL X | | | | | | | | | |
| 8 | INTERNALS | | | | | | | | | |
| 9 | LC-FINER TYPE REACTOR | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | INSUL - YES/NO ERECT WT - | | tons ea | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | DC | | No. | | | | | | | |
| 16 | ID T/T tk SKIRT HT | | lbs. ea. | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | MAT'L CLAD CA | | | | | | | | | |
| 19 | DES PRESS PSIG DES TEMP °F | | | | | | | | | |
| 20 | X-RAY STRESS REL FAB SHOP/FIELD | | | | | | | | | |
| 21 | HORIZONTAL VERTICAL | | | | | | | | | |
| 22 | INTERNALS | | | | | | | | | |
| 23 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | INSUL - YES/NO ERECT WT - | | tons ea | | | | | | | |
| 27 | | | | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT DC | | | | | | | | | |
| 31 | CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | | BY GS | JOB EST. NO. 5571 | ACCT DC | | | |
| 32 | LOCATION BEULAH, NORTH DAKOTA | | LOCATION MH | | DATE 2/15/89 | | | | | |
| 33 | PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | | WAGE RATE (3) $/MH | | REV. 1 | | | | | |

A122 0576-5

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA. 101 HVGO CONDENSER/REW EXCHANGER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE Double Pipe | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 80 /SERV | | 80 SQ FT | | 5 000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 75 PSIG / kPa kg/cm² 800 PSIG / kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 625 °F / °C 550 °F / °C | | | | | | | |
| 9 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA. 102 LVGO CONDENSER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE Double Pipe | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 100 /SERV | | 100 SQ FT | | 5 000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 75 PSIG / kPa kg/cm² 150 PSIG / kPa kg/cm² | | | | | | | |
| 18 | DES TEMP 500 °F / °C 150 °F / °C | | | | | | | |
| 19 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA. 103 HOT IP SEP. VAPOR/STEAM GENERATOR | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE AKU | | | | | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 850 /SERV | | 850 SQ FT | 25 | 21 000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. 1/8" / mm TUBE SIDE C.A. 1/8" / mm | | | | | | | |
| 26 | MAT CS SS | | | | | | | |
| 27 | DES PRESS 800 PSIG / kPa kg/cm² 950 PSIG / kPa kg/cm² | | | | | | | |
| 28 | DES TEMP 650 °F / °C 650 °F / °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2/24/89
REV 2

JOB NO. EST 5571
ACCT EA

A122 10M 6 REV 2

F-8

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | | | | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EA. 104 HOT L P VAPOR / BFW EXCHANGER | | | | 1 | | | | | | |
| 2 | SIZE-IN. D/L | mm D/L | TYPE AEU | | | | | | | | |
| 3 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 220 | /SERV | | 220 SQ FT | 50 | 11 000 | | | |
| 4 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 5 | | SHELL SIDE C.A. 1/8" mm | | TUBE SIDE C.A. 1/8" mm | | | | | | | |
| 6 | MAT | CS | | CS | | | | | | | |
| 7 | DES PRESS | 800 PSIG / kPa kg/cm² | | 450 PSIG / kPa kg/cm² | | | | | | | |
| 8 | DES TEMP | 550 °F / °C | | 650 °F / °C | | | | | | | |
| 9 | TUBES: DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ____ INSUL ☒ | | | ERECT WT | | TONS EA | | | | | |
| 11 | EA. 105 ATM. TOWER REBOILER | | | | 1 | | | | | | |
| 12 | SIZE-IN. D/L | mm D/L | TYPE AEU | | | | | | | | |
| 13 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 500 | /SERV | | 500 SQ FT | 30 | 15 000 | | | |
| 14 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 15 | | SHELL SIDE C.A. / mm | | TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT | CS | | CS | | | | | | | |
| 17 | DES PRESS | 75 PSIG / kPa kg/cm² | | 700 PSIG / kPa kg/cm² | | | | | | | |
| 18 | DES TEMP | 460 °F / °C | | 650 °F / °C | | | | | | | |
| 19 | TUBES: DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ____ INSUL ☒ | | | ERECT. WT | | TONS EA | | | | | |
| 21 | EA. 106 ATM. TOWER CONDENSER | | | | 1 | | | | | | |
| 22 | SIZE-IN. D/L | mm D/L | TYPE AEU | | | | | | | | |
| 23 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 350 | /SERV | | 350 SQ FT | 25 | 9 000 | | | |
| 24 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 25 | | SHELL SIDE C.A. / mm | | TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT | CS | | CS | | | | | | | |
| 27 | DES PRESS | 75 PSIG / kPa kg/cm² | | 150 PSIG / kPa kg/cm² | | | | | | | |
| 28 | DES TEMP | 250 °F / °C | | 150 °F / °C | | | | | | | |
| 29 | TUBES DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO. TUBES ____ INSUL ☐ | | | ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL SERIAL LIQUIDS

PROD FACT
WAGE RATE
LOC M H
LAB COST

BY GS
DATE 2/21/89
REV 1

JOB NO. 5571
EST
ACCT
EA

A122 1/91 REV 2

F-9

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | | | | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EA. 107 FUEL GAS COOLER | | | | 1 | | | | | | |
| 2 | SIZE-IN. D/L | mm D/L | TYPE DOUBLE PIPE | | | | | | | | |
| 3 | NO SHELL/SERV. | SQ FT/SHELL | TOTAL SQ FT 100 | /SERV | | 100 SQ FT | | 5 000 | | | |
| 4 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 5 | | SHELL SIDE C.A. / mm | TUBE SIDE C.A. / mm | | | | | | | | |
| 6 | MAT | CS | CS | | | | | | | | |
| 7 | DES PRESS | 750 PSIG / kPa kg/cm² | 150 PSIG / kPa kg/cm² | | | | | | | | |
| 8 | DES TEMP | 300 °F / °C | 150 °F / °C | | | | | | | | |
| 9 | TUBES: DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ | INSUL ☒ | | ERECT. WT | | TONS EA | | | | | |
| 11 | EA. 108 RECYCLE COMPRESSOR CIRCULATION COOLER | | | | 1 | | | | | | |
| 12 | SIZE-IN. D/L | mm D/L | TYPE AEU | | | | | | | | |
| 13 | NO SHELL/SERV. | SQ FT/SHELL | TOTAL SQ FT 320 | /SERV | | 320 SQ FT | 40 | 13 000 | | | |
| 14 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 15 | | SHELL SIDE C.A. 1/8" / mm | TUBE SIDE C.A. 1/8" / mm | | | | | | | | |
| 16 | MAT | CS | CS | | | | | | | | |
| 17 | DES PRESS | 150 PSIG / kPa kg/cm² | 2500 PSIG / kPa kg/cm² | | | | | | | | |
| 18 | DES TEMP | 150 °F / °C | 320 °F / °C | | | | | | | | |
| 19 | TUBES: DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ | INSUL ☐ | | ERECT. WT | | TONS EA | | | | | |
| 21 | EA. | | | | | | | | | | |
| 22 | SIZE-IN. D/L | mm D/L | TYPE | | | | | | | | |
| 23 | NO SHELL/SERV. | SQ FT/SHELL | TOTAL SQ FT | /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | $m^2$ | | | | | |
| 25 | | SHELL SIDE C.A. / mm | TUBE SIDE C.A. / mm | | | | | | | | |
| 26 | MAT | | | | | | | | | | |
| 27 | DES PRESS | PSIG / kPa kg/cm² | PSIG / kPa kg/cm² | | | | | | | | |
| 28 | DES TEMP | °F / °C | °F / °C | | | | | | | | |
| 29 | TUBES: DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO. TUBES ☐ | INSUL ☐ | | ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC M H.
LAB COST
BY GS
DATE 2-21-89
REV 2
JOB EST NO. 5571
ACCT EA

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EC 101 RECYCLE GAS COOLER | 1 | | | | | | |
| 2 | TOTAL BARE SURF FINNED 2800 SQ FT EA | | 2800 SQ FT | 35 | 98 000 | | | |
| 3 | TOTAL BARE SURF FINNED m²EA | | m² | | | | | |
| 4 | TUBE MAT CS DIA IN LENGTH NO BUNDLES | | | | | | | |
| 5 | mm LENGTH NO ROWS 6 | | | | | | | |
| 6 | DES PRESS 450 PSIG DES TEMP 350 °F TOTAL HP 40 | | | | | | | |
| 7 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 8 | NO. FANS TWO EA / HP 20 kW | | | | | | | |
| 9 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 10 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EC 102 PREFLASH TOWER CONDENSER | 1 | | | | | | |
| 12 | TOTAL BARE SURF FINNED 720 SQ FT EA | | 720 SQ FT | 25 | 18 000 | | | |
| 13 | TOTAL BARE SURF FINNED m²EA | | m² | | | | | |
| 14 | TUBE MAT DIA IN LENGTH NO BUNDLES | | | | | | | |
| 15 | mm LENGTH NO ROWS 6 | | | | | | | |
| 16 | DES PRESS 75 PSIG DES TEMP 380 °F TOTAL HP 10 | | | | | | | |
| 17 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 18 | NO FANS ONE EA / HP 10 kW | | | | | | | |
| 19 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 20 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EC | | | | | | | |
| 22 | TOTAL BARE SURF FINNED SQ FT EA | | SQ FT | | | | | |
| 23 | TOTAL BARE SURF FINNED m²EA | | m² | | | | | |
| 24 | TUBE MAT DIA IN LENGTH NO BUNDLES | | | | | | | |
| 25 | mm LENGTH NO ROWS | | | | | | | |
| 26 | DES PRESS PSIG DES TEMP °F TOTAL HP | | | | | | | |
| 27 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 28 | NO. FANS EA / HP kW | | | | | | | |
| 29 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 30 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT Amoco/Dole - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2-21-89
REV 2

JOB EST NO. 5571
ACCT EC

A122-001 / REV. 3

F-11

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-101 FEED SURGE DRUM | 1 | | | | | | |
| 2 | 5'-6" ID 20'-6" TT TK SKIRT HT | | 9000 LBS | 2 | 18 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C S CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 300 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA-102 HOT HP SEPARATOR | 1 | | | | | | |
| 12 | 3'-0" ID 10'-6" TT TK SKIRT HT | | 20,000 LBS | 3.5 | 70 000 | | | |
| 13 | m ☐ mm ☐ (CLADDING 18-8 SS) | | | | | | | |
| 14 | MAT 2¼Cr-1 Mo CLAD ☒ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS 2500 PSIG DES TEMP 800 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 21 | FA-103 HOT LP SEPARATOR | 1 | | | | | | |
| 22 | 3'-6" ID 9'-0" TT TK SKIRT HT | | 5000 LBS | 5 | 25 000 | | | |
| 23 | m ☐ mm ☐ (CLADDING: 18-8 SS) | | | | | | | |
| 24 | MAT 1¼Cr ½ Mo CLAD ☒ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS 450 PSIG DES TEMP 800 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2/21/89
REV 2

JOB EST NO. 5571
ACCT FA

A122 1051 B REV. 2

F-12

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-104 INTERM. LP SEPARATOR | 1 | | | | | | |
| 2 | 3'-6" ID 11'-0" TT TK SKIRT HT | | 6000 LBS | 3⁻ | 18 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS (SR) CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 5 | DES PRESS 450 PSIG DES TEMP 600 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA-105 COLD LP SEPARATOR | 1 | | | | | | |
| 12 | 6'-0" ID 18'-0" TT TK SKIRT HT | | 25000 LBS | 1.5⁻ | 38 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS (SR) CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 15 | DES PRESS 450 PSIG DES TEMP 200 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS MIST ELIMINATOR, VORTEX BREAKER | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 21 | FA-106 HVGO ACCUMULATOR | 1 | | | | | | |
| 22 | 2'-6" ID 8'-0" TT TK SKIRT HT | | 1500 LBS | 3⁻ | 4500 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 25 | DES PRESS 75 ¢ FV PSIG DES TEMP 625 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS VORTEX BREAKER | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC M H. | BY GS | JOB NO. EST 5571 | ACCT FA
WAGE RATE | LAB COST | DATE 3/21/89 | REV 2

A122 1081 8 REV 2

AREA 100

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-107 LVGO ACCUMULATOR | 1 | | | | | | |
| 2 | 2L6" ID 8'-0" TT TK SKIRT HT | | 1500 LBS | 3 | 4500 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 75 & FV PSIG DES TEMP 500 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA-108 VACUUM HOTWELL | 1 | | | | | | |
| 12 | 3'-6" ID 12'-0" TT TK SKIRT HT | | 7000 LBS | 3 | 21000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS 75 & FV PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: BAFFLE, VORTEX BREAKER, BAROMETRIC | | | | | | | |
| 19 | LEGS | | | | | | | |
| 20 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA-109 ATM. TOWER SURGE DRUM | 1 | | | | | | |
| 22 | 5'-0" ID 12'-0" TT TK SKIRT HT | | 4000 LBS | 3 | 12000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 25 | DES PRESS 75 PSIG DES TEMP 300 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY GS
DATE 2/21/89
REV. 1

JOB EST NO. 5571
ACCT FA

A122 1081-8 REV. 2

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AREA 100

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 110 ATM. TOWER OVH'D ACCUMULATOR | 1 | | | | | | |
| 2 | 2'-6" ID 8'-0" TT TK SKIRT HT | | 1500 LBS | 4¢ | 4500 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG / kPa kg/cm² DES TEMP 250 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS VORTEX BREAKER, WATER POT | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA 111 WATER WASH SURGE DRUM | 1 | | | | | | |
| 12 | 4'-6" ID 11'-0" TT TK SKIRT HT | | 900 LBS | 2¢ | 1800 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS 150 PSIG / kPa kg/cm² DES TEMP 400 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA 112 WATER SEAL POT | 1 | | | | | | |
| 22 | 24" OD 5'-0" TT TK SKIRT HT | | 1000 LBS | 4¢ | 4000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 25 | DES PRESS 75 PSIG / kPa kg/cm² DES TEMP 750 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☒ SHPERE ☐ ERECT. WT | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC M.H. | BY GS | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB. COST | DATE 2/21/89
REV. 1

A122 10R1 R REV. 2

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AREA 100

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 113 WATER COLLECTION POT | 1 | | | | | | |
| 2 | 18" OD 3'-0" TT TK SKIRT HT | | 1000 LBS | 4/ | 4 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 300 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA 114 FUEL GAS K.O. DRUM | 1 | | | | | | |
| 12 | 2'-6" ID 8'-0" TT TK SKIRT HT | | 2000 LBS | 4/ | 8 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 15 | DES PRESS 950 PSIG DES TEMP 150 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: MIST ELIMINATOR | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA 115 RECYCLE GAS K.O. DRUM | 1 | | | | | | |
| 22 | 2'-6" ID 8'-0" TT TK SKIRT HT | | 1500 LBS | 4/ | 4 500 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" mm | | | | | | | |
| 25 | DES PRESS 450 PSIG DES TEMP 150 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: MIST ELIMINATOR | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☒ SHPERE ☐ ERECT. WT | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2/21/80
REV. 1

JOB EST NO. 5571
ACCT FA

A122 1081-8 REV. 2

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- 116 PREFLASH TOWER OVERHEAD DRUM | 1 | | | | | | |
| 2 | 3'-6" ID 9'-0" TT TK SKIRT HT | | 3000 LBS | 4- | 12 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 300 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA- | | | | | | | |
| 12 | ID TT TK SKIRT HT | | LBS | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA- | | | | | | | |
| 22 | ID TT TK SKIRT HT | | LBS | | | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☐ SHPERE ☐ ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY GS | JOB EST NO 5571 | ACCT FA
WAGE RATE | LAB. COST | DATE 3/6/89 | REV 1

A122 1081 B REV. 2

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AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 101 A/S FEED | 2 | | | | | | |
| 2 | GPM 110 SUCT PSIG DISCH PSI TEMP 150 °F | | | | 150 000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR ΔP FT 2525 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER CS 216 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ MULTISTAGE kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 102 A/S LIQUID QUENCH | 2 | | | | | | |
| 12 | GPM 23 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 70 000 | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR ΔP FT 2135 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 80 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ MULTISTAGE kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 103 A/S HVGO | 2 | | | | | | |
| 22 | GPM 10 SUCT PSIG DISCH PSI TEMP 400 °F | | | | 15 000 | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR ΔP FT 100 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS 3 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY GS
DATE 2/21/89
REV. 1

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 104 A/S LVGO | 2 | | | 15 000 | | | |
| 2 | GPM 5 SUCT PSIG DISCH PSI TEMP 120 °F | | | | | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 100 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER CS 1.5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 105 SLOP OIL | 1 | | | 15 000 | | | |
| 12 | GPM 0.2 SUCT PSIG DISCH PSI TEMP 120 °F | | | | | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 70 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 0.9 HP | | | | | | | |
| 17 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 106 S/S SOUR WATER | 2 | | | 15 000 | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP 120 °F | | | | | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT 100 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS 1.5 HP | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC. M.H
LAB COST

BY GS
DATE 2/24/89
REV. 1
JOB NO. EST 5571
ACCT GA

A122 0482 10 REV. 3

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AREA 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 107 AS ATM. TOWER OVH'D | 2 | | | | | | |
| 2 | GPM 10 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 15 000 | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 100 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT. CASE C5 IMPELLER C5 3 HP. | | | | | | | |
| 7 | DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] kW | | | | | | | |
| 8 | TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ] | | | | | | | |
| 9 | MECH. SEAL [ ] | | | | | | | |
| 10 | INSUL [ ] ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA- 108 AS VAC. TOWER BOTTOMS | 2 | | | | | | |
| 12 | GPM 3 SUCT PSIG DISCH PSI TEMP 600 °F | | | | 30 000 | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 80 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT. CASE 11-13 Cr IMPELLER 11-13 Cr 1 HP. | | | | | | | |
| 17 | DRIVE EM – [ ] TURB [ ] DIESEL [ ] OTHER [X] SLURRY kW | | | | | | | |
| 18 | TYPE CENT – [ ] RECIP [X] PROP [ ] OTHERS [ ] API [ ] ANSI [ ] | | | | | | | |
| 19 | MECH. SEAL [ ] | | | | | | | |
| 20 | INSUL [X] ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA- 109, 110 & 111 REACTOR RECYCLE (3 OPER.) | 3 | | | | | | |
| 22 | GPM 2800 SUCT PSIG DISCH PSI TEMP 850 °F | | | | 500 000 | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT 20 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT. CASE S5 IMPELLER S5 50 HP (EACH) | | | | | | | |
| 27 | DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] kW | | | | | | | |
| 28 | TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ] | | | | | | | |
| 29 | MECH. SEAL [X] TUNGSTEN CARB. — SPECIAL VERTICAL | | | | | | | |
| 30 | INSUL [ ] ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT HYDROCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY GS | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 2/2/79 | REV. — | GA

A122 0482-10 REV. 3

AREA 100

**LUMMUS** — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 112 A/S WASH WATER | 2 | | | | | | |
| 2 | GPM 42 SUCT PSIG DISCH PSI TEMP 210 °F | | | | 20 000 | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 350 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER CS 18 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 113 A/S HDS FEED | 2 | | | | | | |
| 12 | GPM 137 SUCT PSIG DISCH PSI TEMP 410 °F | | | | 20 000 | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 8 HP | | | | | | | |
| 17 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA- 114 A/S FRESH FEED | 2 | | | | | | |
| 22 | GPM 110 SUCT PSIG DISCH 100 PSI TEMP 150 °F | | | | 20 000 | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS 11 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL LIQUIFIED LIQUIDS

PROD FACT | LOC. M H | BY GS | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB COST | DATE 2/21/89 | REV 1

A122 0482-10 REV. 3

A...A 100

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 115 A/S PREFLASH TOWER OVERHEAD | 2 | | | | | | |
| 2 | GPM 35 SUCT PSIG DISCH PSI TEMP 200 °F | | | | 15 000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 60 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CS # HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA- | | | | | | | |
| 12 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT. CASE IMPELLER HP | | | | | | | |
| 17 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA- | | | | | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE IMPELLER HP | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULA, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY GS | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 3-6-89 | GA
REV. 1

A122 0482-10 REV 3

F-22

AREA 100

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GB- 101 A/S RECYCLE COMPRESSOR PACKAGE | 2 | | | | | | |
| 2 | CAP. SCFM 7624 STM PSIG/kPa kg/cm² P2/P1 2 (PER STAGE) | | | | 1,400,000 | | | |
| 3 | MAT'L HANDLED ~ 97% $H_2$ ~ 3% $CH_4$ 2.1 MW | | | | | | | |
| 4 | SUCT 295 PSIA/kPa kg/cm² TEMP 105 °F °C | | | | | | | |
| 5 | DISCH 2300 PSIA/kPa kg/cm² Cp/Cv 1.397 STGS 3 | | | | | | | |
| 6 | MAT. CASE CS IMPELLER CS VOLTS | | | | | | | |
| 7 | DRIVER-EM ☐ TURB ☐ DIESEL ☐ 1805 BHP/kW | | | | | | | |
| 8 | INCL: GEAR ☐ LUBE & SEAL ☒ INTERCOOLER ☒ COND ☒ # 3 STAGE UNITS | | | | | | | |
| 9 | TYPE: CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. COMPR + DRIVE | | TONS | | | | | |
| 11 | GB- 102 A/S FUEL GAS COMPRESSOR | 2 | | | | | | |
| 12 | CAP. SCFM 12 667 STM PSIG/kPa kg/cm² P2/P1 2.85 | | | | 300,000 | | | |
| 13 | MAT'L HANDLED FUEL GAS 18.6 MW | | | | | | | |
| 14 | SUCT 15.7 PSIA/kPa kg/cm² TEMP 110 °F °C | | | | | | | |
| 15 | DISCH 44.7 PSIA/kPa kg/cm² Cp/Cv 1.25 STGS | | | | | | | |
| 16 | MAT. CASE CS IMPELLER CS VOLTS | | | | | | | |
| 17 | DRIVER EM ☐ TURB ☐ DIESEL ☐ 120 BHP/kW | | | | | | | |
| 18 | INCL: GEAR ☐ LUBE & SEAL ☒ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 19 | TYPE: CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. COMPR. + DRIVE | | TONS | | | | | |
| 21 | GB- | | | | | | | |
| 22 | CAP. SCFM STM PSIG/kPa kg/cm² P2/P1 | | | | | | | |
| 23 | MAT'L HANDLED MW | | | | | | | |
| 24 | SUCT PSIA/kPa kg/cm² TEMP °F °C | | | | | | | |
| 25 | DISCH PSIA/kPa kg/cm² Cp/Cv STGS | | | | | | | |
| 26 | MAT. CASE IMPELLER VOLTS kW | | | | | | | |
| 27 | DRIVER EM ☐ TURB ☐ DIESEL ☐ BHP/kW | | | | | | | |
| 28 | INCL: GEAR ☐ LUBE & SEAL ☐ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 29 | TYPE: CENT ☐ RECIP ☐ ROTARY ☐ SCREW ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. COMPR + DRIVE | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT | PROD FACT | | LOC M H | | BY GS | JOB EST NO. 5571 |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 2/21/89 | ACCT GB |
| PROJECT JET FUEL FROM COAL DERIVED LIQUID | WAGE RATE | | LAB COST | | REV 2 | |

A122 1081 11 REV 2

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | PA-101 | 1 | | | | | | |
| 2 | VACUUM EJECTOR PACKAGE | | | | | | | |
| 3 | PROVIDE A MULTISTAGE (TWO OR THREE) | | | | | | | |
| 4 | VACUUM SYSTEM TO EVACUATE CONTINUOUS | | | | | | | |
| 5 | OVERHEAD STREAM FROM VACUUM TOWER | | | | 25,000 | | | |
| 6 | DA-101. VENDOR TO SUPPLY EJECTORS | | | | | | | |
| 7 | INTER & AFTER CONDENSERS AS WELL AS | | | | | | | |
| 8 | INLET AND ISOLATING STEAM VALVES | | | | | | | |
| 9 | WHOLE SYSTEM TO BE LOCATED IN STEEL STRUCTURE | | | | | | | |
| 10 | LOAD: | | | | | | | |
| 11 | NON-CONDENSIBLE AND CONDENSIBLE | | | | | | | |
| 12 | GASES 68 #/HR MW = 32 | | | | | | | |
| 13 | ESTM. AIR LEAKAGE 6 #/HR | | | | | | | |
| 14 | ESTIMATED DISCH. PRESSURE : 2 PSIG | | | | | | | |
| 15 | SUCTION PRESSURE : 0.5 PSIA | | | | | | | |
| 16 | SYSTEM WILL DISCHARGE THROUGH | | | | | | | |
| 17 | BAROMETRIC LEGS INTO VACUUM | | | | | | | |
| 18 | HOTWELL (NOT PART OF PACKAGE) | | | | | | | |
| 19 | INLET (SUCTION) TEMP.: 100 °F | | | | | | | |
| 20 | MOTIVE STEAM PRESSURE | | | | | | | |
| 21 | MP SAT'D: 100 PSIG @ 337 °F | | | | | | | |
| 22 | COOLING WATER: 82 °F INLET | | | | | | | |
| 23 | | | | | | | | |
| 24 | PA-102 A/S | 2 | | | | | | |
| 25 | FLAME ARRESTOR. PROVIDE TWO | | | | 5,000 | | | |
| 26 | (ONE OPERATING, ONE SPARE) | | | | | | 1 | |
| 27 | CAPACITY: MAX: 20 #/HR MW ≈ 29 | | | | | | | |
| 28 | PRESSURE DROP: MAX 2 IN (WATER) | | | | | | | |
| 29 | PA-103 | | | | | | | |
| 30 | CORROSION INHIBITOR PACKAGE (STD.) | 1 | | | 15,000 | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT SCT FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M H. | WAGE RATE | LAB COST

BY GS
DATE 2/23/09
REV 1

JOB EST NO. 5571

ACCT

AREA 100

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | PA-104 PSA UNIT | 1 | | | | | | INC |
| 2 | | | | | 4,000,000 | | | 1,500,000 |
| 3 | PROVIDE ONE FULLY INSTRUMENTED | | | | | | | |
| 4 | AND PIPED (EXCLUDING OFFGAS SURGE DRUM) | | | | | | | |
| 5 | SYSTEM FOR THE FOLLOWING GAS | | | | | | | |
| 6 | LOAD: | | | | | | | |
| 7 | FLOW: 7,736,000 SCFD | | | | | | | |
| 8 | MOL WT: 2.72 | | | | | | | |
| 9 | PRESSURE: 310 PSIG | | | | | | | |
| 10 | TEMPERATURE: 110 °F | | | | | | | |
| 11 | | | | | | | | |
| 12 | GAS COMPOSITION — MOL% | | | | | | | |
| 13 | $H_2O$ — 0.42 | | | | | | | |
| 14 | $H_2$ — 95.87 | | | | | | | |
| 15 | $C_1$ — 1.94 | | | | | | | |
| 16 | $C_2$ — 0.76 | | | | | | | |
| 17 | $C_3$ — 0.37 | | | | | | | |
| 18 | $C_4$ — 0.17 | | | | | | | |
| 19 | $C_5^+$ — 0.47 | | | | | | | |
| 20 | 100.00 | | | | | | | |
| 21 | | | | | | | | |
| 22 | PRODUCT GAS: 99.9+ $H_2$ (MIN.) | | | | | | | |
| 23 | EXPECTED $H_2$ RECOVERY: 86% (MIN.) | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC M H | WAGE RATE | LAB COST

BY GS | DATE 2/23/89 | REV 2

JOB NO EST 5571 | ACCT

AREA 200

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89 03:36 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 2 | $370 | 60% | $222 |
| TOWERS | 3 | $81 | 110% | $89 |
| INTERNALS | | $19 | | |
| REACTORS | 1 | $900 | 70% | $630 |
| EXCHANGERS | 10 | $376 | 90% | $338 |
| AIR COOLERS | 2 | $88 | 90% | $79 |
| VESSELS | 9 | $266 | 100% | $266 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 12 | $315 | 100% | $315 |
| COMPRESSORS | 6 | $5,100 | 60% | $3,060 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 45 | $7,515 | | $5,000 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $7,515 | |
| COMMODITIES | $5,000 | |
| LABOR | $3,751 | (10% EQUIP,60% COMM) |
| INDIRECTS | $3,751 | (100% LABOR) |
| ENGINEERING | $2,700 | (1000/PC X $60) |
| SUBTOTAL | $22,717 | |
| CONTINGENCY | $4,543 | (20%) |
| TOTAL | $27,261 | |
| PSA | $7,500 | PSA 5MM X 1.5 TIC |
| TOTAL | $34,761 | |

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BA- 201 HDS FEED HEATER ✓ | | | | 1 | | | 70 000 | | | |
| 2 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | |
| 3 | MM Btu/h | | | 1.60 | | | | | | | |
| 4 | kW | | | | | | | | | | |
| 5 | DES PRESS | 2900 PSIG / kPa kg/cm² | | PSIG / kPa kg/cm² | | | | | | | |
| 6 | DES TEMP | 800 °F / (FLUID) °C | | °F / °C | | | | | | | |
| 7 | MAT TUBES | 5Cr - ½ Mo | | | | | | | | | |
| 8 | TYPE | CYL. VERTICAL | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT WT | | TONS | | | | | |
| 11 | BA- 202 JPB TOWER FEED HEATER ✓ | | | | 1 | | | 300 000 | | | |
| 12 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | |
| 13 | MM Btu/h | 24.00 | 1.00 (a) | 25.00 | | | | | | | |
| 14 | kW | | | | | | | | | | |
| 15 | DES PRESS | 150 PSIG / kPa kg/cm² | | 150 PSIG / kPa kg/cm² | | | | | | | |
| 16 | DES TEMP | 750 °F / (FLUID) °C | | 600 °F / °C | | | | | | | |
| 17 | MAT TUBES | 5Cr - ½ Mo | | CS FOR STEAM COIL | | | | | | | |
| 18 | TYPE | CYL. VERTICAL | | | | | | | | | |
| 19 | (a) STEAM SUPERHEATING | | | | | | | | | | |
| 20 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT. WT. | | TONS | | | | | |
| 21 | BA- | | | | | | | | | | |
| 22 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | |
| 23 | MM Btu/h | | | | | | | | | | |
| 24 | kW | | | | | | | | | | |
| 25 | DES PRESS | PSIG / kPa kg/cm² | | PSIG / kPa kg/cm² | | | | | | | |
| 26 | DES TEMP | °F / °C | | °F / °C | | | | | | | |
| 27 | MAT TUBES | | | | | | | | | | |
| 28 | TYPE | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | |

CLIENT Amoco / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | WAGE RATE | LOC M H. | LAB COST

BY HHH
DATE FEB 1979
REV

JOB EST NO. 5571
ACCT
BA

F-27

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA 201 JPB TOWER ✓ | 1 | | | | | | |
| 2 | 7'-6" ID 50'-0" TT TK 25' SKIRT HT | | 33000 LBS | 17¢ | 56 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☑ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 730 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS TRAYS-INSTALLED SHOP ☑ FIELD ☐ 20 VALVE TRAYS | | 700 | | 14 000 | | | |
| 9 | 410 SS | | | | | | | |
| 10 | INSUL ☑ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 11 | DA 202 JPB PRODUCT STRIPPER ✓ | 1 | | | | | | |
| 12 | 3'-0" ID 20'-0" TT TK 25' SKIRT HT | | 7000 LBS | 22¢ | 15 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 75 PSIG DES TEMP 500 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS-INSTALLED SHOP ☑ FIELD ☐ 6 VALVE TRAYS | | 300 | | 1 800 | | | |
| 19 | VORTEX BREAKER 410 SS | | | | | | | |
| 20 | INSUL ☑ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 21 | DA 203 NAPHTHA STABILISER ✓ | 1 | | | | | | |
| 22 | 2'-6" ID 25'-0" TT TK MIN. SHIRT HT | | 5000 LBS | 25¢ | 10 000 | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ 1/8" CA / mm | | | | | | | |
| 25 | DES PRESS 150 PSIG DES TEMP 450 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS TRAYS INSTALLED SHOP ☐ FIELD ☐ 10 VALVE TRAYS | | 300 | | 3 000 | | | |
| 29 | 410 SS | | | | | | | |
| 30 | INSUL ☑ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT FT FUEL FROM COAL DEMO

PROD FACT | WAGE RATE | LOC M H | LAB COST

BY HHK | DATE FEB 1989 | REV 0 | JOB NO. EST 5571 | ACCT DA

F-28

AREA 200

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DC 201 HDS REACTOR ✓ | 1 | 260,000 | 3.15 | 900,000 | | | |
| 2 | 6'-0" ID 30'-0" TT TK MIN SKIRT HT | | | | | | | |
| 3 | m [ ] mm [ ] | | | | | | | |
| 4 | MAT 2¼Cr - 1 Mo CLAD [ ] LINING [ ] CA / mm | | | | | | | |
| 5 | DES PRESS 2600 PSIG DES TEMP 830 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | X RAY SPOT [ ] 100% [✓] STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 8 | INTERNALS TWO(2) - CATALYST BEDS : 8'-0" AND 16'-0" HIGH WITH | | | | | | | |
| 9 | CATALYST SUPPORT PLATES ; HOLDOWN PLATES | | | | | | | |
| 10 | INSUL [✓] HORIZ [ ] VERT [✓] ERECT WT | | TONS | | | | | |
| 11 | DC | | | | | | | |
| 12 | ID TT TK SKIRT HT | | | | | | | |
| 13 | m [ ] mm [ ] | | | | | | | |
| 14 | MAT CLAD [ ] LINING [ ] CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY SPOT [ ] 100% [ ] STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL [ ] HORIZ [ ] VERT [ ] ERECT WT | | TONS | | | | | |
| 21 | DC | | | | | | | |
| 22 | ID TT TK SKIRT HT | | | | | | | |
| 23 | m [ ] mm [ ] | | | | | | | |
| 24 | MAT CLAD [ ] LINING [ ] CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY SPOT [ ] 100% [ ] STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL [ ] HORIZ [ ] VERT [ ] ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT

PROD FACT
EST HRS
LOC MH
LAB COST

BY HHK
DATE 12/5/79

JOB EST NO 5571
ACCT DC

AREA 200

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA. 201 HDS REACTOR FEED/EFFLUENT EXCHANGER ✓ | 1 | | | | | | |
| 2 | SIZE IN. D/L mm D/L TYPE DES OR EQUIV. | | | | | | | |
| 3 | NO SHELL/SERV. ONE SQ FT/SHELL 1850 TOTAL SQ FT 1850 /SERV | | 1850 SQ FT | 125 | 231 200 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A / mm | | | | | | | |
| 6 | MAT 2¼ Cr - ½ Mo 2¼ Cr - ½ Mo | | | | | | | |
| 7 | DES PRESS 2900 PSIG / kPa kg/cm² 2600 PSIG / kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 750 °F / °C 800 °F / °C | | | | | | | |
| 9 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EA. 202 JPB TOWER FEED/BOTTOMS EXCHANGER ✓ | 1 | | | | | | |
| 12 | SIZE IN D/L mm D/L TYPE AEU | | | | | | | |
| 13 | NO SHELL/SERV ONE SQ FT/SHELL 240 TOTAL SQ FT 240 /SERV | | 240 SQ FT | 35 | 8 400 | | | |
| 14 | NO SHELL/SERV $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 16 | SHELL SIDE C.A. 1/8" / mm TUBE SIDE C.A 1/8" / mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 150 PSIG / kPa kg/cm² 175 PSIG / kPa kg/cm² | | | | | | | |
| 18 | DES TEMP 300 °F / °C 650 °F / °C | | | | | | | |
| 19 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EA. 203 JPB TOWER OVERHEAD CONDENSER ✓ | 1 | | | | | | |
| 22 | SIZE IN D/L mm D/L TYPE AEU | | | | | | | |
| 23 | NO SHELL/SERV. ONE SQ FT/SHELL 5250 TOTAL SQ FT 5250 /SERV | | 5250 SQ FT | 10 | 53 000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. 1/8" / mm TUBE SIDE C.A 1/8" / mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 75 PSIG / kPa kg/cm² 150 PSIG / kPa kg/cm² | | | | | | | |
| 28 | DES TEMP 400 °F / °C 300 °F / °C | | | | | | | |
| 29 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/ODE - GREAT PLAINS GASIFIE PLANT — PROD FACT — LOC M H — BY GS HHK — JOB EST NO. 5571 — ACCT

LOCATION BEULAH, NORTH DAKOTA — LAB COST — DATE FEB. 1981 — EA

AREA 200

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 204 NAP. STABILISER FEED/BOTTOMS EXCHANGER ✓ | 1 | | | | | | |
| 2 | SIZE IN D/L mm D/L TYPE AES or DP | | | | | | | |
| 3 | NO SHELL/SERV. ONE SQ FT/SHELL 100 TOTAL SQ FT 100 /SERV | | 100 SQ FT | | 5000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. 1/8" mm TUBE SIDE C.A 1/8" mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 175 PSIG kPa kg/cm² 150 PSIG kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 300 °F °C 400 °F °C | | | | | | | |
| 9 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EA 205 NAP. STABILISER REBOILER ✓ | 1 | | | | | | |
| 12 | SIZE IN D/L mm D/L TYPE AKT | | | | | | | |
| 13 | NO SHELL/SERV. ONE SQ FT/SHELL 370 TOTAL SQ FT 370 /SERV | | 370 SQ FT | 25 | 9000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. 1/8" mm TUBE SIDE C.A 1/8" mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 150 PSIG kPa kg/cm² 175 PSIG kPa kg/cm² | | | | | | | |
| 18 | DES TEMP 400 °F °C 500 °F °C | | | | | | | |
| 19 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS WELDED ☐ NO TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EA 206 NAP. STABILISER O/H CONDENSER ✓ | 1 | | | | | | |
| 22 | SIZE IN D/L mm D/L TYPE AEU or DP | | | | | | | |
| 23 | NO SHELL/SERV. ONE SQ FT/SHELL 170 TOTAL SQ FT 170 /SERV | | 170 SQ FT | 40 | 6000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. 1/8" mm TUBE SIDE C.A 1/8" mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 150 PSIG kPa kg/cm² 150 PSIG kPa kg/cm² | | | | | | | |
| 28 | DES TEMP 300 °F °C 300 °F °C | | | | | | | |
| 29 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT MOCO LODE - GREAT PLAINS GASIFIER PLANT
LOCATION BEULAH, NORTH DAKOTA
PROD FACT
WAGE RATE
LOC MH
LAB COST
BY GS MHK
DATE FEB 1979
REV 0
JOB EST NO. 5571
ACCT
EA

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 207 STABILISED NAPHTHA COOLER ✓ | 1 | | | | | | |
| 2 | SIZE-IN D/L mm D/L TYPE AEU OR DP | | | | | | | |
| 3 | NO SHELL/SERV. 300 SQ FT/SHELL 300 TOTAL SQ FT 300 /SERV | | 300 SQ FT | 30 | 9 000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. 1/8" mm — TUBE SIDE C.A. 1/8" mm | | | | | | | |
| 6 | MAT | | | | | | | |
| 7 | DES PRESS 150 PSIG kPa kg/cm² — 150 PSIG kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 300 °F °C — 300 °F °C | | | | | | | |
| 9 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EA 208 MAKE-UP H₂ COMPRESSOR CIRCULATION COOLER ✓ | 1 | | | | | | |
| 12 | SIZE-IN D/L mm D/L TYPE AET OR DP | | | | | | | |
| 13 | NO SHELL/SERV ONE SQ FT/SHELL 300 TOTAL SQ FT 300 /SERV | | 300 SQ FT | 45 | 13 500 | | | |
| 14 | NO SHELL/SERV $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. 1/8" mm — TUBE SIDE C.A. 1/8" mm | | | | | | | |
| 16 | MAT CS — CS | | | | | | | |
| 17 | DES PRESS 150 PSIG kPa kg/cm² — 2900 PSIG kPa kg/cm² | | | | | | | |
| 18 | DES TEMP 150 °F °C — 300 °F °C | | | | | | | |
| 19 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS WELDED ☐ NO TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EA 209 TAIL GAS COMPRESSOR AFTERCOOLER ✓ | 1 | | | | | | |
| 22 | SIZE-IN D/L mm D/L TYPE AEU | | | | | | | |
| 23 | NO SHELL/SERV ONE SQ FT/SHELL 1210 TOTAL SQ FT 1210 /SERV | | 1210 SQ FT | 30 | 36 300 | | | |
| 24 | NO SHELL/SERV $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. 1/8" mm — TUBE SIDE C.A. 1/8" mm | | | | | | | |
| 26 | MAT CS — CS | | | | | | | |
| 27 | DES PRESS 150 PSIG kPa kg/cm² — 410 PSIG kPa kg/cm² | | | | | | | |
| 28 | DES TEMP 10 °F °C — 300 °F °C | | | | | | | |
| 29 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIFICATION PLANT
LOCATION BEULAH, NORTH DAKOTA
PROD FACT
WAGE RATE
LOC M H
LAB COST
BY GS
DATE
REV
JOB NO. EST 5571
ACCT EA

F-32

AREA 200

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 2/0 HDS RECYCLE GAS COMPRESSOR CIRCULATION COOLER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE DOUBLE PIPE | | | | | | | |
| 3 | NO SHELL/SERV. ONE SQ FT/SHELL 100 TOTAL SQ FT 100 /SERV | | 100 SQ FT | | 5000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. 1/8" mm TUBE SIDE C.A 1/8" mm | | | | | | | |
| 6 | MAT | | | | | | | |
| 7 | DES PRESS 150 PSIG kg/cm² 2600 PSIG kg/cm² | | | | | | | |
| 8 | DES TEMP 150 °F °C 300 °F °C | | | | | | | |
| 9 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EA | | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE | | | | | | | |
| 13 | NO SHELL/SERV. SQ FT/SHELL TOTAL SQ FT /SERV | | SQ FT | | | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. TUBE SIDE C.A. mm | | | | | | | |
| 16 | MAT | | | | | | | |
| 17 | DES PRESS PSIG kg/cm² PSIG kg/cm² | | | | | | | |
| 18 | DES TEMP °F °C °F °C | | | | | | | |
| 19 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EA | | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE | | | | | | | |
| 23 | NO SHELL/SERV SQ FT/SHELL TOTAL SQ FT /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 26 | MAT | | | | | | | |
| 27 | DES PRESS PSIG kg/cm² PSIG kg/cm² | | | | | | | |
| 28 | DES TEMP °F °C °F °C | | | | | | | |
| 29 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT ARMOCO/DOE GREAT PLAINS GASIFICATION PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT ESTIMATE FROM CMI MCILVAIN/HUMAC

PROD FACT
WAGE RATE
LOC M H
LAB COST
BY GS
DATE 4.10.80
JOB NO EST 5571
ACCT
EA

AREA 200

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EC 201 HDS REACTOR EFFLUENT CONDENSER ✓ | 1 | | | | | | |
| 2 | TOTAL BARE SURF 1700 FINNED / SQ FT EA | | 1700 SQ FT | 40 | 68 000 | | | |
| 3 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 4 | TUBE MAT CS WITH DIA IN LENGTH NO BUNDLES | | | | | | | |
| 5 | 10 BWG TUBES mm LENGTH NO ROWS 6 | | | | | | | |
| 6 | DES PRESS 2600 PSIG DES TEMP 475 °F TOTAL HP 25 | | | | | | | |
| 7 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 8 | NO. FANS ONE EA / HP 25 / kW | | | | | | | |
| 9 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 10 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EC 202 JP8 PRODUCT COOLER ✓ | 1 | | | | | | |
| 12 | TOTAL BARE SURF 800 FINNED / SQ FT EA | | 800 SQ FT | 25 | 20 000 | | | |
| 13 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 14 | TUBE MAT CS DIA IN LENGTH NO BUNDLES | | | | | | | |
| 15 | mm LENGTH NO ROWS 6 | | | | | | | |
| 16 | DES PRESS 175 PSIG DES TEMP °F TOTAL HP 10 | | | | | | | |
| 17 | DES PRESS 450 kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 18 | NO. FANS ONE EA / HP 10 / kW | | | | | | | |
| 19 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. | | TONS EA | | | | | |
| 21 | EC | | | | | | | |
| 22 | TOTAL BARE SURF FINNED / SQ FT EA | | SQ FT | | | | | |
| 23 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 24 | TUBE MAT DIA IN. LENGTH NO. BUNDLES | | | | | | | |
| 25 | mm LENGTH NO. ROWS | | | | | | | |
| 26 | DES PRESS PSIG DES TEMP °F TOTAL HP | | | | | | | |
| 27 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 28 | NO. FANS EA / HP / kW | | | | | | | |
| 29 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 30 | INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| CLIENT Amoco/PDC - GREAT PLAINS GASIF. PLANT | PROD FACT | LOC. M.H. | BY HHK | JOB EST NO. 5571 | ACCT EC |
| LOCATION BEULAH, NORTH DAKOTA | | | DATE FEB. 1981 | | |
| PROJECT JET FUEL FROM COAL VIA SYN LIQUIDS | WAGE RATE | LAB. COST | REV 0 | | |

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 201 HDS FEED SURGE DRUM ✓ | 1 | | | | | | |
| 2 | 5'-0" ID 25'-0" TT TK 30' SKIRT HT | | 13000 LBS | 1.75 | 23 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 500 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☑ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA 202 HDS REACTOR EFFLUENT HP/LT SEPARATOR ✓ | 1 | | | | | | |
| 12 | 5'-0" ID 15'-0" TT TK MIN. SKIRT HT | | 7/000 LBS | 2- | 140 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 2600 PSIG DES TEMP 500 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS BAFFLES ; VORTEX BREAKERS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 21 | FA 203 HDS RECYCLE GAS COMPR. SUCT. K.O. DRUM ✓ | 1 | | | | | | |
| 22 | 2'-0" ID 5'-0" TT TK MIN. SKIRT HT | | 6500 LBS | 4- | 26 000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 2600 PSIG DES TEMP 500 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS NONE | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☑ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC MH | BY HHK | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB COST | DATE FEB. 1979 | REV 0

AREA 200

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- 204 JPB TOWER FEED SURGE DRUM ✓ | 1 | | | | | | |
| 2 | 5'-0" ID 20'-0" TT TK MIN. SKIRT HT | | 21000 LBS | 1.54 | 32 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 500 PSIG DES TEMP 300 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: IMPINGEMENT BAFFLE ; VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☑ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA- 205 JPB TOWER OVERHEAD REFLUX/PROD. DRUM ✓ | 1 | | | | | | |
| 12 | 5'-0" ID 20'-0" TT TK 30' SKIRT HT | | 13000 LBS | 1.77 | 23 000 | | | |
| 13 | m ☐ mm ☐ WITH 2' Φ x 5' T/T WATER BOOT | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 75 PSIG DES TEMP 300 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: VORTEX BREAKER | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☑ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA- 206 NAP. STABILISER OVERHEAD REFLUX DRUM ✓ | 1 | | | | | | |
| 22 | 2'-0" ID 5'-0" TT TK 15' SKIRT HT | | 1500 LBS | 4- | 4 500 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 150 PSIG DES TEMP 300 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS VORTEX BREAKER | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY HHK | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB COST | DATE DEC. 1979 | REV 0

A122 1081 A REV. 2

F-36

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- | | | | | | | |
| 2 | ID TT TK SKIRT HT | | LBS | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 5 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA- | | | | | | | |
| 12 | ID TT TK SKIRT HT | | LBS | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 21 | FA- 207 PSA UNIT FEEDGAS K.O. DRUM ✓ | 1 | | | | | | |
| 22 | 3'-6" ID 8'-0" TT TK MIN. SKIRT HT | | 4000 LBS | 2 | 8 000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 375 PSIG DES TEMP 300 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☑ SHPERE ☐ ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC M H. | BY HHK | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB COST | DATE 11-8-1981 | REV 0

A122 1081-B REV 2

F-37

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 208 MAKE-UP $H_2$ COMPRESSOR SUCTION K.O. DRUM | 1 | | | | | | |
| 2 | 2'-0" ID 5'-0" TT TK SKIRT HT | | 1500 LBS | 4- | 4500 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 375 PSIG DES TEMP 300 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS MIST ELIMINATOR (411 SS) | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA 209 PSA TAIL GAS K.O. DRUM | 1 | | | | | | |
| 12 | 2'-0" ID 5'-0" TT TK SKIRT HT | | 1500 LBS | 4- | 4500 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS 410 PSIG DES TEMP 300 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 21 | FA | | | | | | | |
| 22 | ID TT TK SKIRT HT | | LBS | | | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☐ SHPERE ☐ ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT AMOCO/DOE GREAT PLAINS GASIFICATION PLANT | PROD FACT | | LOC M.H. | | BY GS | JOB EST NO. 5571 | ACCT FA |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 4-19-89 | | |
| PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE | | LAB COST | | REV 1 | | |

Area 200

CE LUMMUS Bloomfield

## ESTIMATE WORKSHEET

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS | STD LABOR MH UNIT | STD LABOR MH TOTAL (1) | LOCATION LABOR COST (1) x (2) x (3) | UNIT COST | MATERIAL COST | SUB CONTRACT COST | TOTAL COST M + L + S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GA - 201 A/S HDS FEED PUMP AND SPARE ✓ | TWO | No | | | | | | | |
| 2 | GPM 135 SUCT 50 PSIG DISCH 2550 PSIG | | | | | | | | | |
| 3 | TEMP 409 °F SpGr .73 ΔP 7911 FT 2500 PSI | | | | | | | 200 000 | | |
| 4 | MAT'L CASE CI IMPELLER 13 Cr | | | | | | | | | |
| 5 | TYPE CENTRIF. MFR STGS | | | | | | | | | |
| 6 | DRIVER MOTOR 290 HP RPM | | No | | | | | | | |
| 7 | PULSATION DAMPENERS AT SUCTION AND | | | | | | | | | |
| 8 | DISCHARGE | | | | | | | | | |
| 9 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | tons ea | | | | | | | |
| 10 | GA - 202 A/S IPB TOWER O/H REFLUX/PROD. PUMP & S ✓ | TWO | No | | | | | | | |
| 11 | GPM 260 SUCT 15 PSIG DISCH 155 PSIG | | | | | | | 20 000 | | |
| 12 | TEMP 120 °F SpGr .71 ΔP 456 FT 140 PSI | | | | | | | | | |
| 13 | MAT'L CASE CI IMPELLER CS | | | | | | | | | |
| 14 | TYPE CENTRIF MFR STGS | | | | | | | | | |
| 15 | DRIVER MOTOR 31 HP RPM | | No | | | | | | | |
| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | tons ea | | | | | | | |
| 19 | GA - 203 A/S IPB PRODUCT PUMP & SPARE ✓ | TWO | No | | | | | | | |
| 20 | GPM 125 SUCT 16 PSIG DISCH 96 PSIG | | | | | | | 15 000 | | |
| 21 | TEMP 435 °F SpGr .84 ΔP 220 FT 80 PSI | | | | | | | | | |
| 22 | MAT'L CASE CI IMPELLER CS | | | | | | | | | |
| 23 | TYPE CENTRIF MFR STGS | | | | | | | | | |
| 24 | DRIVER MOTOR 10 HP RPM | | No | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | | | | | | | | | | |
| 27 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | tons ea | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT GA | | | | | | | | | |

31 CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT
32 LOCATION BEULAH, NORTH DAKOTA
33 PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

TYPE OF ESTIMATE

PRODUCTIVITY FACTOR (2)
LOCATION MH
WAGE RATE (3) $/MH

BY HHK
DATE FEB. 1979
REV 0

JOB EST NO 5571
ACCT GA

Area 200

ELUMMUS Bloomfield

## ESTIMATE WORKSHEET

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS | STD LABOR MH UNIT | STD LABOR MH TOTAL (1) | LOCATION LABOR COST (1) × (2) = (3) | UNIT COST | MATERIAL COST | SUB CONTRACT COST | TOTAL COST M + L + S/C T |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GA - 204 A/S IPB TOWER BOTTS. PUMP & SPARE ✓ | TWO | No | | | | | 15000 | | |
| 2 | GPM 65 SUCT 20 PSIG DISCH 105 PSIG | | | | | | | | | |
| 3 | TEMP 590 °F SpGr .91 ΔP 216 FT 85 PSI | | | | | | | | | |
| 4 | MAT'L CASE CS IMPELLER 13 Cr | | | | | | | | | |
| 5 | TYPE CENTRIF. MFR STGS | | | | | | | | | |
| 6 | DRIVER MOTOR 6 HP RPM | | No | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | 1000 Lb | | | | | | | |
| 10 | GA - 205 A/S NAP. STABILISER REFLUX PUMPS ✓ | TWO | No | | | | | 15000 | | |
| 11 | GPM 10 SUCT 110 PSIG DISCH 170 PSIG | | | | | | | | | |
| 12 | TEMP 180 °F SpGr .5 ΔP 277 FT 60 PSI | | | | | | | | | |
| 13 | MAT'L CASE CI IMPELLER CS | | | | | | | | | |
| 14 | TYPE CENTRIF. MFR STGS | | | | | | | | | |
| 15 | DRIVER MOTOR 3/4 HP RPM | | No | | | | | | | |
| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | 1000 Lb | | | | | | | |
| 19 | GA - 206 A/S HP WASH WATER PUMP & SPARE ✓ | TWO | No | | | | | 50000 | | |
| 20 | GPM 10 SUCT 350 PSIG DISCH 2450 PSIG | | | | | | | | | |
| 21 | TEMP 100 °F SpGr 1.0 ΔP 4851 FT 2100 PSI | | | | | | | | | |
| 22 | MAT'L CASE CS IMPELLER CS | | | | | | | | | |
| 23 | TYPE RECIP. MFR STGS | | | | | | | | | |
| 24 | DRIVER MOTOR 25 HP RPM | | No | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | | | | | | | | | | |
| 27 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | 1000 Lb | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT GA | | | | | | | | | |
| 31 | CLIENT DOE/AMOCO - GREAT PLAINS BASIF PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | | | BY HHK | | JOB EST NO 5571 | | ACCT |
| 32 | LOCATION BEULAH, NORTH DAKOTA | | LOCATION MH | | | DATE FEB. 1989 | | | | GA |
| 33 | PROJECT SYT FUEL FROM COAL DEPOT REQUIR. | | WAGE RATE (3) $/MH | | | REV 0 | | | | |

F-40

AREA

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GB 201 A/S $H_2S$ RECYCLE GAS COMPRESSOR | 2 | | | | | | |
| 2 | CAP. SCFM 3820 STM PSIG/kPa kg/cm² P2/P1 1.085 | | | | 300,000 | | | |
| 3 | MAT'L HANDLED $H_2$ RICH GAS 3.56 MW | | | | | | | |
| 4 | SUCT 2350 PSIA/kPa kg/cm² TEMP 120 °F °C | | | | | | | |
| 5 | DISCH 2550 PSIA/kPa kg/cm² Cp/Cv 1.37 STGS ONE | | | | | | | |
| 6 | MAT CASE 0.2 MOL% $H_2S$, 96% $H_2$ IMPELLER VOLTS | | | | | | | |
| 7 | DRIVER-EM ☒ TURB ☐ DIESEL ☐ 86 BHP/kW | | | | | | | |
| 8 | INCL: GEAR ☐ LUBE & SEAL ☐ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 9 | TYPE: CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT COMPR + DRIVE | | TONS | | | | | |
| 11 | GB 202 A/S MAKE-UP $H_2$ COMPRESSOR PACKAGE | 2 | | | | | | |
| 12 | CAP SCFM 10766 STM PSIG/kPa kg/cm² P2/P1 1.95/STAGE | | | | 2,000,000 | | | |
| 13 | MAT'L HANDLED 2.02 MW | | | | | | | |
| 14 | SUCT 340 PSIA/kPa kg/cm² TEMP 65 °F °C | | | | | | | |
| 15 | DISCH 2520 PSIA/kPa kg/cm² Cp/Cv 1.4 STGS 3 | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS VOLTS | | | | | | | |
| 17 | DRIVER EM ☒ TURB ☐ DIESEL ☐ 2870 BHP/kW | | | | | | | |
| 18 | INCL GEAR ☐ LUBE & SEAL ☒ INTERCOOLER ☒ COND ☒ | | | | | | | |
| 19 | TYPE CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT WT COMPR + DRIVE | | TONS | | | | | |
| 21 | GB 203 A/S PSA TAIL GAS COMPRESSOR PACKAGE | 2 | | | | | | |
| 22 | CAP SCFM 9080 STM PSIG/kPa kg/cm² P2/P1 2.66/STAGE | | | | 2,800,000 | | | |
| 23 | MAT'L HANDLED 19.25 MW | | | | | | | |
| 24 | SUCT 20 PSIA/kPa kg/cm² TEMP 110 °F °C | | | | | | | |
| 25 | DISCH 375 PSIA/kPa kg/cm² Cp/Cv 1.25 STGS 3 | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS VOLTS kW | | | | | | | |
| 27 | DRIVER EM ☒ TURB ☐ DIESEL ☐ 4000 BHP/kW | | | | | | | |
| 28 | INCL GEAR ☐ LUBE & SEAL ☒ INTERCOOLER ☒ COND ☒ | | | | | | | |
| 29 | TYPE CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT WT COMPR + DRIVE | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT DOE/AMOCO GREAT PLAINS GASIFICATION PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC MH
LAB COST

BY GS
DATE 4-19-89
REV 1
JOB EST NO 5571
ACCT GB

AREA 200

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | PA-201 PSA PACKAGE UNIT TO PURIFY THE MAKE UP $H_2$ | 1 | | | | | | |
| 2 | | | | | | | | TIC |
| 3 | Feedgas conditions | | | | 5,000,000 | | | 7,500,000 |
| 4 | $H_2$ 63.19 mol% | | | | | | | |
| 5 | CO 18.61 " | | | | | | | |
| 6 | $CO_2$ 1.48 " | | | | | | | |
| 7 | $CH_4$ 16.31 " | | | | | | | |
| 8 | $C_2H_6$ .31 " | | | | | | | |
| 9 | $N_2$/Argon .19 " | | | | | | | |
| 10 | $H_2O$ .01 " | | | | | | | |
| 11 | 100.00 | | | | | | | |
| 12 | COS, $H_2S$, $CS_2$ 100 ppmv (max) | | | | | | | |
| 13 | Temp. @ B.L 65 °F | | | | | | | |
| 14 | Pressure @ B.L 350 psig | | | | | | | |
| 15 | Capacity - Normal 28.1 MMSCFD | | | | | | | |
| 16 | Design 33 " | | | | | | | |
| 17 | Product hydrogen | | | | | | | |
| 18 | Hydrogen purity : 99.9 plus mol% | | | | | | | |
| 19 | Hydrogen recovery : 75% (min.) | | | | | | | |
| 20 | | | | | | | | |
| 21 | Scope of supply | | | | | | | |
| 22 | From outlet of feedgas flow control valve | | | | | | | |
| 23 | To product hydrogen and tail gas without any | | | | | | | |
| 24 | compression. | | | | | | | |
| 25 | Utility available | | | | | | | |
| 26 | Electric power; nitrogen. | | | | | | 1 | |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT [illegible]
PROD. FACT
WAGE RATE
LOC. M H.
LAB COST
BY HHK
DATE FEB. 1989
REV 0
JOB EST NO 5571
ACCT PA

AREA 300

LCI PROJECT 5571
TASK 4.0

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Apr-89 03:05 PM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | 1 | $60 | 100% | $60 |
| TOWERS | | | 110% | |
| INTERNALS | | | | |
| REACTORS | 1 | $560 | 70% | $392 |
| EXCHANGERS | 2 | $85 | 100% | $85 |
| AIR COOLERS | 1 | $70 | 100% | $70 |
| VESSELS | 3 | $85 | 120% | $102 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 2 | $100 | 100% | $100 |
| COMPRESSORS | 2 | $400 | 80% | $320 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 12 | $1,360 | | $1,129 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,360 | |
| COMMODITIES | $1,129 | |
| LABOR | $813 | (10% EQUIP,60% COMM) |
| INDIRECTS | $813 | (100% LABOR) |
| ENGINEERING | $720 | (1000/PC X $60) |
| SUBTOTAL | $4,836 | |
| CONTINGENCY | $967 | (20%) |
| TOTAL | $5,803 | |

AREA 300

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BA- BA-301 HCR FEED HEATER ✓ | | | | 1 | | | | | | |
| 2 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | 60,000 | | | |
| 3 | MM Btu/h | 1.30 | | 1.30 | | | | | | | |
| 4 | kW | | | | | | | | | | |
| 5 | DES PRESS | 2250 PSIG / kPa kg/cm² | | PSIG / kPa kg/cm² | | | | | | | |
| 6 | DES TEMP | 750 °F / °C | | °F / °C | | | | | | | |
| 7 | MAT TUBES | 5 Cr - ½ Mo | | | | | | | | | |
| 8 | TYPE | CYL. VERTICAL | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT WT. | | TONS | | | | | |
| 11 | BA- | | | | | | | | | | |
| 12 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | |
| 13 | MM Btu/h | | | | | | | | | | |
| 14 | kW | | | | | | | | | | |
| 15 | DES PRESS | PSIG / kPa kg/cm² | | PSIG / kPa kg/cm² | | | | | | | |
| 16 | DES TEMP | °F / °C | | °F / °C | | | | | | | |
| 17 | MAT TUBES | | | | | | | | | | |
| 18 | TYPE | | | | | | | | | | |
| 19 | | | | | | | | | | | |
| 20 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT. WT. | | TONS | | | | | |
| 21 | BA- | | | | | | | | | | |
| 22 | ABSORBED DUTY: | RAD | CONV | TOTAL | | | | | | | |
| 23 | MM Btu/h | | | | | | | | | | |
| 24 | kW | | | | | | | | | | |
| 25 | DES PRESS | PSIG / kPa kg/cm² | | PSIG / kPa kg/cm² | | | | | | | |
| 26 | DES TEMP | °F / °C | | °F / °C | | | | | | | |
| 27 | MAT TUBES | | | | | | | | | | |
| 28 | TYPE | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | PREHEATER ☐ ECONOMIZER ☐ | | | ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CLIENT | AMOCO / DOE - GREAT PLAINS GASIF. PLANT | PROD. FACT | | LOC. M.H. | | BY HHK |
| LOCATION | BEULAH, NORTH DAKOTA | | | | | DATE FEB 1983 |
| PROJECT | JET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE | | LAB. COST | | REV. 0 |

JOB EST NO. 5571 — ACCT BA

F-44

AREA 300

**LUMMUS** — **ESTIMATE SHEET** — **THE LUMMUS COMPANY** Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DC 301 HCR REACTOR ✓ | 1 | | | | | | |
| 2 | 6'-0" ID 38'-0" TT TK MIN SKIRT HT | | 140,000# | 4 - | 560000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT 2¼ Cr - 1 Mo CLAD [ ] LINING [ ] CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 1900 PSIG DES TEMP 750 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 8 | INTERNALS CATALYST BED SUPPORT, HOLDOWN PLATES, GAS | | | | | | | |
| 9 | DISTRIBUTORS; 5 CATALYST BEDS (3'-6", 7'6" EACH). | | | | | | | |
| 10 | INSUL [✓] HORIZ [ ] VERT [✓] ERECT WT | | TONS | | | | | |
| 11 | DC | | | | | | | |
| 12 | ID TT TK SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CLAD [ ] LINING [ ] CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY SPOT ☐ 100% ☐ STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL [ ] HORIZ [ ] VERT [ ] ERECT WT | | TONS | | | | | |
| 21 | DC | | | | | | | |
| 22 | ID TT TK SKIRT HT | | | | | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CLAD [ ] LINING [ ] CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY SPOT ☐ 100% ☐ STRESS REL [ ] FAB SHOP [ ] FIELD [ ] | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL [ ] HORIZ [ ] VERT [ ] ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT DOE/AMOCO - GREAT PLAINS GASIF PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT
WAGE RATE
LOC MH
LAB COST

BY HHK
DATE FEB 1989
REV

JOB EST NO 5571
ACCT DC

AREA 300

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | | | | | | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EA 301 HCR REACTOR FEED/EFFLUENT EXCHANGER ✓ | | | | | | 1 | | | | | | |
| 2 | SIZE IN. D/L | mm D/L | | TYPE DES OR EQUIV. | | | | | | | | | |
| 3 | NO SHELL/SERV. ONE | SQ FT/SHELL 800 | | TOTAL SQ FT 800 | /SERV | | | 800 SQ FT | 100 | 80 000 | | | |
| 4 | NO SHELL/SERV. | $m^2$/SHELL | | TOTAL $m^2$ | /SERV | | | $m^2$ | | | | | |
| 5 | | SHELL SIDE C A 1/8" | mm | TUBE SIDE C A 1/8" | mm | | | | | | | | |
| 6 | MAT | CS - 1/2 Mo | | 2 1/4 Cr - 1/2 Mo | | | | | | | | | |
| 7 | DES PRESS | 2250 PSIG | kPa kgf/cm² | 1900 PSIG | kPa kgf/cm² | | | | | | | | |
| 8 | DES TEMP | 650 °F | °C | 750 °F | °C | | | | | | | | |
| 9 | TUBES DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | |
| 10 | TUBE ENDS WELDED ☐ NO. TUBES ☐ | INSUL ☐ | | ERECT WT | | TONS EA | | | | | | | |
| 11 | EA 302 HCR RECYCLE COMPRESSOR CIRC. COOLER | | | | | | 1 | | | | | | |
| 12 | SIZE IN. D/L | mm D/L | | TYPE DOUBLE PIPE | | | | | | | | | |
| 13 | NO SHELL/SERV. ONE | SQ FT/SHELL 180 | | TOTAL SQ FT | /SERV | | | 180 SQ FT | | 5000 | | | |
| 14 | NO SHELL/SERV. | $m^2$/SHELL | | TOTAL $m^2$ | /SERV | | | $m^2$ | | | | | |
| 15 | | SHELL SIDE C A 3/8" | mm | TUBE SIDE C A | mm | | | | | | | | |
| 16 | MAT | CS | | CS | | | | | | | | | |
| 17 | DES PRESS | 150 PSIG | kPa kgf/cm² | 1900 PSIG | kPa kgf/cm² | | | | | | | | |
| 18 | DES TEMP | 150 °F | °C | 200 °F | °C | | | | | | | | |
| 19 | TUBES DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | |
| 20 | TUBE ENDS WELDED ☐ NO TUBES ☐ | INSUL ☐ | | ERECT WT | | TONS EA | | | | | | | |
| 21 | EA | | | | | | | | | | | | |
| 22 | SIZE IN. D/L | mm D/L | | TYPE | | | | | | | | | |
| 23 | NO SHELL/SERV. | SQ FT/SHELL | | TOTAL SQ FT | /SERV | | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. | $m^2$/SHELL | | TOTAL $m^2$ | /SERV | | | $m^2$ | | | | | |
| 25 | | SHELL SIDE C A | mm | TUBE SIDE C A | mm | | | | | | | | |
| 26 | MAT | | | | | | | | | | | | |
| 27 | DES PRESS | PSIG | kPa kgf/cm² | PSIG | kPa kgf/cm² | | | | | | | | |
| 28 | DES TEMP | °F | °C | °F | °C | | | | | | | | |
| 29 | TUBES DIA | GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | |
| 30 | TUBE ENDS WELDED ☐ NO TUBES ☐ | INSUL ☐ | | ERECT WT | | TONS EA | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIFI PLANT
LOCATION BEULAH, NORTH DAKOTA
PROD FACT
WAGE RATE
LOC M H
LAB COST
BY GS HHK
DATE FEB 1979
REV
JOB EST NO. 5571
ACCT
EA

AREA 300

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EC 301 HCR REACTOR EFFLUENT CONDENSER ✓ | 1 | | | | | | |
| 2 | TOTAL BARE SURF 2000 FINNED / SQ FT EA | | SQ FT | 35 | 70 000 | | | |
| 3 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 4 | TUBE MAT CS DIA IN. LENGTH NO BUNDLES | | | | | | | |
| 5 | mm LENGTH NO ROWS 6 | | | | | | | |
| 6 | DES PRESS 1900 PSIG DES TEMP 450 °F TOTAL HP | | | | | | | |
| 7 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 8 | NO. FANS 1 EA / HP 25 / kW | | | | | | | |
| 9 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 10 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 11 | EC | | | | | | | |
| 12 | TOTAL BARE SURF FINNED / SQ FT EA | | SQ FT | | | | | |
| 13 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 14 | TUBE MAT DIA IN LENGTH NO BUNDLES | | | | | | | |
| 15 | mm LENGTH NO ROWS | | | | | | | |
| 16 | DES PRESS PSIG DES TEMP °F TOTAL HP | | | | | | | |
| 17 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 18 | NO FANS EA / HP / kW | | | | | | | |
| 19 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 20 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| 21 | EC | | | | | | | |
| 22 | TOTAL BARE SURF FINNED / SQ FT EA | | SQ FT | | | | | |
| 23 | TOTAL BARE SURF FINNED / $m^2$ EA | | $m^2$ | | | | | |
| 24 | TUBE MAT DIA IN. LENGTH NO. BUNDLES | | | | | | | |
| 25 | mm LENGTH NO. ROWS | | | | | | | |
| 26 | DES PRESS PSIG DES TEMP °F TOTAL HP | | | | | | | |
| 27 | DES PRESS kPa kg/cm² DES TEMP °C TOTAL kW | | | | | | | |
| 28 | NO. FANS EA / HP / kW | | | | | | | |
| 29 | KNOCK DOWN/PREASSEMBLED | | | | | | | |
| 30 | INSUL ☐ ERECT WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CLIENT Amoco/DOE - GREAT PLAINS GASIF. PLANT | PROD FACT | | LOC M.H. | | BY MHK | JOB EST NO. 5571 ACCT EC |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE FEB 1983 | |
| PROJECT JET FUEL FROM COAL IN SYN LIQUIDS | WAGE RATE | | LAB COST | | REV 0 | |

F-47

AREA 300

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 301 HCR FEED SURGE DRUM ✓ | 1 | | | | | | |
| 2 | 4'-0" ID 16'-0" TT TK 20' SKIRT HT | | 6000 LBS | 25% | 15 600 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 400 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA 302 HCR REACTOR EFFLUENT HP/LT SEPARATOR ✓ | 1 | | | | | | |
| 12 | 4'-0" ID 12'-0" TT TK MIN SKIRT HT | | 30000 LBS | 2% | 60 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS 1900 PSIG DES TEMP 300 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: DIVIDING BAFFLE ; VORTEX BREAKER | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA 303 HCR RECYCLE COMPRESSOR K.O. DRUM | 1 | | | | | | |
| 22 | 2'-6" ID 8'-0" TT TK SKIRT HT | | 4000 LBS | 25% | 10 000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 25 | DES PRESS 1900 PSIG DES TEMP 200 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY HHK | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB COST | DATE FEB 1981 | REV. 1

A-17-1081 B REV. 2

F-48

Area 300

**ESTIMATE WORKSHEET**

LUMMUS Bloomfield

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS | STD LABOR MH UNIT | STD LABOR MH TOTAL (1) | LOCATION LABOR COST (1) × (2) = (3) | UNIT COST | MATERIAL COST | SUB CONTRACT COST | TOTAL COST M + L + S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GA - 301 A/B HCR FEED PUMP & SPARE ✓ | 2 | No | | | | | | | |
| 2 | GPM 60 SUCT 50 PSIG DISCH 1850 PSIG | | | | | | | 100 000 | | |
| 3 | TEMP 300 °F SpGr .83 ΔP 5010 FT 1800 PSI | | | | | | | | | |
| 4 | MAT'L CASE CI IMPELLER CS | | | | | | | | | |
| 5 | TYPE CENTRIF. MFR STGS | | | | | | | | | |
| 6 | DRIVER MOTOR 105 HP RPM | | No | | | | | | | |
| 7 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | lbs ea | | | | | | | |
| 10 | GA | | No | | | | | | | |
| 11 | GPM SUCT PSIG DISCH PSIG | | | | | | | | | |
| 12 | TEMP °F SpGr ΔP FT PSI | | | | | | | | | |
| 13 | MAT'L CASE IMPELLER | | | | | | | | | |
| 14 | TYPE MFR STGS | | | | | | | | | |
| 15 | DRIVER HP RPM | | No | | | | | | | |
| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | lbs ea | | | | | | | |
| 19 | GA | | No | | | | | | | |
| 20 | GPM SUCT PSIG DISCH PSIG | | | | | | | | | |
| 21 | TEMP °F SpGr ΔP FT PSI | | | | | | | | | |
| 22 | MAT'L CASE IMPELLER | | | | | | | | | |
| 23 | TYPE MFR STGS | | | | | | | | | |
| 24 | DRIVER HP RPM | | No | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | | | | | | | | | | |
| 27 | INSUL YES/NO ERECT WT - PUMP & DRIVER | | lbs ea | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT GA | | | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 31 | CLIENT DOE/AMOCO - GREAT PLAINS GASIF. PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | BY HHK | JOB EST NO. 5571 | ACCT |
| 32 | LOCATION BEULAH, NORTH DAKOTA | | LOCATION MH | DATE FEB, 1979 | | GA |
| 33 | PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | | WAGE RATE ($/MH) | REV 0 | | |

Area 300

LUMMUS Bloomfield

## ESTIMATE WORKSHEET

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS. | STD. LABOR MH UNIT | STD. LABOR MH TOTAL (1) | LOCATION LABOR COST (1) x (2) x (3) | UNIT COST | MATERIAL COST | SUB-CONTRACT COST | TOTAL COST M + L + S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GB - 301 A/S HCR RECYCLE GAS COMPRESSOR/SPARE | 2 | No. | | | | | 400 000 | | |
| 2 | CAP. ACTUAL SUCTION CFM 182.1 | | | | | | | | | |
| 3 | MATERIAL HANDLED $H_2$-RICH GAS (90.8 MOL%) 4.10 MW | | | | | | | | | |
| 4 | SUCT. 1650 PSIA TEMP 120 °F P2/P1 | | | | | | | | | |
| 5 | DISCH. 1850 PSIA Cp/Cv 1.38 STGS ONE | | | | | | | | | |
| 6 | MAT'L: CASE IMPELLER | | | | | | | | | |
| 7 | TYPE RECIP. MFR RPM | | | | | | | | | |
| 8 | INCL: Gear Lub & Seal Intercool Cond | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | DRIVER MOTOR 344 HP RPM | | No. | | | | | | | |
| 12 | VOLTAGE STEAM-PSIG IN OUT | | | | | | | | | |
| 13 | | | | | | | | | | |
| 14 | INSUL YES/NO ERECT WT COMPR + DR - | | tons ea. | | | | | | | |
| 15 | GB | | No. | | | | | | | |
| 16 | CAP. ACTUAL SUCTION CFM | | | | | | | | | |
| 17 | MATERIAL HANDLED MW | | | | | | | | | |
| 18 | SUCT. PSIA TEMP °F P2/P1 | | | | | | | | | |
| 19 | DISCH. PSIA Cp/Cv STGS | | | | | | | | | |
| 20 | MAT'L: CASE IMPELLER | | | | | | | | | |
| 21 | TYPE MFR RPM | | | | | | | | | |
| 22 | INCL: Gear Lub & Seal Intercool Cond | | | | | | | | | |
| 23 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 25 | DRIVER HP RPM | | No. | | | | | | | |
| 26 | VOLTAGE STEAM-PSIG IN OUT | | | | | | | | | |
| 27 | | | | | | | | | | |
| 28 | INSUL YES/NO ERECT WT COMPR + DR - | | tons ea. | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT GB | | | | | | | | | |
| 31 | CLIENT DOE/AMOCO - GREAT PLAINS GASIF. PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | | | BY HHK | | JOB EST. NO. 5571 | ACCT GB | |
| 32 | LOCATION BEULAH NORTH DAKOTA | | LOCATION MH | | | DATE FEB. 1979 | | | | |
| 33 | PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | | WAGE RATE (3) $/MH | | | REV. 0 | | | | |

A122 0576 11

AREA 500

CLIENT:DOE PROJECT:5571
OCATION:BEULAH,ND.
PROJECT:JET FUEL DATE/BY: 22-Mar-89
08:27 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | | | | |
| INTERNALS | | | | |
| REACTORS | | | | |
| EXCHANGERS | | | | |
| AIR COOLERS | | | | |
| VESSELS | 4 | $105 | 120% | $126 |
| TANKS | | | | |
| FILTERS | | | | |
| PUMPS | 4 | $48 | 120% | $58 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 8 | $153 | | $184 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $153 | |
| COMMODITIES | $184 | |
| LABOR | $125 | (10% EQUIP,60% COMM) |
| INDIRECTS | $125 | (100% LABOR) |
| ENGINEERING | $480 | (1000/PC X $60) |
| SUBTOTAL | $1,068 | |
| CONTINGENCY | $214 | (20%) |
| TOTAL | $1,281 | |
| ESCALATION | $128 | 10% |
| TOTAL | $1,409 | |

CASE 1 MAXIMUM JP-4 500 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- 501 CATALYST OIL DRUM | 1 | | | | | | |
| 2 | 4'-6" ID 8'-0" TT TK SKIRT HT | | 4000 LBS | 3 | 12000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C S CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 35 PSIG DES TEMP 650 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 11 | FA- 502 CATALYST FEED HOPPER | 1 | | | 5000 | | | |
| 12 | 4'-0" ID 3'-0" TT TK SKIRT HT | | LBS | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT C S CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 35 PSIG DES TEMP 150 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: CONE BOTTOM | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA- 503 CATALYST TRANSFER VESSEL | 1 | | | | | | |
| 22 | 3'-0" ID 8'-0" TT TK 5'-0" SKIRT HT | | 17000 LBS | 4- | 68000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT 2 1/2 Cr 1 Mo CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 25 | DES PRESS 2600 PSIG DES TEMP 650 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☒ STRESS REL ☒ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ HORIZ ☐ VERT ☒ SHPERE ☐ ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY M/C. | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB. COST | DATE 11/25/87 | REV. 0

A122 10R1-8 REV. 2

CASE 1 MAXIMUM JP-4 500 AREA

**LUMMUS** ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- 504 SPENT CATALYST VESSEL | 1 | | | | | | |
| 2 | 5'-0" ID 15'-0" TT TK 30'-0" SKIRT HT | | LBS | | 20,000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C S CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS +8"WC & -2"WC VAC PSIG DES TEMP 250 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: CONE BOTTOM | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FA- | | | | | | | |
| 12 | ID TT TK SKIRT HT | | LBS | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA- | | | | | | | |
| 22 | ID TT TK SKIRT HT | | LBS | | | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☐ SHPERE ☐ ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | 105,000 | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY MLC. | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB. COST | DATE 11/25/87 | REV. 0

A122 10R1-8 REV. 2

F-53

CASE 1 MAXIMUM JP-4 500 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 501AFS CAT. TRANSFER PUMP | 2 | | | | | | |
| 2 | GPM 10 SUCT PSIG DISCH PSI TEMP 600 °F | | | | 40000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 2600 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT. CASE SS IMPELLER 25 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT PUMP & DRIVER TONS | | | | | | | |
| 11 | GA 502AFS CATALYST OIL PUMP | 2 | | | 8000 | | | |
| 12 | GPM 10 SUCT PSIG DISCH PSI TEMP 200 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 250 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT. CASE CS IMPELLER 3 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☒ ERECT. WT. PUMP & DRIVER TONS | | | | | | | |
| 21 | GA- | | | | | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT. CASE IMPELLER HP | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER TONS | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | 48000 | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY MH | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 11/25/87 | GA
REV. 0

A122 0482-10 REV. 3

# 6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

## 6.2 Naphtha Stream

### 6.2.1 AREA 600

### 6.2.2 AREA 700

AREA 600

CLIENT:DOE PROJECT:5571
LOCATION:BEULAH,ND.
PROJECT:JET FUEL DATE/BY: 22-Mar-89
08:57 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 2 | $48 | 140% | $67 |
| INTERNALS | | $8 | | |
| REACTORS | | | | |
| EXCHANGERS | 1 | $125 | 85% | $106 |
| AIR COOLERS | | | | |
| VESSELS | 9 | $123 | 100% | $123 |
| TANKS | 7 | $89 | 100% | $89 |
| FILTERS | | | | |
| PUMPS | 16 | $68 | 100% | $68 |
| COMPRESSORS | 4 | $230 | 60% | $138 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 39 | $691 | | $591 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $691 | |
| COMMODITIES | $591 | |
| LABOR | $424 | (10% EQUIP,60% COMM) |
| INDIRECTS | $424 | (100% LABOR) |
| ENGINEERING | $1,872 | (800/PC X $60) |
| SUBTOTAL | $4,002 | |
| CONTINGENCY | $800 | (20%) |
| TOTAL | $4,803 | |
| ESCALATION | $600 | 12.5% |
| TOTAL | $5,403 | |

CASE 7 MAX PROFIT 600 AREA 1)

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA 601 NAPHTHA DISTIL. COLN | 1 | | | | | | |
| 2 | 2'-6" ID 50'-0" TT TK SKIRT HT | | 2000 LBS | 3- | 21000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 75 PSIG DES TEMP 325 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS TRAYS INSTALLED SHOP ☑ FIELD ☐ | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 11 | DA 602 HDT NAPHTHA STABILIZER | 1 | | | | | | |
| 12 | 2'-6" ID 32'-0" TT TK SKIRT HT | | 2000 LBS | 9- | 21000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS 100 PSIG DES TEMP 325 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS-INSTALLED SHOP ☒ FIELD ☐ | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 21 | DA | | | | | | | |
| 22 | ID TT TK SHIRT HT | | LBS | | | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS' TRAYS-INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT Amoco/DoE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC MH | BY MC | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB COST | DATE 4 JAN 88 | DA
REV 0

F-57

CASE 7 MAX PROFIT 600 AREA (1)

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB 601 NAPHTHA DISTILL. TRAYS | | | | | | | | | | | |
| 2 | TYPE | DIA | DIA m [ ] mm [ ] | MAT. | NO. PASSES | | | | | | | |
| 3 | Valve | 2'-6" | | CS | 1 | 30 | | 150- | 4500 | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | OTHER INTERNALS | | | | | | | | | | | |
| 10 | | | | | ERECT WT | | TONS | | | | | |
| 11 | DB 602 HDT NAPHTHA STABIL. TRAYS | | | | | | | | | | | |
| 12 | TYPE | DIA | DIA m [ ] mm [ ] | MAT | NO. PASSES | | | | | | | |
| 13 | Valve | 2-6" | | CS | 1 | 18 | | 150- | 2700 | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | OTHER INTERNALS | | | | | | | | | | | |
| 20 | | | | | ERECT WT | | TONS | | | | | |
| 21 | DB | | | | | | | | | | | |
| 22 | TYPE | DIA | DIA m [ ] mm [ ] | MAT | NO. PASSES | | | | | | | |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | OTHER INTERNALS | | | | | | | | | | | |
| 30 | | | | | ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT ET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC M H. | BY MLC
WAGE RATE | LAB COST | DATE 4 JAN 88
REV 0

JOB NO. EST 5571 ACCT DB

F-58

CASE 7 MAX PROFIT

600 AREA

LUMMUS Bloomfield

## ESTIMATE WORKSHEET

| | DESCRIPTION | QUANTITY AMOUNT | QUANTITY UNIT MEAS. | STD. LABOR MH UNIT | STD. LABOR MH TOTAL (1) | LOCATION LABOR COST (1) x (2) x (3) | UNIT COST | MATERIAL COST | SUB-CONTRACT COST | TOTAL COST M + L + S/C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DC - 601 HYDROTREATER REACTOR | | No. | | | | | | | |
| 2 | 4'-0" ID 16'-0" T/T tk SKIRT HT | 23000 | lbs. ea. | | | | 5.00 | 125000 | | |
| 3 | | | | | | | | | | |
| 4 | MAT'L C-½M CLAD CA 1/4" | | | | | | | | | |
| 5 | DES PRESS 870 PSIG DES TEMP 525 °F | | | | | | | | | |
| 6 | X-RAY STRESS REL FAB SHOP/FIELD | | | | | | | | | |
| 7 | HORIZONTAL VERTICAL | | | | | | | | | |
| 8 | INTERNALS Catalyst, Bed Support | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |
| 13 | INSUL - YES/NO ERECT WT= | | tons ea. | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | DC | | No. | | | | | | | |
| 16 | ID T/T tk SKIRT HT | | lbs. ea. | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | MAT'L CLAD CA | | | | | | | | | |
| 19 | DES PRESS PSIG DES TEMP °F | | | | | | | | | |
| 20 | X-RAY STRESS REL FAB SHOP/FIELD | | | | | | | | | |
| 21 | HORIZONTAL VERTICAL | | | | | | | | | |
| 22 | INTERNALS | | | | | | | | | |
| 23 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | INSUL - YES/NO ERECT WT = | | tons ea. | | | | | | | |
| 27 | | | | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | TOTAL THIS PAGE | | | | | | | | | |
| 30 | TOTAL ACCOUNT DC | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 31 | CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | BY MC | JOB EST. NO. 5571 ACCT DC |
| 32 | LOCATION BEULAH, NORTH DAKOTA | | LOCATION MH | DATE 4 JAN 88 | |
| 33 | PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | | WAGE RATE (3) $/MH | REV. 0 | |

A122 0578-5

SE 7 MAX PROFIT 609 EA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 601 NAPHTHA DISTIL. COL'N REBOILER | 1 | | | | | | |
| 2 | SIZE-IN D/L mm D/L TYPE AEU | | | | | | | |
| 3 | NO SHELL/SERV. / SQ FT/SHELL 700 TOTAL SQ FT 700 /SERV | | / SQ FT | 18- | 13000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 85 PSIG / kPa 140 PSIG / kPa | | | | | | | |
| 8 | DES TEMP 325 °F / °C 360 °F / °C | | | | | | | |
| 9 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA 602 NAPHTHA DISTIL. COL'N. CONDENSER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 13 | NO SHELL/SERV. / SQ FT/SHELL 400 TOTAL SQ FT 400 /SERV | | SQ FT | 20- | 8000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 75 PSIG / kPa 130 PSIG / kPa | | | | | | | |
| 18 | DES TEMP 190 °F / °C 120 °F / °C | | | | | | | |
| 19 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA 603 HDT REACTOR FEED/EFFL. EXCH. | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE AEU | | | | | | | |
| 23 | NO SHELL/SERV. 2 SQ FT/SHELL 325 TOTAL SQ FT 650 /SERV | | SQ FT | 35- | 23000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT C-½Mo C-½Mo | | | | | | | |
| 27 | DES PRESS 870 PSIG / kPa 870 PSIG / kPa | | | | | | | |
| 28 | DES TEMP 525 °F / °C 475 °F / °C | | | | | | | |
| 29 | TUBES DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT — PROD. FACT — LOC. M.H. — BY M/L. — JOB EST NO. 5571 — ACCT EA

LOCATION BEULAH, NORTH DAKOTA — WAGE RATE — LAB. COST — DATE 4 JAN 88

PROJECT JET FUEL FROM COAL DERIVED LIQUIDS — REV. 0

A122 1081-6 REV. 2

F-60

C E 7 MAX PROFIT 600' EA

CE LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 604 MDT REACTOR RECYCLE GAS HEATER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE AEU | | | | | | | |
| 3 | NO SHELL/SERV. SQ FT/SHELL 2000 TOTAL SQ FT 2000 /SERV | | SQ FT | 20- | 40 000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 6 | MAT C-½Mo CS | | | | | | | |
| 7 | DES PRESS 870 PSIG kPa 635 PSIG kPa | | | | | | | |
| 8 | DES TEMP 475 °F °C 775 °F °C | | | | | | | |
| 9 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA 605 STABILIZER FEED EXCHANGER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE AEU | | | | | | | |
| 13 | NO SHELL/SERV. SQ FT/SHELL 175 TOTAL SQ FT 175 /SERV | | SQ FT | 40- | 7 000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 870 PSIG kPa 870 PSIG kPa | | | | | | | |
| 18 | DES TEMP 270 °F °C 380 °F °C | | | | | | | |
| 19 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA 606 REACTOR EFFLUENT COOLER | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE AEU | | | | | | | |
| 23 | NO SHELL/SERV. SQ FT/SHELL 350 TOTAL SQ FT 350 /SERV | | SQ FT | 25- | 9 000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 130 PSIG kPa 870 PSIG kPa | | | | | | | |
| 28 | DES TEMP 120 °F °C 250 °F °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC M.H.
LAB. COST

BY WLC.
DATE 4JAN88
REV. 0

JOB NO. EST 5571 ACCT EA

A122 1081-6 REV. 2

F-61

SE 7 MAX PROFIT 600 EA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MN UNIT | STD LABOR MN TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 607 STABILIZER FEED HEATER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE AEU | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL 550 TOTAL SQ FT 550 /SERV | | SQ FT | 18 - | 10 000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 120 PSIG / kPa kg/cm² 140 PSIG / kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 300 °F / °C 360 °F / °C | | | | | | | |
| 9 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA 608 NAPHTHA STABILIZER CONDENSER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL 350 TOTAL SQ FT 350 /SERV | | SQ FT | 20 - | 7 000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 100 PSIG / kPa kg/cm² 130 PSIG / kPa kg/cm² | | | | | | | |
| 18 | DES TEMP 220 °F / °C 120 °F / °C | | | | | | | |
| 19 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA 609 HPT NAPHTHA COOLER | | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL 200 TOTAL SQ FT 200 /SERV | | SQ FT | 30 | 6 000 | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 110 PSIG / kPa kg/cm² 130 PSIG / kPa kg/cm² | | | | | | | |
| 28 | DES TEMP 325 °F / °C 120 °F / °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY M/L.
WAGE RATE | LAB. COST | DATE 4 JAN 83 | REV. 0

JOB NO. EST 5571 ACCT EA

A172 10814 REV. 2

F-62

CASE 7 MAX PROFIT

600 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-601 CRUDE NAPHTHA FEED SURGE | 1 | | | | | | |
| 2 | 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT | | 4000 LBS | 3- | 12000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 50 PSIG DES TEMP °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: VORTEX BREAKER | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☑ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT | | TONS | | | | | |
| 11 | FA-602 DISTIL. COL'N REFLUX DRUM | 1 | | | | | | |
| 12 | 3'-0" ID 11'-0" TT TK SKIRT HT | | 4000 LBS | 3- | 12000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS 75 PSIG DES TEMP 170 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT | | TONS | | | | | |
| 21 | FA-603 HDT FEED SURGE DRUM | 1 | | | | | | |
| 22 | 4'-0" ID 8'-0" TT TK 10'-0" SKIRT HT | | 4000 LBS | 3- | 12000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 25 | DES PRESS 125 PSIG DES TEMP 325 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY WL.
DATE 11 JAN 84
REV 0

JOB EST NO. 5571 ACCT FA

A172 10R1 8 REV. 2

CASE 7 MAX PROFIT

600 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-604 MAKEUP GAS KO | 1 | | | | | | |
| 2 | 2'-0" ID 8'-0" TT TK 1111N SKIRT HT | | 3000 LBS | 3 | 9000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 400 PSIG DES TEMP 125 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: Demister | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☑ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FA-605 HT/HP SEPARATOR | | | | | | | |
| 12 | ID TT TK SKIRT HT | | LBS | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA-606 LT/HP SEPARATOR | 1 | | | | | | |
| 22 | 3'-6" ID 6'-6" TT TK MIN. SKIRT HT | | 19000 LBS | 2- | 20000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 25 | DES PRESS 870 PSIG DES TEMP 170 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: Baffle, Demister | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY MC.
WAGE RATE | LAB. COST | DATE 14JAN88 | REV. 0

JOB EST NO. 5571 | ACCT FA

A122 10R1-8 REV. 2

F-64

CASE 7 MAX PROFIT 600 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA 607 RECYCLE GAS KO | 1 | | | | | | |
| 2 | 2'-0" ID 8'-0" TT TK MIN. SKIRT HT | | 4000 LBS | 3 - | 12,000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 5 | DES PRESS 170 PSIG | | DES TEMP 170 °F | | | | | |
| 6 | DES PRESS kPa kg/cm² | | DES TEMP °C | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS Demister | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT WT. | | TONS | | | | | |
| 11 | FA 608 NAPHTHA STABIL. REFLUX | 1 | | | | | | |
| 12 | 3'-0" ID 11'-0" TT TK SKIRT HT | | 4000 LBS | 3 - | 12000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm | | | | | | | |
| 15 | DES PRESS 100 PSIG | | DES TEMP 170 °F | | | | | |
| 16 | DES PRESS kPa kg/cm² | | DES TEMP °C | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☐ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: Baffle, Boot, 1'6" ID x 2'0" TT | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA | | | | | | | |
| 22 | ID TT TK SKIRT HT | | LBS | | | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS PSIG | | DES TEMP °F | | | | | |
| 26 | DES PRESS kPa kg/cm² | | DES TEMP °C | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☐ VERT ☐ SHPERE ☐ ERECT. WT | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY MC. | JOB EST NO. 5571 | ACCT FA
WAGE RATE | LAB COST | DATE 7 JAN 88 | REV 0

A172 1081 B REV. 2

F-65

CAS 7 MAX PROFIT 600 AF

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 601A/S CRUDE NAPHTHA FEED | 2 | | | 8000 | | | |
| 2 | GPM 25 SUCT PSIG DISCH PSI TEMP 33 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR. ΔP FT 40 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER CS 1.5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 602A/S DISTIL. COL'N BOTTOMS | 2 | | | 8000 | | | |
| 12 | GPM 18 SUCT PSIG DISCH PSI TEMP 275 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR ΔP FT 30 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 1 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 603A/S DISTIL. COL'N REFLUX | 2 | | | 8000 | | | |
| 22 | GPM 45 SUCT PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT 30 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS 2 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☒ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY MLL
DATE 4 JAN 88
REV. 0

JOB EST NO. 5571 ACCT GA

A122 0482 10 REV. 3

F-66

CA 7 MAX PROFIT 600AF

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 604A/S HDT FEED | 2 | | | 12000 | | | |
| 2 | GPM 18 SUCT PSIG DISCH PSI TEMP 275°F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR ΔP FT 815 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE IMPELLER 30 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 605A/S PROCESS WATER | 2 | | | 6000 | | | |
| 12 | GPM 6 SUCT PSIG DISCH PSI TEMP 70 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR ΔP FT 710 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 10 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 606A/S HDT NAPHTHA | 2 | | | 8000 | | | |
| 22 | GPM 20 SUCT PSIG DISCH PSI TEMP 275°F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR ΔP FT 30 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CS 1 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY MLL
DATE 4 JAN 88
REV. 0

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

F-67

CA: 7 MAX PROFIT 600 AF

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 607A/S NAPHTHA STABIL. REFLUX | 2 | | | 5000 | | | |
| 2 | GPM 30 SUCT PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 30 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT. CASE CS IMPELLER CS 1.5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☑ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 608A/S SOUR WATER | 2 | | | 8000 | | | |
| 12 | GPM 1/2 SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 60 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT. CASE CS IMPELLER 12 cir 1/2 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA | | | | | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT. CASE IMPELLER HP | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY MLL DATE 4 JAN 88 REV. 0

JOB EST NO. 5571 ACCT GA

A122 0482-10 REV 3

CASE 7 MAX PROFIT 600 AREA (1)

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GB- 601A/B MAKEUP GAS COMPRESSOR | 2 | | | | | | |
| 2 | CAP. SCFM 96 STM PSIG/kPa kg/cm² P2/P1 2.47 | | | | 110 000 | | | |
| 3 | MAT'L HANDLED 99.99% $H_2$ 0.01% $C_1$ 2.02 MW | | | | | | | |
| 4 | SUCT 340 PSIA/kPa kg/cm² TEMP 70 °F °C | | | | | | | |
| 5 | DISCH 840 PSIA/kPa kg/cm² Cp/Cv 1.43 STGS 1 | | | | | | | |
| 6 | MAT. CASE CS IMPELLER VOLTS | | | | | | | |
| 7 | DRIVER-EM ☒ TURB ☐ DIESEL ☐ 20 BHP/kW | | | | | | | |
| 8 | INCL: GEAR ☒ LUBE & SEAL ☒ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 9 | TYPE CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 10 | INSUL ☒ ERECT WT. COMPR + DRIVE TONS | | | | | | | |
| 11 | GB- 602A/B RECYCLE GAS COMPRESSOR | 2 | | | 120 000 | | | |
| 12 | CAP. SCFM 1050 STM PSIG/kPa kg/cm² P2/P1 1.19 | | | | | | | |
| 13 | MAT'L HANDLED 95% $H_2$, 1% $H_2S$, 4% $C_1$-$C_4$ 4.1 MW | | | | | | | |
| 14 | SUCT 705 PSIA/kPa kg/cm² TEMP 120 °F °C | | | | | | | |
| 15 | DISCH 840 PSIA/kPa kg/cm² Cp/Cv 1.39 STGS 1 | | | | | | | |
| 16 | MAT. CASE CS IMPELLER VOLTS | | | | | | | |
| 17 | DRIVER EM ☒ TURB ☐ DIESEL ☐ 20 BHP/kW | | | | | | | |
| 18 | INCL: GEAR ☒ LUBE & SEAL ☒ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 19 | TYPE CENT ☐ RECIP ☒ ROTARY ☐ SCREW ☐ | | | | | | | |
| 20 | INSUL ☒ ERECT WT. COMPR + DRIVE TONS | | | | | | | |
| 21 | GB- | | | | | | | |
| 22 | CAP. SCFM STM PSIG/kPa kg/cm² P2/P1 | | | | | | | |
| 23 | MAT'L HANDLED MW | | | | | | | |
| 24 | SUCT PSIA/kPa kg/cm² TEMP °F °C | | | | | | | |
| 25 | DISCH PSIA/kPa kg/cm² Cp/Cv STGS | | | | | | | |
| 26 | MAT. CASE IMPELLER VOLTS kW | | | | | | | |
| 27 | DRIVER EM ☐ TURB ☐ DIESEL ☐ BHP/kW | | | | | | | |
| 28 | INCL: GEAR ☐ LUBE & SEAL ☐ INTERCOOLER ☐ COND ☐ | | | | | | | |
| 29 | TYPE CENT ☐ RECIP ☐ ROTARY ☐ SCREW ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. COMPR. + DRIVE TONS | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET INCLINATION & AI PERMEDIA

PROD FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT GB
WAGE RATE | LAB. COST | DATE 4 JAN 88
REV 0

A122 1081 11 REV 2

F-69

AREA 700

CLIENT:DOE PROJECT:5571
LOCATION:BEULAH,ND.
PROJECT:JET FUEL DATE/BY: 22-Mar-89
09:08 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 10 | $350 | 140% | $490 |
| INTERNALS | | $66 | | |
| REACTORS | | | | |
| EXCHANGERS | 20 | $113 | 100% | $113 |
| AIR COOLERS | | | | |
| VESSELS | 9 | $65 | 120% | $78 |
| TANKS | 7 | $117 | 100% | $117 |
| FILTERS | | | | |
| PUMPS | 44 | $180 | 120% | $216 |
| COMPRESSORS | | | 60% | |
| PACKAGE UNITS | 3 | $20 | 100% | $20 |
| | | | | |
| TOTAL | 93 | $911 | | $1,034 |

SUMMARY

| | | |
|---|---|---|
| EQUIPMENT | $911 | |
| COMMODITIES | $1,034 | |
| LABOR | $712 | (10% EQUIP,60% COMM) |
| INDIRECTS | $712 | (100% LABOR) |
| ENGINEERING | $4,464 | (800/PC X $60) |
| SUBTOTAL | $7,832 | |
| CONTINGENCY | $1,566 | (20%) |
| TOTAL | $9,398 | |
| ESCALATION | $940 | 10.0% |
| TOTAL | $10,338 | |

CASE 7 MAX PROFIT 700 AREA

LUMMUS

## ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA 701 EXTRACTOR COLUMN | 1 | | | | | | |
| 2 | 2'-6" ID 109'-0" TT TK 5'-0" SKIRT HT | | 18,000 LBS | 2.50 | 45 000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT. CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 150 Bottom PSIG DES TEMP 250 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 8 | INTERNALS TRAYS – INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 11 | DA 702 RAFFINATE WATER WASH COLUMN | 1 | | | | | | |
| 12 | 1'-6" ID 60'-0" TT TK 5'-0" SKIRT HT | | 6000 LBS | 4.- | 24 000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT. CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS 135 Bottom. PSIG DES TEMP 250 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS – INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☐ DA - lbs DB - lbs ERECT WT. | | TONS | | | | | |
| 21 | DA 703 STRIPPER | 1 | | | | | | |
| 22 | 2'-9" ID 83'-0" TT TK 19'-0" SHIRT HT | | 15,000 LBS | 2.50 | 38 000 | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT. CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 400 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS' TRAYS – INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ DA - lbs DB - lbs ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAD DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB COST

BY ML
DATE 12/18/87
REV. 3

JOB EST NO. 5571
ACCT DA

A122-1081-3 REV. 3

CASE 7 MAX PROFIT 700 AREA (1)

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA- 704 RECOVERY COLUMN | 1 | | | | | | |
| 2 | 3'-0" ID 112'-0" TT TK 18'-0" SKIRT HT | | 29,000 LBS | 2.50 | 58000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT. CS. CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 50 PSIG DES TEMP 400 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: TRAYS–INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ DA - lbs DB - lbs ERECT. WT | | TONS | | | | | |
| 11 | DA- 705 WATER STRIPPER | 1 | | | | | | |
| 12 | 1'-6" ID 20'-0" TT TK — SKIRT HT | | 3000 LBS | 4- | 12000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT. CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS 50 PSIG DES TEMP 310 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS–INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 19 | FLANGED BOTH ENDS, TOP MH. COVER. | | | | | | | |
| 20 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 21 | DA- 706 SOLVENT REGENERATOR | 1 | | | | | | |
| 22 | 1'-9" ID 15'-0" TT TK 6'-0" SHIRT HT | | 3000 LBS | 4- | 12000 | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT. C.S. CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 400 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS' TRAYS–INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 29 | EA-710 THRU SHELL, INLET DISTRIB, 6" VAPOR MESH. | | | | | | | |
| 30 | INSUL ☒ DA - lbs DB - lbs ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M H. | WAGE RATE | LAB. COST

BY ML
DATE 12/18/87
REV. 0

JOB EST NO. 5571
ACCT DA

A177-1081-2 REV. 2

CASE 7 MAX PROFIT — 700 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | DA 707A/B CLAY TOWERS | 2 | | | | | | |
| 2 | 2'-6" ID 28'-0" TT TK 10'-0" SKIRT HT | | 11,000 LBS EACH | 3- | 66000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT. CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS 365 PSIG DES TEMP 450 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 8 | INTERNALS TRAYS—INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 11 | DA 708 BENZENE COLUMN | 1 | | | | | | |
| 12 | 3'-6" ID 130'-0" TT TK 15'-6" SKIRT HT | | 25,000 LBS | 2- | 50000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT. C.S. CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS 50 PSIG DES TEMP 360 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS TRAYS—INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 19 | | | | | | | | |
| 20 | INSUL ☒ DA - lbs DB - lbs ERECT WT | | TONS | | | | | |
| 21 | DA 709 TOLUENE COLUMN | 1 | | | | | | |
| 22 | 2'-0" ID 111'-0" TT TK 15'-0" SHIRT HT | | 15,000 LBS | 3- | 45000 | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT. C.S. CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 390 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X RAY SPOT ☐ 100% ☐ STRESS REL ☐ FAB SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS' TRAYS—INSTALLED SHOP ☐ FIELD ☐ | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☒ DA - lbs DB - lbs ERECT. WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M H. | BY ML | JOB EST NO. 5571 | ACCT DA
WAGE RATE | LAB. COST | DATE 12/18/87 | REV. 0

F-73

CASE 7 MAX PROFIT

700 AREA

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB 701 EXTRACTOR TRAYS | | | | | | | | | | | |
| 2 | TYPE | DIA | DIA m ☐ mm ☐ | MAT. | NO. PASSES | | | | | | | |
| 3 | STILLING TRAY | 2'-6" | | CS | | 1 | | 150 | | | | |
| 4 | RAIN DECK | 2'-6" | | CS | 2 | 94 | | 150 | 14000 | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | OTHER INTERNALS: 6" OF GRATING IN BTM., VORTEX BKR | | | | | | | | | | | |
| | | | | | ERECT. WT | | TONS | | | | | |
| 10 | | | | | | | | | | | | |
| 11 | DB 702 RAFFINATE WATER WASH TRAYS | | | | | | | | | | | |
| 12 | TYPE | DIA | DIA m ☐ mm ☐ | MAT | NO PASSES | | | | | | | |
| 13 | LIQ-LIQ. CONTACTING | 1'-6" | | CS | | 6 | | 75 | 1000 | | | |
| 14 | FEED TRAY | 1'-6" | | CS | | 1 | | 75 | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | OTHER INTERNALS: 4" OF GRATING IN BTM., FEED DISTRIB. | | | | | | | | | | | |
| | | | | | ERECT WT | | TONS | | | | | |
| 20 | | | | | | | | | | | | |
| 21 | DB 703 STRIPPER TRAYS | | | | | | | | | | | |
| 22 | TYPE | DIA | DIA m ☐ mm ☐ | MAT | NO PASSES | | | | | | | |
| 23 | VALVE | 2'-9" | | CS | 2 | 30 | | 150 | 5000 | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | OTHER INTERNALS: REBOILER TRAPOUT, INLET DISTRIB. | | | | | | | | | | | |
| | | | | | ERECT. WT. | | TONS | | | | | |
| 30 | | | | | | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY ML
DATE 12/14/87
REV 0

JOB EST NO. 5571
ACCT DB

F-74

CASE 7 MAX PROFIT

700 AREA

LUMMUS

## ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB- 704 RECOVERY COLUMN TRAYS | | | | | | | | | | | |
| 2 | TYPE | DIA | DIA m ☐ mm ☐ | MAT | NO PASSES | | | | | | | |
| 3 | VALVE | 3'-0" | | CS | 1 | 15 | | 150 | 5000 | | | |
| 4 | VALVE | 3'-0" | | CS | 2 | 18 | | 150 | | | | |
| 5 | TRAPS | 3'-0" | | CS | | 5 | | - | | | | |
| 6 | COLLECTORS | 3'-0" | | CS | | 2 | | | 3000 | | | |
| 7 | LIQUID DISTRIB. | 3'-0" | | CS | | 1 | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | OTHER INTERNALS: VORTEX BKR. | | | | | | | | | | | |
| 10 | EA-705 IN SHELL. | | | | ERECT WT | | TONS | | | | | |
| 11 | DB- 705 WATER STRIPPER TRAYS | | | | | | | | | | | |
| 12 | TYPE | DIA | DIA m ☐ mm ☐ | MAT | NO PASSES | | | | | | | |
| 13 | VALVE (CARTRIDGE TYPE) | 1'-6" | | CS | | 5 | | 75 | 1000 | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | OTHER INTERNALS: | | | | | | | | | | | |
| 20 | | | | | ERECT WT | | TONS | | | | | |
| 21 | DB- | | | | | | | | | | | |
| 22 | TYPE | DIA | DIA m ☐ mm ☐ | MAT | NO PASSES | | | | | | | |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | OTHER INTERNALS: | | | | | | | | | | | |
| 30 | | | | | ERECT WT | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT AMOCO/DOE - GREAT PLAINS SASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY IHL
DATE 12/18/87
REV 4

JOB EST NO. 5571
ACCT DB

CASE 7 MAX PROFIT 700 AREA

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DB 707A/B CLAY TOWER PACKING. | | | | | | | | | | | |
| 2 | TYPE | DIA | DIA m ☐ mm ☐ | MAT. | NO. PASSES | | | | | | | |
| 3 | SCREENED SILICA SAND | | 20 FT³ | | | | | | | | | |
| 4 | CLAY - FILTROL GRADE | | 240 FT³ | | | | | 1 | 20 000 | | | |
| 5 | | | + 120 FT³ SPARE CHARGE. | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | OTHER INTERNALS: 4 - 6" SECTIONS OF WIRE MESH, | | | | | | | | | | | |
| 10 | 3/4" CERAMIC BALLS IN BTM, FEED DISTRIBUTOR. ERECT. WT. | | | | | | TONS | | | | | |
| 11 | DB 708 BENZENE COLUMN TRAYS | | | | | | | | | | | |
| 12 | TYPE | DIA | DIA m ☐ mm ☐ | MAT. | NO. PASSES | | | | | | | |
| 13 | VALVE | 3'-6" | | CS | 1 | 61 | | 200 | 12000 | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 19 | OTHER INTERNALS: | | | | | | | | | | | |
| 20 | ERECT. WT. | | | | | | TONS | | | | | |
| 21 | DB 709 TOLUENE COLUMN TRAYS | | | | | | | | | | | |
| 22 | TYPE | DIA | DIA m ☐ mm ☐ | MAT. | NO. PASSES | | | | | | | |
| 23 | VALVE | 2'-0" | | CS | 1 | 50 | | 100 | 5000 | | | |
| 24 | TRAP | 2'-0" | | CS | | 1 | | 100 | | | | |
| 25 | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | OTHER INTERNALS: | | | | | | | | | | | |
| 30 | ERECT. WT. | | | | | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | |

CLIENT Amoco/DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY ML
DATE 12/14/77
REV 0

JOB EST NO. 5571 ACCT DB

CASE 7 MAX PROFIT 700[illegible] A

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 701 RAFFINATE COOLER | | | | | | | |
| 2 | SIZE-IN. D/L — mm D/L — TYPE DOUBLE PIPE | 1 | | | | | | |
| 3 | NO SHELL/SERV. 1 — SQ FT/SHELL — TOTAL SQ FT 50 /SERV | | SQ FT | 100 | 5000 | | | |
| 4 | NO SHELL/SERV. — $m^2$/SHELL — TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm — TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT: C S — C S | | | | | | | |
| 7 | DES PRESS: 130 PSIG / kPa — 130 PSIG / kPa | | | | | | | |
| 8 | DES TEMP: 250 °F / °C — 175 °F / °C | | | | | | | |
| 9 | TUBES: DIA — GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ — ERECT. WT | | TONS EA | | | | | |
| 11 | EA 702 LEAN/RICH SOLVENT EXCHANGER | 1 | | | | | | |
| 12 | SIZE-IN. D/L — mm D/L — TYPE AES | | | | | | | |
| 13 | NO SHELL/SERV. 2 — SQ FT/SHELL 280 — TOTAL SQ FT 560/SERV | | SQ FT | 20- | 11000 | | | |
| 14 | NO SHELL/SERV. — $m^2$/SHELL — TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm — TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT: C S — C S | | | | | | | |
| 17 | DES PRESS: 150 PSIG / kPa — 310 PSIG / kPa | | | | | | | |
| 18 | DES TEMP: 280 °F / °C — 340 °F / °C | | | | | | | |
| 19 | TUBES: DIA 3/4 — GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ — ERECT. WT | | TONS EA | | | | | |
| 21 | EA 703 STRIPPER KEBOILER | 1 | | | | | | |
| 22 | SIZE-IN. D/L — mm D/L — TYPE NEN | | | | | | | |
| 23 | NO SHELL/SERV. 1 — SQ FT/SHELL — TOTAL SQ FT 230/SERV | | SQ FT | 20- | 5000 | | | |
| 24 | NO SHELL/SERV. — $m^2$/SHELL — TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. / mm — TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT: C.S. — C.S. | | | | | | | |
| 27 | DES PRESS: 75 PSIG / kPa — 635 PSIG / kPa | | | | | | | |
| 28 | DES TEMP: 400 °F / °C — 775 °F / °C | | | | | | | |
| 29 | TUBES: DIA 3/4 — GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ — ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DoE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 12/18/87 | EA
REV. 0

A122 1081-8 REV. 2

F-77

C. .C 7 MAX PROFIT 700[illegible]A

THE LUMMUS COMPANY
Bloomfield

LUMMUS

## ESTIMATE SHEET

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 704 STRIPPER CONDENSER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 200 /SERV | | | SQ FT 20- | 4000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | | $m^2$ | | | | |
| 5 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 6 | MAT C.S. C.S. | | | | | | | |
| 7 | DES PRESS 75 PSIG kPa kg/cm² 130 PSIG kPa kg/cm² | | | | | | | |
| 8 | DES TEMP 250 °F °C 175 °F °C | | | | | | | |
| 9 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT TONS EA | | | | | | | |
| 11 | EA 705 RECOVERY COLUMN REBOILER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE STABBED-IN. B-U | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 60 /SERV | | | SQ FT | 3000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | | $m^2$ | | | | |
| 15 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 16 | MAT COLUMN CS (FINNED TUBES) | | | | | | | |
| 17 | DES PRESS PSIG kPa kg/cm² 635 PSIG kPa kg/cm² | | | | | | | |
| 18 | DES TEMP °F °C 775 °F °C | | | | | | | |
| 19 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT TONS EA | | | | | | | |
| 21 | EA 706 RECOV. COL'N INTER. REBOILER | 1 | | | 3000 | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE STABBED-IN. B-U | | | | | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 40 /SERV | | | SQ FT | | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | | $m^2$ | | | | |
| 25 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 26 | MAT COLUMN CS (FINNED TUBES) | | | | | | | |
| 27 | DES PRESS PSIG kPa kg/cm² 635 PSIG kPa kg/cm² | | | | | | | |
| 28 | DES TEMP °F °C 775 °F °C | | | | | | | |
| 29 | TUBES: DIA 3/4" GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT TONS EA | | | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO /DoE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY ML
DATE 12/18/87
REV. 0

JOB EST NO. 5571
ACCT EA

A172 1081-6 REV. 2

CASE 7 MAX PROFIT 700 MA

**LUMMUS** ESTIMATE SHEET THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | | | | | | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EA 707 RECOVERY COLUMN CONDENSER | | | | | | 1 | | | | | | |
| 2 | SIZE-IN. D/L | mm D/L | TYPE AES | | | | | | | | | | |
| 3 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 725 | /SERV | | | | SQ FT | 18 - | 13000 | | | |
| 4 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. | mm | TUBE SIDE C.A. | mm | | | | | | | | | |
| 6 | MAT CS | | CS | | | | | | | | | | |
| 7 | DES PRESS 75 PSIG | kPa kg/cm² | 130 PSIG | kPa kg/cm² | | | | | | | | | |
| 8 | DES TEMP 250 °F | °C | 175 °F | °C | | | | | | | | | |
| 9 | TUBES: DIA 3/4" GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ | | | | ERECT. WT | | | TONS EA | | | | | |
| 11 | EA 708 RECOV. COL'N EJECTOR COND. | | | | | | 1 | | | | | | |
| 12 | SIZE-IN. D/L | mm D/L | TYPE AES | | | | | | | | | | |
| 13 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 50 | /SERV | | | | SQ FT | 120 - | 6000 | | | |
| 14 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. | mm | TUBE SIDE C.A. | mm | | | | | | | | | |
| 16 | MAT CS | | CS | | | | | | | | | | |
| 17 | DES PRESS 75 PSIG | kPa kg/cm² | 130 PSIG | kPa kg/cm² | | | | | | | | | |
| 18 | DES TEMP 250 °F | °C | 175 °F | °C | | | | | | | | | |
| 19 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ | | | | ERECT. WT | | | TONS EA | | | | | |
| 21 | EA 709 WATER STRIPPER REBOILER | | | | | | 1 | | | | | | |
| 22 | SIZE-IN. D/L | mm D/L | TYPE BKU (MOD) | | | | (DA-705 MOUNTS ON SHELL) | | | 10000 | | | |
| 23 | NO SHELL/SERV. 1 | SQ FT/SHELL | TOTAL SQ FT 140 | /SERV | | | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. | $m^2$/SHELL | TOTAL $m^2$ | /SERV | | | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. | mm | TUBE SIDE C.A. | mm | | | | | | | | | |
| 26 | MAT CS | | CS | | | | | | | | | | |
| 27 | DES PRESS 75 PSIG | kPa kg/cm² | 310 PSIG | kPa kg/cm² | | | | | | | | | |
| 28 | DES TEMP 300 °F | °C | 400 °F | °C | | | | | | | | | |
| 29 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ | | | | ERECT. WT | | | TONS EA | | | | | |
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| | TOTAL ACCOUNT | | | | | | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML
WAGE RATE | LAB. COST | DATE 12/18/87 | REV. 0

JOB EST NO. 5571 ACCT EA

A172 10814 REV. 2

C. E-7 MAX PROFIT 700 TA

LUMMUS

# ESTIMATE SHEET

THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA. 710 SOLVENT REGENERATOR REBOILER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE STABBED-IN B-U | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 10 /SERV | | SQ FT | | 3000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT COLUMN CS (FINNED TUBES) | | | | | | | |
| 7 | DES PRESS PSIG / kPa, kg/cm² 635 PSIG / kPa, kg/cm² | | | | | | | |
| 8 | DES TEMP °F / °C 775 °F / °C | | | | | | | |
| 9 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA. 711 SOLVENT COOLER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 186 /SERV | | SQ FT | 20 - | 4000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT CS C.S. | | | | | | | |
| 17 | DES PRESS 310 PSIG / kPa, kg/cm² 130 PSIG / kPa, kg/cm² | | | | | | | |
| 18 | DES TEMP 400 °F / °C 175 °F / °C | | | | | | | |
| 19 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| 21 | EA. 712 CLAY TWR. FEED/EFFL. EXCHANGER | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 75 /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | 40 - | 3000 | | | |
| 25 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 365 PSIG / kPa, kg/cm² 365 PSIG / kPa, kg/cm² | | | | | | | |
| 28 | DES TEMP 360 °F / °C 430 °F / °C | | | | | | | |
| 29 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML
WAGE RATE | LAB. COST | DATE 12/18/87 | REV. 0

JOB EST NO. 5571 | ACCT EA

A122 10814 REV. 2

F-80

C. SE 7 MAX PROFIT 100 A

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA. 713 CLAY TOWER FEED HEATER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE DOUBLE PIPE | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 20 /SERV | | SQ FT | 100 | 2000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 470 PSIG / kPa 635 PSIG / kPa | | | | | | | |
| 8 | DES TEMP 460 °F / °C 775 °F / °C | | | | | | | |
| 9 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 11 | EA. 714 BENZENE COLUMN REBOILER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE BEU | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 180 /SERV | | SQ FT | 35 | 5000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 75 PSIG / kPa 635 PSIG / kPa | | | | | | | |
| 18 | DES TEMP 360 °F / °C 775 °F / °C | | | | | | | |
| 19 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA. 715 BENZENE PRODUCT COOLER | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE DOUBLE PIPE | | | | 5000 | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 75 /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 100 PSIG / kPa 130 PSIG / kPa | | | | | | | |
| 28 | DES TEMP 250 °F / °C 175 °F / °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 12/18/87 | EA
REV. 0

A122 1081-8 REV. :

C. G 7 MAX PROFIT 700 [illegible] A

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA. 716 BENZENE COLUMN CONDENSER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 475 /SERV | | SQ FT | 15 | 7000 | | | |
| 4 | NO SHELL/SERV. m²/SHELL TOTAL m² /SERV | | m² | | | | | |
| 5 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 75 PSIG bPa kg/cm² 130 PSIG bPa kg/cm² | | | | | | | |
| 8 | DES TEMP 250 °F °C 175 °F °C | | | | | | | |
| 9 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| 11 | EA. 717 TOLUENE COLUMN REBOILER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE BEU | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 70 /SERV | | SQ FT | | 5000 | | | |
| 14 | NO SHELL/SERV. m²/SHELL TOTAL m² /SERV | | m² | | | | | |
| 15 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 75 PSIG bPa kg/cm² 635 PSIG bPa kg/cm² | | | | | | | |
| 18 | DES TEMP 390 °F °C 775 °F °C | | | | | | | |
| 19 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☒ ERECT. WT | | TONS EA | | | | | |
| 21 | EA. 718 XYLENE PRODUCT COOLER | 1 | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE DOUBLE PIPE | | | | 5000 | | | |
| 23 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 55 /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. m²/SHELL TOTAL m² /SERV | | m² | | | | | |
| 25 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 26 | MAT CS CS | | | | | | | |
| 27 | DES PRESS 75 PSIG bPa kg/cm² 130 PSIG bPa kg/cm² | | | | | | | |
| 28 | DES TEMP 390 °F °C 175 °F °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY MLL
DATE 12/18/87
REV. 0

JOB EST NO. 5571 ACCT EA

A122 1081-8 REV. 2

F-82

C..E 7 MAX PROFIT 700 DA

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY TOTAL | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | EA 719 TOLUENE COLUMN CONDENSER | 1 | | | | | | |
| 2 | SIZE-IN. D/L mm D/L TYPE AES | | | | | | | |
| 3 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 75 /SERV | | SQ FT | | 5000 | | | |
| 4 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 5 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 6 | MAT CS CS | | | | | | | |
| 7 | DES PRESS 75 PSIG kPa TUBE 130 PSIG kPa | | | | | | | |
| 8 | DES TEMP 305 °F °C 175 °F °C | | | | | | | |
| 9 | TUBES: DIA 3/4 GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 10 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| 11 | EA 720 TOLUENE PRODUCT COOLER | 1 | | | | | | |
| 12 | SIZE-IN. D/L mm D/L TYPE DOUBLE PIPE | | | | | | | |
| 13 | NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 30 /SERV | | SQ FT | | 3000 | | | |
| 14 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 15 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 16 | MAT CS CS | | | | | | | |
| 17 | DES PRESS 150 PSIG kPa 130 PSIG kPa | | | | | | | |
| 18 | DES TEMP 250 °F °C 175 °F °C | | | | | | | |
| 19 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 20 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| 21 | EA | | | | | | | |
| 22 | SIZE-IN. D/L mm D/L TYPE | | | | | | | |
| 23 | NO SHELL/SERV. SQ FT/SHELL TOTAL SQ FT /SERV | | SQ FT | | | | | |
| 24 | NO SHELL/SERV. $m^2$/SHELL TOTAL $m^2$ /SERV | | $m^2$ | | | | | |
| 25 | SHELL SIDE C.A. mm TUBE SIDE C.A. mm | | | | | | | |
| 26 | MAT | | | | | | | |
| 27 | DES PRESS PSIG kPa PSIG kPa | | | | | | | |
| 28 | DES TEMP °F °C °F °C | | | | | | | |
| 29 | TUBES: DIA GA MIN ☐ AV ☐ WELDED ☐ SMLS ☐ EXP JOINT ☐ | | | | | | | |
| 30 | TUBE ENDS: WELDED ☐ NO. TUBES ☐ INSUL ☐ ERECT. WT | | TONS EA | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H.
WAGE RATE | LAB. COST

BY ML
DATE 12/18/87
REV. 0

JOB EST NO. 5571 ACCT EA

A122 1081-6 REV. 2

CASE 7 MAX PROFIT 700 AREA

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-701 FEED SURGE DRUM | 1 | | | | | | |
| 2 | 2'-6" ID 8'-0" TT TK MIN. SKIRT HT | | 3000 LBS | 3- | 9000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C.S. CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 5 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: VORTEX BKR. | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FA-702 STRIPPER REFLUX DRUM | 1 | | | | | | |
| 12 | 1'-6" ID 11'-0" TT TK SKIRT HT | | 2000 LBS | 3- | 6000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: DIPLEG & VORTUX BKRS. | | | | | | | |
| 19 | 18"ϕ x 2'lg.-BOOT | | | | | | | |
| 20 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA-703 RECOVERY COLUMN REFLUX DRUM | 1 | | | | | | |
| 22 | 1'-6" ID 20'-0" TT TK SKIRT HT | | 2000 LBS | 3- | 6000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: DIPLEG & VORTEX BKR. | | | | | | | |
| 29 | 18"ϕ x 2'-6" T-T BOOT. | | | | | | | |
| 30 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

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|---|---|---|---|---|---|---|---|
| CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT | PROD. FACT | | LOC. M.H. | | BY M.L. | JOB EST NO. 5571 | ACCT FA |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 12/14/87 | | |
| PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE | | LAB. COST | | REV. 4 | 7 | |

A172 1081-8 REV. 2

F-84

CASE 7 MAX PROFIT

700 AREA

LUMMUS

## ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA-704 EJECTOR CONDENSATE DRUM | 1 | | | | | | |
| 2 | 1'-6" ID 4'-0" TT TK SKIRT HT | | 1000 LBS | 4- | 4000 | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 5 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: 3 BAFFELS, INT. PIPE DISTRIB. | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☒ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FA-705 SOLVENT SUMP | 1 | | | | | | |
| 12 | 8'-0" ID 6'-0" TT TK SKIRT HT | | 2000 LBS | 2- | 4000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 15 | DES PRESS 50 PSIG DES TEMP 400 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: LEVEL BUBBLER, 3'-0" ID NECK 2 T-T | | | | | | | |
| 19 | COATED AND WRAPPED FOR BURIAL. | | | | | | | |
| 20 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA-706 VENT KO DRUM | 1 | | | | | | |
| 22 | 2'-0 ID 10'-0" TT TK 5'-0" SKIRT HT | | 2000 LBS | 4- | 8000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 425 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: | | | | | | | |
| 29 | HEATTRACED BOTTOM ½ | | | | | | | |
| 30 | INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

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|---|---|---|---|---|---|---|
| CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT | PROD. FACT | | LOC. M.H. | | BY MLC. | JOB EST NO. 5571 ACCT FA |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 12/15/77 | |
| PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE | | LAB. COST | | REV. 0 | |

A122 10R1 8 REV. 2

F-85

CASE 7 MAX PROFIT

700 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FA- | | | | | | | |
| 2 | ID TT TK SKIRT HT | | LBS | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 5 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 6 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 7 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐ | | | | | | | |
| 8 | INTERNALS: | | | | | | | |
| 9 | | | | | | | | |
| 10 | INSUL ☐ HORIZ ☐ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FA- 708 BENZENE COL'N REFLUX DRUM. | 1 | | | | | | |
| 12 | 4'-0" ID 17'-0" TT TK SKIRT HT | | 8000 LBS | 2.50 | 20000 | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 16 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 17 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 18 | INTERNALS: | | | | | | | |
| 19 | WITH 18"Ø x 2' T-T BOOT AND DIPPIPE | | | | | | | |
| 20 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FA- 709 TOLUENE COL'N REFLUX DRUM. | 1 | | | | | | |
| 22 | 2'-0" ID 7'-0" TT TK SKIRT HT | | 2000 LBS | 4/- | 8000 | | | |
| 23 | m ☐ mm | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS 50 PSIG DES TEMP 250 °F | | | | | | | |
| 26 | DES PRESS kPa kg/cm² DES TEMP °C | | | | | | | |
| 27 | X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☒ FIELD ☐ | | | | | | | |
| 28 | INTERNALS: DIPPIPE | | | | | | | |
| 29 | | | | | | | | |
| 30 | INSUL ☐ HORIZ ☒ VERT ☐ SPHERE ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY M.C.
WAGE RATE | LAB. COST | DATE 12/18/87
REV 0

JOB EST NO. 5571 | ACCT FA

A122 10R1-8 REV. 2

F-86

CASE 7 MAX PROFIT 700 AREA (1)

**LUMMUS** ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB-701 SOLVENT STORAGE TANK | 1 | | | | | | |
| 2 | 13'-0" ID 13'-0" TT TK — SKIRT HT | | | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 300 BARRELS/ GALLONS/ M³ | | | 100 | | | | 30 000 |
| 8 | INTERNALS HEATING COIL | | | | | | | |
| 9 | TYPE: CR ☐ FR ☒ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 10 | INSUL ☒ API ☒ BULLET ☐ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FB-702 WET SOLVENT STORAGE TANK | 1 | | | | | | |
| 12 | 9'-0" ID 9'-0" TT TK — SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 100 BARRELS/ GALLONS/ M³ | | | 150 | 15 000 | | | |
| 18 | INTERNALS HEATING COIL | | | | | | | |
| 19 | TYPE: CR ☐ FR ☒ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 20 | INSUL ☒ API ☒ BULLET ☐ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FB-703 CLAY TOWER SURGE TANK | 1 | | | | | | |
| 22 | 12'-6" ID 12'-0" TT TK — SKIRT HT | | | | | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8 mm | | | | | | | |
| 25 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 250 BARRELS/ GALLONS/ M³ | | | 100 | | | | 25 000 |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE: CR ☐ FR ☒ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 30 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML. | JOB EST NO. 5571 | ACCT FB
WAGE RATE | LAB. COST | DATE 12/14/87 | REV. 0

F-87

CASE 7 MAX PROFIT 700 AHLA

LUMMUS **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB-704 BENZENE DAY TANK | 1 | | | | | | |
| 2 | 13'-6" ID 13'-0" TT TK — SKIRT HT | | | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 5 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 320 BARRELS GALLONS M³ | | | 100 | | | | 32000 |
| 8 | INTERNALS | | | | | | | |
| 9 | TYPE: CR ☐ FR ☒ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 10 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
| 11 | FB-705 XYLENE DAY TANK | 1 | | | | | | |
| 12 | 4'-0" ID 7'-0" TT TK — SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 15 | DES PRESS ATMOS PSIG DES TEMP °F | | | 200 | 3000 | | | |
| 16 | DES PRESS kg/cm² DES TEMP 120 °C | | | | | | | |
| 17 | CAPACITY: 15 BARRELS GALLONS M³ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☒ VERT ☐ | | | | | | | |
| 20 | INSUL ☐ API ☐ BULLET ☒ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
| 21 | FB-706A&B TOLUENE DAY TANKS | 2 | | | | | | |
| 22 | 9'-0" ID 9'-0" TT. TK — SKIRT HT | | | | | | | |
| 23 | m ☐ mm ☐ | | | 100 | 12000 | | | |
| 24 | MAT CS CLAD ☐ LINING ☐ CA 1/8" mm | | | | | | | |
| 25 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 120 BARRELS GALLONS M³ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 30 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☒ FIELD ☐ ERECT. WT. | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY MC. DATE 12/18/87 REV. 0

JOB EST NO. 5571 ACCT FB

CA-57 MAX PROFIT 700 AR...

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA-701A/S FEED CHARGE PUMP | 2 | | | | | | |
| 2 | GPM 15 SUCT 15 PSIG DISCH PSI TEMP 100 °F | | | | 8000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP-GR ΔP FT 160 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CI 2½ H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA-702A/S PUMPAROUND PUMP | 2 | | | 8000 | | | |
| 12 | GPM 1 SUCT 60 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT: CASE CS IMPELLER CS ½ H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA-703A/S RAFFINATE PUMP | 2 | | | 8000 | | | |
| 22 | GPM 2 SUCT 60 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE C.S. IMPELLER C.S. ½ H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 12/15/87
REV. 0

A122 0482-10 REV. 3

F-89

CASE 7 MAX PROFIT 700 AR&A

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA-704A/S STRIPPER BOTTOMS PUMP | 2 | | | 8000 | | | |
| 2 | GPM 80 SUCT 20 PSIG DISCH PSI TEMP 350 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CI 5 H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA-705A/S STRIPPER WATER PUMP | 2 | | | 8000 | | | |
| 12 | GPM 2 SUCT 5 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT: CASE CS IMPELLER CS 1/2 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA-706A/S EXTRACTOR RECYCLE PUMP | 2 | | | 6000 | | | |
| 22 | GPM 15 SUCT 5 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP-GR ΔP FT 135 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE CS IMPELLER CI 2 1/2 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 12/18/87 | GA
REV. 0

A122 0482-10 REV. 3

F-90

CASE 7 MAX PROFIT 700 AR_A

**LUMMUS** ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 707A/S LEAN SOLVENT PUMP | 2 | | | | | | |
| 2 | GPM 65 SUCT 5 PSIG DISCH PSI TEMP 345 °F | | | | 12 000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP-GR ΔP FT 200 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CS 15 H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | 2 | TONS | | | | | |
| 11 | GA- 708A/S WASH WATER PUMP | 2 | | | 8 000 | | | |
| 12 | GPM 3 SUCT -5 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP-GR ΔP FT 105 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT: CASE CS IMPELLER CS 1/2 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA- 709A/S RECOVERY COLN OVHD PUMP | 2 | | | 8000 | | | |
| 22 | GPM 25 SUCT -5 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP-GR ΔP FT 90 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE CS IMPELLER CI 2 1/2 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 12/14/87 | REV. 0 | GA

A-22 0482-10 REV 3

CASE 7 MAX PROFIT 700 AR.A

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA-710A/S WATER STRIPPER BTMS PUMP | 2 | | | 8 000 | | | |
| 2 | GPM 2 SUCT 10 PSIG DISCH PSI TEMP 251 °F | | | | | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP-GR ΔP FT 15 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CS 1/2 H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☐ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA-711A/S EJECTOR CONDENSATE | 2 | | | 8 000 | | | |
| 12 | GPM 1 SUCT -5 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT: CASE CS IMPELLER CS 1/2 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA-712 SOLVENT TRANSFER PUMP | 1 | | | 4 000 | | | |
| 22 | GPM 50 SUCT 0 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP-GR ΔP FT 100 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE CS IMPELLER CI 5 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 12/18/87 | REV. 0

A122 0482-10 REV. 3

F-92

CASE 7 MAX PROFIT 700 ARLA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA-713 WET SOLVENT PUMP | 1 | | | 4000 | | | |
| 2 | GPM 20 SUCT PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP-GR ΔP FT 260 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT: CASE CS IMPELLER CI 5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. PUMP & DRIVER TONS | | | | | | | |
| 11 | GA-714A&B SOLVENT SUMP PUMP (HORIZONTAL SPARE) | 2 | | | 8000 | | | |
| 12 | GPM 50 SUCT 0 PSIG DISCH PSI TEMP 350 °F | | | | | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP-GR ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT: CASE CI IMPELLER CI 2 1/2 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ VERTICAL SUMP PUMP. | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER TONS | | | | | | | |
| 21 | GA-715A&S CLAY TOWER FEED PUMP | 2 | | | 8000 | | | |
| 22 | GPM 10 SUCT 0 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP-GR ΔP FT 285 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT: CASE CS IMPELLER CS 3 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER TONS | | | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 12/18/87 | REV. 0

A122 0482 10 REV. 3

F-61

CASE 7 MAX PROFIT 700 ARC

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA- 716A/S BENZENE COL'N BTMS PUMP | 2 | | | 8000 | | | |
| 2 | GPM 15 SUCT 15 PSIG DISCH PSI TEMP 300 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 40 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT. CASE CS IMPELLER CI 1 H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA- 717A/S BENZENE COL'N REFLUX PUMP | 2 | | | 8000 | | | |
| 12 | GPM 50 SUCT 5 PSIG DISCH PSI TEMP 140 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 85 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT. CASE CS IMPELLER CI 5 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA- 718A/S BENZENE COL'N WATER PUMP | 2 | | | 8000 | | | |
| 22 | GPM V3 SUCT 10 PSIG DISCH PSI TEMP 140 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT 45 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT. CASE CS IMPELLER CS 1/2 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☒ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
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| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY ML | JOB NO. EST 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 12/18/87 | REV.

A122 0482-10 REV. 3

F-94

CA. 7 MAX PROFIT 700A

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 719A/S BENZENE PRODUCT PUMP | 2 | | | 8000 | | | |
| 2 | GPM 60 SUCT 0 PSIG DISCH PSI TEMP 100 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 85 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER CI 5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 720A/S TOLUENE COLN BTMS PUMP | 2 | | | 8000 | | | |
| 12 | GPM 7 SUCT 15 PSIG DISCH PSI TEMP 330 °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR ΔP FT 30 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER CS 1/2 HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☒ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 721A/S TOLUENE COLN REFLUX PUMP | 2 | | | 8000 | | | |
| 22 | GPM 20 SUCT 5 PSIG DISCH PSI TEMP 200 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR ΔP FT 75 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER CI 2 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☒ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL / REVIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY MLG
DATE 17/IX/87
REV. 0

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

CAS - 7 MAX PROFIT 700 A

**LUMMUS** **ESTIMATE SHEET** THE LUMMUS COMPANY Bloomfield

| | DESCRIPTION | | | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GA 722A/S XYLENE PRODUCT PUMP | | | | | | | 2 | | | 8000 | | | |
| 2 | GPM 7 | SUCT 0 | PSIG | DISCH | PSI | TEMP 100 °F | | | | | | | | |
| 3 | $m^3/h$ | SUCT kPa kg/cm² | | DISCH kPa kg/cm² | | TEMP °C | | | | | | | | |
| 4 | SP GR | ΔP | FT 85 | PSI | STGS | | | | | | | | | |
| 5 | | ΔP | m kPa kg/cm² | | RPM | | | | | | | | | |
| 6 | MAT CASE CS | IMPELLER CI | | | 1 HP | | | | | | | | | |
| 7 | DRIVE EM - ☒ TURB ☐ DIESEL ☐ OTHER ☐ | | | | kW | | | | | | | | | |
| 8 | TYPE CENT - ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | | | | | | | |
| 10 | INSUL ☐ | ERECT WT PUMP & DRIVER | | | TONS | | | | | | | | | |
| 11 | GA 723A/S TOLUENE PRODUCT PUMP | | | | | | | 2 | | | 8000 | | | |
| 12 | GPM 25 | SUCT 0 | PSIG | DISCH | PSI | TEMP 100 °F | | | | | | | | |
| 13 | $m^3/h$ | SUCT kPa kg/cm² | | DISCH kPa kg/cm² | | TEMP °C | | | | | | | | |
| 14 | SP GR | ΔP | FT 85 | PSI | STGS | | | | | | | | | |
| 15 | | ΔP | m kPa kg/cm² | | RPM | | | | | | | | | |
| 16 | MAT CASE CS | IMPELLER CI | | | 2½ HP | | | | | | | | | |
| 17 | DRIVE EM - ☒ TURB ☐ DIESEL ☐ OTHER ☐ | | | | kW | | | | | | | | | |
| 18 | TYPE CENT - ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 19 | MECH SEAL ☒ | | | | | | | | | | | | | |
| 20 | INSUL ☐ | ERECT WT PUMP & DRIVER | | | TONS | | | | | | | | | |
| 21 | GA | | | | | | | | | | | | | |
| 22 | GPM | SUCT | PSIG | DISCH | PSI | TEMP °F | | | | | | | | |
| 23 | $m^3/h$ | SUCT kPa kg/cm² | | DISCH kPa kg/cm² | | TEMP °C | | | | | | | | |
| 24 | SP GR | ΔP | FT | PSI | STGS | | | | | | | | | |
| 25 | | ΔP | m kPa kg/cm² | | RPM | | | | | | | | | |
| 26 | MAT CASE | IMPELLER | | | HP | | | | | | | | | |
| 27 | DRIVE EM - ☐ TURB ☐ DIESEL ☐ OTHER ☐ | | | | kW | | | | | | | | | |
| 28 | TYPE CENT - ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 29 | MECH SEAL ☐ | | | | | | | | | | | | | |
| 30 | INSUL ☐ | ERECT WT PUMP & DRIVER | | | TONS | | | | | | | | | |
| | TOTAL THIS PAGE | | | | | | | | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL / MIXED LIQUIDS

PROD. FACT | LOC. M.H. | BY WLL | JOB EST NO 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 12/21/87 | REV 6

A122 0482-10 REV. 3

F-96

CASE 1 MAX FICOFIT

DESIGN COMPUTATIONS FOR AMOCO/DOE

JOB 5571 ACCT.

MISCELLANEOUS

FD-701 LEAN SOLVENT FILTER.

CAPACITY - 65 GPM OF SOLVENT

ΔP = 2 PSI CLEAN 15 PSI DIRTY
DP = 310 PSIG DT = 250°F

PARTICLE REMOVAL - 50 MICRONS & LARGER

$5,000

EE-701 EJECTORS - TWO REQ'D

HP STM FLOW - 100 #/HR.

TO EDUCT 400 #/HR VAPOR FROM 5 PSIA TO 16 PSIA

DP = 635 PSIG DT = 775°F

$5,000

PA-701 CLAY HANDLING EQUIPMENT

1 LOADING HOPPER
1 LOT CANVAS HOSE (~200F)
1 LOADING CHUTE

$15,000

A2.601

| REV. | DATE | MADE | CHKD. | APPR. | Record | REV. | ISSUE | DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| 0 | 12/8/82 | | | | | | | |

LUMMUS THE LUMMUS COMPANY Bloomfield N. J.

A106 03 0776-1 REV.1

# 6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

## 6.3 Phenol Stream

### 6.3.1 AREA 800

### 6.3.2 AREA 850

### 6.3.3 AREA 900

AREA 800

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571

DATE/BY: 21-Mar-89 08:46 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 5 | $776 | 100% | $776 |
| INTERNALS | | $143 | 0% | $0 |
| REACTORS | | | 90% | $0 |
| EXCHANGERS | 14 | $332 | 100% | $332 |
| VESSELS | 9 | $73 | 120% | $88 |
| TANKS | 3 | $53 | 80% | $42 |
| FILTERS | | | | $0 |
| PUMPS | 52 | $440 | 100% | $440 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | 7 | $165 | 70% | $115 |
| | | | | |
| TOTAL | 90 | $1,982 | | $1,794 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,982 | |
| COMMODITIES | $1,794 | |
| LABOR | $1,274 | (10% EQUIP,60% COMM) |
| INDIRECTS | $1,274 | (100% LABOR) |
| ENGINEERING | $3,600 | (800/PC X $50) |
| SUBTOTAL | $9,924 | |
| CONTINGENCY | $1,985 | (20%) |
| TOTAL | $11,909 | |

EQUIPMENT SUMMARY

| | | WEIGHT | MATL. | $/LB | $ |
|---|---|---|---|---|---|
| DA-801 | FLASH COLUMN | 72000 | CS CLAD | $3.00 | $216,000 |
| DA-802 | DRYER | 9000 | CS CLAD | $4.50 | $40,500 |
| DA-803 | PHENOL COLUMN | 123000 | CS CLAD | $3.00 | $369,000 |
| DA-804 | STRIPPING COLUMN | 33000 | CS CLAD | $3.50 | $115,500 |
| DA-805 | LIGHT ENDS COLUMN | 7000 | CS CLAD | $5.00 | $35,000 |
| | | | | TOTAL | $776,000 |

| | | FT2 | MATL. | $/FT2 | $ |
|---|---|---|---|---|---|
| DB-801 | FLASH COLUMN | 2200 | CS/SS VA | $18.00 | $39,600 |
| DB-802 | DRYER | 125 | | $20.00 | $2,500 |
| DB-803 | PHENOL COLUMN | 4500 | | $18.00 | $81,000 |
| DB-804 | STRIPPING COLUMN | 1000 | | $18.00 | $18,000 |
| DB-805 | LIGHT ENDS COLUMN | 110 | | $20.00 | $2,200 |
| | TOTAL | | | | $143,300 |

| | | FT2 | MATL. | $/FT2 | $ |
|---|---|---|---|---|---|
| EA-801 | FLASH COL COND. | 1195 | CS/CS | $15.00 | $17,925 |
| EA-802 | FLASH COL REBOIL | 4455 | CS/316 | $26.25 | $116,944 |
| EA-803 | DEPHENOLTIZED CRESYLIC ACID COOLER | 140 | 316/316 | $135.00 | $18,900 |
| EA-804 | FLASH COL TRIM COOL. | 390 | CS/CS | $23.00 | $8,970 |
| EA-805 | DRYER CONDENSER | 530 | CS/CS | $19.00 | $10,070 |
| EA-806 | PHENOL COL REBOIL | 1480 | CS/316 | $35.00 | $51,800 |
| EA-807 | PHENOL COL COND | 1730 | CS/CS | $14.00 | $24,220 |
| EA-808 | LT. ENDS COL COND | 345 | CS/CS | $23.00 | $7,935 |
| EA-809 | LT. ENDS COL REBOIL | 150 | CS/316 | $122.50 | $18,375 |
| EA-810 | STRIPPING COL COND | 1050 | CS/CS | $16.00 | $16,800 |
| EA-811 | STRIPPING COL REBOIL | 105 | 316/316 | $122.50 | $12,863 |
| EA-812 | PHENOL COOLER | 90 | 316/316 | $122.50 | $11,025 |
| EA-813 | TAR COOLER | 175 | CS/CS | $40.00 | $7,000 |
| EA-814 | STRIPPING COL SIDE REBOIL | 450 | CS/CS | $20.00 | $9,000 |
| | | | | TOTAL | $331,826 |

EQUIPMENT SUMMARY

| | | WEIGHT | MATL. | $/LB | $ |
|---|---|---|---|---|---|
| FA-801 | FLASH COL REFLUX DRUM | 2000 | CS | $3.50 | $7,000 |
| FA-802 | DRYER COL | 3000 | CS | $2.75 | $8,250 |
| FA-803 | PHENOL COL REFLUX DRUM | 4000 | CS | $2.25 | $9,000 |
| FA-804 | STRIPPING COL REFLUX DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-805 | LT. ENDS COL REFLUX DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-806 | CRUDE PHENOL SURGE DRUM | 16000 | CS | $1.50 | $24,000 |
| FA-807 | CRYSYLIC ACID DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-808 | PHENOL DRAWOFF DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-809 | LT. ENDS DRUM | 4000 | CS | $2.25 | $9,000 |
| | | | | TOTAL | $73,250 |

| | | BARRELS | MATL. | $/BBL | $ |
|---|---|---|---|---|---|
| FB-801 | SULFURIC ACID DAY TANK | 90 | CS | $90.00 | $8,100 |
| FB-802 | TAR DAY TANK | 576 | CS | $40.00 | $23,040 |
| FB-803 | PHENOL DAY TANK | 440 | CS | $50.00 | $22,000 |
| | | | | | $53,140 |

| | HP | MATL. | $/HP | $ |
|---|---|---|---|---|
| GA-801, CRUDE PHENOL PUMP | <10hp | CS | ------- | $15,000 |
| GA-802, FLASH COL REFLUX | <10hp | CS | ------- | $15,000 |
| GA-803, FLASH COL BTTM. | <10hp | CS | ------- | $15,000 |
| GA-804, ACID TAR | <10hp | CS | ------- | $15,000 |
| GA-805, FLASH COL WATER | <10hp | CS | ------- | $15,000 |
| GA-806, LT.ENDS COL FEED | <10hp | CS | ------- | $15,000 |
| GA-807, SULFURIC ACID | <10hp | CS | ------- | $15,000 |
| GA-808, CRESYLIC ACID | <10hp | CS | ------- | $15,000 |
| GA-809, LT. ENDS COL REFLUX | <10hp | CS | ------- | $15,000 |
| GA-819, LT. ENDS COL BTTMS | <10hp | CS | ------- | $15,000 |
| GA-811, DRYER WATER | <10hp | CS | ------- | $15,000 |
| GA-812, DRYER REFLUX | <10hp | CS | ------- | $15,000 |
| GA-813, PHENOL COL REFLUX | 20HP | CS | ------- | $20,000 |
| GA-814, PHENOL DRAWOFF | <10hp | CS | ------- | $15,000 |
| GA-815, PHENOL COL BTTM | <10hp | CS | ------- | $15,000 |
| GA-816, STRIPPING COL REFLUX | <10hp | CS | ------- | $15,000 |
| GA-817, STRIPPING COL EXTRACT | <10hp | CS | ------- | $15,000 |
| GA-818, STRIPPING COL BTTM | <10hp | CS | ------- | $15,000 |
| GA-819, PHENOL CHARGE | <10hp | CS | ------- | $15,000 |
| GA-820, DRYER COL BTTMS | <10hp | CS | ------- | $15,000 |
| GA-821. WASH WATER | <10hp | CARP 20 | ------- | $30,000 |
| GA-822, TAR CIRC. | <10hp | CARP 20 | ------- | $30,000 |
| GA-823, WASH WATER CIRC | <10hp | CARP 20 | ------- | $30,000 |
| GA-824, TAR PUMP | <10hp | CS | ------- | $15,000 |
| GA-825, TAR STORAGE | <10hp | CS | ------- | $15,000 |
| GA-826, LT. ENDS COL WATER PUMP | <10hp | CS | ------- | $15,000 |
| | | | TOTA | $440,000 |

EQUIPMENT SUMMARY

| | | $ |
|---|---|---|
| FD-801 | 1ST STG WASH FILTER | $5,000 |
| FD-802 | 2ND STG WASH FILTER | $5,000 |
| GD-801 | 1ST STG WASH MIXER | $5,000 |
| GD-802 | 2ND STG WASH MIXER | $5,000 |
| GD-803 | SULFURIC ACID MIXER | $5,000 |
| ED-801 | THIN FILM EVAP | $90,000 |
| PA-801 | VACUUM SYSTEM | $50,000 |
| | TOTAL | $165,000 |

VESSEL NO. DA-801 COMB WITH

VESSEL NAME FLASH COLUMN

DIAMETER 7'-6" I.D. O.D.

VERT HT 88'-0" T-T SHELL 15'-0" T-T

HORIZ LENGTH

OPER TEMP: TOP 194 °F BOTT 445 °F DRUM °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS -12.7 (502) psig OR -6.9 (80 mm) psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW: SHELL 4.5mm in HEADS in

DES TEMP 470 °F

DES PRESS 45 psig VAC FULL mmHg

HEADS: ELIP ✓ DISHED CONE FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES ✓ CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER Note (2) THK in

INSULATION: CONSERV'N ✓ PROTECTN NONE

DECK MATL CS VALVE MATL. 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO. | NO | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | 6 | VAPOR OUTLET TO EA-801 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | 1 | 12 | REFLUX IN FROM FA-801 |
| 11 | 1 | 2 | FEED FROM GA-RC |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | 1 | 16 | TO (REBOILER) (RES PUMP) |
| 15 | 1 | 20 | FROM REBOILER |
| 16 | 1 | 2 | EQUALIZING LINE WITH FA-607 |
| 17 | 1 | 1½ | BOTTOM OUTLET TO GA-803 |
| 18 | | | LIQUID OUTLET TO |
| 19 | 1 | 2 | DRAWOFF TO FA-807 |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Q) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Q) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

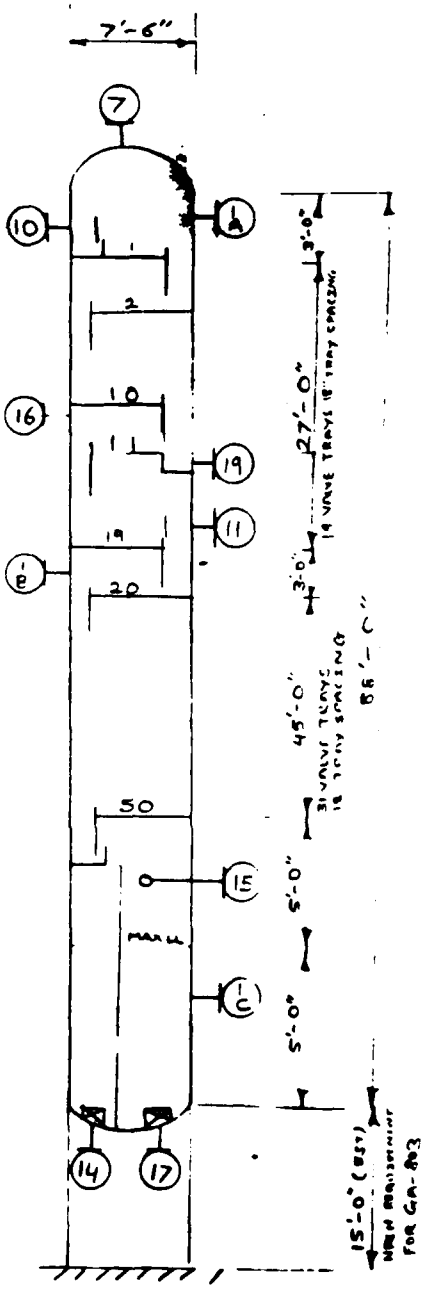
PLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.

NOTES

(1) LIQUID SP. GR. = .97 (avg) @ operating temp

(2) 316L SS CLAD BELOW TRAY # 22.

NO CORROSION ALLOW FOR CS SHELL IN THIS SECTION




| REV | DATE | DESCRIPTION | PROJ | PROCESS | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | ADD FOR TRAY 4 | | | | |

LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

PROCESS VESSEL SHEET

VESSEL NO DA-801

[illegible] EQUIPMENT [illegible] DATE [illegible]
[illegible] SERIES [illegible] [illegible] TUBE ORIENTED TO [illegible] TOMMOS JOB OR ESTIMATE 5571
DA-601 FLASH DRUM [illegible] DEPT 302 DEPT LTD

LAYOUT DIMENSIONS

TRAY SPACING,INCHES [illegible] INSIDE TOWER DIAMETER,INCHES 90.00
TYPE OF FLOW [illegible]

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/CU FT | LIQUID RATE GPM | LIQUID DENSITY LBS/CU FT | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 4967[illegible] | .062 | .84[illegible] | 59.[illegible] | 26.49 | .34300 |
| MINIMUM = | 4[illegible] | .095[illegible] | 42525.[illegible] | 57.[illegible] | 31.49 | .30200 |

(BASED ON [illegible] TURNDOWN TO [illegible] % OF VAPOR AND [illegible] % OF LIQUID MINIMUM RATES FOR MAXIMUM LOADED TRAY)

(BASED ON TURNDOWN TO 70.0 % OF VAPOR AND [illegible] % OF LIQUID MINIMUM RATES FOR MINIMUM LOADED TRAY)

DOWNCOMER LOCATION [illegible]
DOWNCOMER TYPE [illegible]
DIMENSIONS AT TOP OF DOWNCOMER,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | [illegible] | 9.[illegible] |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 9. |
| OUTLET WEIR HEIGHT | | 1.25 |
| OUTLET WEIR LENGTH | [illegible] | 54.0[illegible] |
| CHORD LENGTH AT DOWNCOMER PLATE | [illegible] | 54.0[illegible] |

DIMENSIONS AT BOTTOM OF DOWNCOMER,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | [illegible] | 7.0[illegible] |
| DOWNCOMER CLEARANCE | [illegible] | .25[illegible] |
| DOWNCOMER BOTTOM TO TRAY [illegible] | [illegible] | .00[illegible] |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 9.[illegible] |
| LENGTH OF DOWNCOMER PLATE | [illegible] | 50.[illegible] |

NOTE 1 - PER DOWNCOMER, NOTE 2 - PER [illegible] PLATE, [illegible] NOTE 3 - PER [illegible] TRAY [illegible], NOTE 4 - HORIZONTAL DISTANCE

* * * * * ATTACH THIS SHEET TO THE VAPOR TRAY DRAWING [illegible] MASTER SPECIFICATION FOR THIS TRAY * * * * * *

VESSEL NO DA-502 DOMB WITH

VESSEL NAME DRYER COLUMN

DIAMETER 4'-0" INSIDE

VERT HT 24'-3" INSIDE SEAM 15'-0"

HORIZ LENGTH

OPER TEMP: TOP 221 °F BOTT 255 °F DRUM °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS -12.5 (TRY) psig OR -12.7 (CALC) psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW: SHELL 1/8" @ HEADS in

DES TEMP 300 °F

DES PRESS 45 psig VAC FULL psig

HEADS: ELIP ✓ DISHED CONE FLAT

CODE: ASME VIII ✓ API OTHER

STRESS RELIEVED: YES ✓ CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER NOTE (2) THK in

INSULATION: CONSERV'N ✓ PROTECTN NONE

DECK MATL: CS VALVE MATL: 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

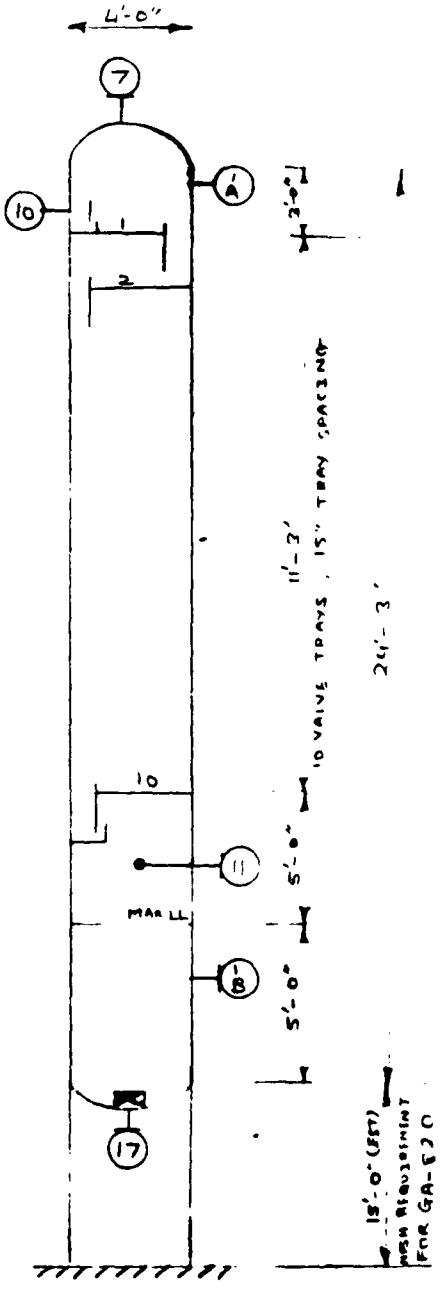
| ITEM NO. | NO REQD | SIZE IN | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | 1 | 10 | VAPOR OUTLET TO EA-505 |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | 1 | 1½ | REFLUX IN FROM EA-502 |
| 11 | 1 | 1 | FEED FROM EA-501 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | — | — | TO (REBOILER) (REB. PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH |
| 17 | 1 | 3 | BOTTOM OUTLET TO GA-520 |
| 18 | — | — | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (SL COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P ) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T ) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | 2 | — | EXTERNAL LEVEL |
| 47 | — | — | EXTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | |
| 50 | — | — | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES:

(1) LIQUID SP. GR. = 0.78 (avg) @ operating temp.

(2) 316L SS CLAD BELOW TRAY # 10. NO CORR ALLOW FOR CS SHELL IN THIS SECTION.




THE LUMMUS COMPANY

WILD JET FUEL PROJECT

| REV | DESCRIPTION | DRAWN | CHKD | APPD | APPD |
|---|---|---|---|---|---|
| 1 | FOR TRIP 4 | | | | |

PRESSURE VESSEL SECTION

VESSEL NO DA-502

CE LUMMUS VALV TRAY COMPUTER PROGRAM 4.9211 RELEASE 03 DATED APR 25 1986 BATCH
BY SUNIL USED AT 09.44.43 ON 88/11/29. DESIGN FINAL ROUNDED ID SXF LUMMUS JOB OR ESTIMATE 5571
DA-802 DRYING COLUMN (ANG JET FUELS PROJECT) DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING,INCHES 15.000 INSIDE TOWER DIAMETER,INCHES 32.00 (502)
TYPE OF FLOW SXF (1-PASS)

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 6568.00 | .18340 | 7373.00 | 56.94000 | 20.96 | .28300 |
| (BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| [redacted] | 2745.20 | .13700 | 2497.80 | 58.13000 | 23.40 | .29000 |
| (BASED [redacted] TURNDOWN TO [redacted].0 O/O OF VAPOR AND TO 70.0 O/O OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION 1=SIDE
DOWNCOMER TYPE 1= STRAIGHT

| | | |
|---|---|---|
| [redacted] | (NOTE 1) | 4.000 |
| [redacted] ALLOWANCE | | 4.000 |
| OUTLET WEIR HEIGHT | | 2.250 |
| [redacted] NOTCH | | 1.500 |
| [redacted] | (NOTE 2) | 20.396 |
| [redacted] | (NOTE 2) | 20.396 |

[redacted]

| | | |
|---|---|---|
| [redacted] | (NOTE 1) | 4.000 |
| [redacted] | (NOTE 3) | .750 |
| [redacted] TRAY INLET | (NOTE 4) | .000 |
| | | 4.000 |
| | (NOTE 2) | 20.396 |

NOTE 1 -PER DOWNCOMER, NOTE 2 -PER DOWNCOMER PLATE, NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 [redacted] IN ( ) REFER TO THE APPLICABLE MESSAGES ON THE DIAGNOSTICS SHEET , NOTE 6 - * INDICATES SPECIAL TRAY FEATURE

[redacted] TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY * * * * *

VESSEL NO DA 803 CONS WITH
VESSEL NAME PHENOL COLUMN
DIAMETER 9'-0" I.D. O.D.
VESS HT 118'-0" S/S SKIRT 15'-0" S/S
HORIZ LENGTH O.D.
OPER TEMP TOP 212 °F BOTT 350 °F STEAM °F
MAX TEMP TOP °F BOTT °F STEAM °F
NORM OPER PRESS -12.7(10.2) psig OR -6.0(Bottom) psig
MAX OPER PRESS psig OR psig
CORROSION ALLOW SHELL 4.5mm in BRKTS in

DSN TEMP 375 °F
DSN PRESS 45 psig VAC FULL psig
HEADS: ELIP V DISHED CONE FLAT
CODE: ASME VIII API OTHER
STRESS RELIEVED: YES V CODE
RADIOGRAPHED YES CODE
EARTHQUAKE: WIND mph

MATL: SHELL CS LINER N 825 (2) THK in
INSULATION: CONSERV'N V PROTECT'N NONE
DISCH MATL: CS VALVE 304 SS 304 SS

NOZZLES FLG CLASS 150 COUPL CLASS

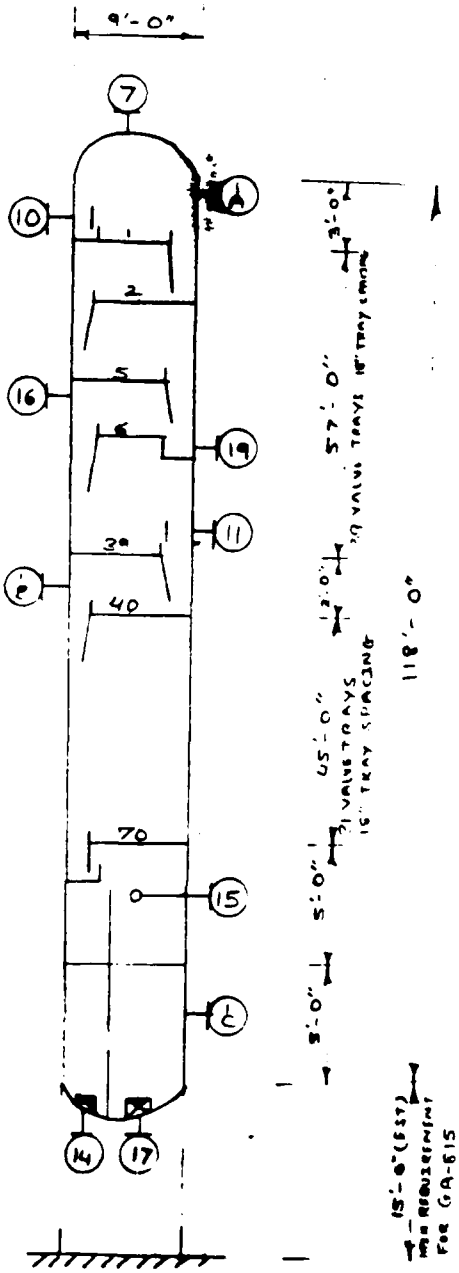
| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | | | |
| 7 | 1 | 24 | VAPOR OUTLET TO FA-807 |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | 1 | 4 | REFLUX IN FROM FA-803 |
| 11 | 1 | 1½ | FEED FROM GA-820 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | 1 | 12 | TO (REBOILER) (REB. PUMP) |
| 15 | 1 | 20 | FROM REBOILER |
| 16 | 1 | 3 | EQUALIZING LINE WITH FA-806 |
| 17 | 1 | 1½ | BOTTOM OUTLET TO GA-815 |
| 18 | 1 | 3 | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO FA-806 |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (SV) |
| 34 | — | — | SAFETY VALVE (SVW) (VBV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P ) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T ) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | |
| 45 | — | — | GAUGE GLASS (GG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | 1 | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | |
| 50 | — | — | |

PLANNED NOZZLES ARE DESIGNED 1-45 FOR COUPLING ADD 89 TO NOZZLE NO.

(1) LIQUID SP. GR = 0.942 (avg) @ operating temp.

(2) 316L CS CLAD BELOW TRAY # 5.

NO CORR ALLOW FOR CS SHELL IN THIS SECTION.




THE LUMMUS COMPANY

TITLE JET FUEL PRODUCT

DRAWING NO 05571

| REV | DESCRIPTION | DRAWN | APPD |
|---|---|---|---|
| 1 | FOR TENDER | | |
| 2 | | | |

VESSEL NO DA-803

[illegible]

DA 805

LAYOUT DIMENSIONS

TRAY SPACING,INCHES = [illegible] TRAY DIAMETER,INCHES = 116.00

TYPE OF FLOW [illegible]

| DESIGN LOADS | VAPOR RATE LB/HR | VAPOR DENSITY LB/CU FT | LIQUID RATE LB/HR | LIQUID DENSITY LB/CU FT | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 69[illegible].00 | .[illegible] | 63854.[illegible] | 60.98[illegible] | [illegible].0 | .46000 |
| (BASED ON OVERDESIGN FLOOD [illegible] OF VAPOR AND [illegible] OF LIQUID TYPICAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| MINIMUM = | 565[illegible].23 | .[illegible] | 6068[illegible].7 | 56.[illegible] | 22.[illegible] | .29500 |
| (BASED ON TURNDOWN OF [illegible] OF VAPOR AND [illegible] OF LIQUID TYPICAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION [illegible]E
DOWNCOMER TYPE [illegible]
[illegible]

DIMENSIONS AT TOP OF DOWNCOMER,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | [illegible] | 18. |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 18. |
| OUTLET WEIR HEIGHT | | 1. |
| OUTLET WEIR LENGTH | [illegible] | 6[illegible] |
| CHORD LENGTH AT DOWNCOMER PLATE | [illegible] | 6[illegible] |

DIMENSIONS AT BOTTOM OF DOWNCOM,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | [illegible] | 8. |
| DOWNCOMER CLEARANCE | [illegible] | 1. |
| DOWNCOMER BOTTOM TO TRAY INLET | [illegible] | 3. |
| INLET WEIR HEIGHT | | 1. |
| INLET WEIR LENGTH | [illegible] | [illegible] |
| DOWNCOMER PLATE TO SHELL DISTANCE | | [illegible] |
| LENGTH OF DOWNCOMER PLATE | [illegible] | [illegible] |
| INLET WEIR TO SHELL DISTANCE | | 11. |
| CHORD LENGTH AT INLET WEIR | [illegible] | [illegible] |

NOTE 1 -PER DOWNCOMER. NOTE 2 -PER DOWNCOMER PLATE. [illegible] NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 -NUMBERS IN [illegible] TO BE APPLICABLE [illegible] FOR [illegible]

* * * * * ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET [illegible] SPECIFICATION FOR THIS TRAY * * * * * *

VESSEL NO DA-805 COSHS WITH

VESSEL NAME LIGHT ENDS COLUMN

DIAMETER 2'-8" Rdn & Rdn

VERT HT 36'-0" Rdn SKIRT 15'-0" Rdn

HORIZ LENGTH Rdn

OPER TEMP TOP 222 °F BOTT 372 °F DRUM °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS 0 PSI (TOP) psig OR 40 (BOTTOM) psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW: SHELL 4.5mm in DISHS in

DES TEMP 400 °F

DES PRESS 45 psig VAC — psia

HEADS: ELIP DISHED CONE FLAT

CODE: ASME VIII APP OTHER

STRESS RELIEVED: YES ✓ CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER NOTE 12 THK in

INSULATION: CONSERVTN ✓ PROTECTN SIDING

DISH MATL: CS VALVE NOTE 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

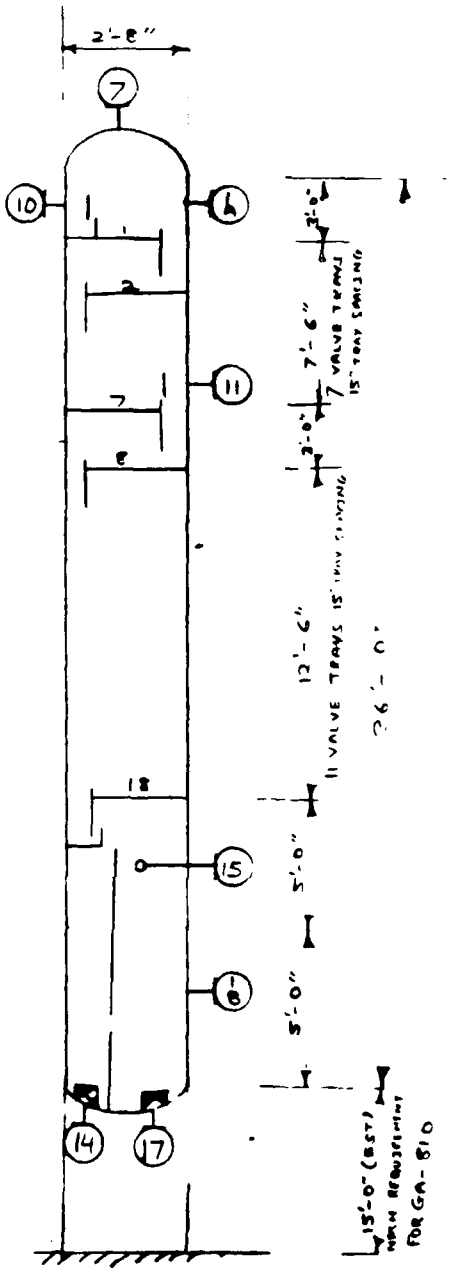
| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | MANHOLE |
| 5 | | | |
| 6 | 1 | 6 | VAPOR OUTLET TO EA-805 |
| 7 | | | VENT |
| 8 | | | TO VACUUM EQUIPMENT |
| 9 | 1 | 1½ | REFLUX IN FROM EA-805 |
| 10 | 1 | 1½ | FEED FROM GA-806 |
| 11 | | | FEED FROM |
| 12 | | | FEED FROM |
| 13 | 1 | 4 | TO (REBOILER) (REB. PUMP) |
| 14 | 1 | 8 | FROM REBOILER EA-809 |
| 15 | | | EQUALIZING LINE WITH |
| 16 | 1 | 16 | BOTTOM OUTLET TO GA-810 |
| 17 | | | LIQUID OUTLET TO |
| 18 | | | DRAWOFF TO |
| 19 | | | RETURN FROM |
| 20 | | | DRAWOFF TO |
| 21 | | | RETURN FROM |
| 22 | | | DRAWOFF TO |
| 23 | | | RETURN FROM |
| 24 | | | REFLUX DRAWOFF TO |
| 25 | | | REFLUX IN, FROM |
| 26 | | | REFLUX DRAWOFF TO |
| 27 | | | REFLUX IN, FROM |
| 28 | | | PROCESS STEAM |
| 29 | | | STEAM OUT (SO) |
| 30 | | | DRAIN |
| 31 | | | SAMPLE CONN. (S), COOLER (SC) |
| 32 | | | SAFETY VALVE (SV) |
| 33 | | | SAFETY VALVE (PVSV) (VSV) |
| 34 | | | UTILITY CONNECTION |
| 35 | | | PRESSURE GAGE (PG) |
| 36 | | | PRESSURE CONTROLLER (P) |
| 37 | | | PRESSURE TAP (PT) |
| 38 | | | |
| 39 | | | TEMPERATURE INDICATOR (TI) |
| 40 | | | TEMPERATURE CONTROLLER (T) |
| 41 | | | TEMPERATURE RECORDER (TR) |
| 42 | | | TEMPERATURE WELL (TW) |
| 43 | | | |
| 44 | | | GAGE GLASS (GG) |
| 45 | | | EXTERNAL LEVEL |
| 46 | 1 | | INTERNAL LEVEL |
| 47 | | | LEVEL ALARM (LA) |
| 48 | | | |

PLANNED NOZZLES ARE REQUIRED 1-09. FOR COUPLING ADD 09 TO NOZZLE NO.

NOTES:

1) LIQUID SP GR = 0.92 (avg) @ operating temp.

2) 316L SS CLAD BELOW TRAY @ P. NO. CORR ALLOW FOR CS SHELL IN THIS SECTION




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ⚠ | | | | | | | |
| ⚠ | [illegible] | FOR TRAY 4 | SR | | | | |
| REV | [illegible] | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR | |

LUMMUS — THE LUMMUS COMPANY

JET FUEL PROJECT

PROCESS VESSEL DESIGN

VESSEL NO DA-805

CE LUMMUS
BY SUNIL

VALVE TRAY COMPUTER PROGRAM 4-9217
JSED AT 09.19.43 ON 84/11/29.
(LNG JET FUELS PROJECT)

RELEASE 03 DATED APR 25 1984
DESIGN - FIND NUMBER(S) TO SEE

BATCH
LUMMUS JOB OR ESTIMATE 5571
DEPT 302 OFFICE LTD

A-805

LAYOUT DIMENSIONS

TRAY SPACING, INCHES 15.000 INSIDE TOWER DIAMETER, INCHES 48.00
TYPE OF FLOW SXF (1-PASS)

| | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 7643.00 | .01640 | 7802.00 | 61.42000 | 29.10 | .40800 |
| (BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| [illegible] | 93[illegible].80 | .01640 | 5641.40 | 61.42000 | 29.10 | .40800 |
| [illegible] O/O OF VAPOR AND TO 70.0 O/O OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION= 1=SIDE
DOWNCOMER TYPE 1= STRAIGHT

| | | |
|---|---|---|
| [illegible] | (NOTE 2) | 5.000 |
| [illegible] | | 5.000 |
| [illegible] | | 2.503 |
| [illegible] | | 4.503 |
| [illegible] | (NOTE 2) | 29.326 |
| [illegible] | (NOTE 2) | 29.326 |

[illegible] INCHES

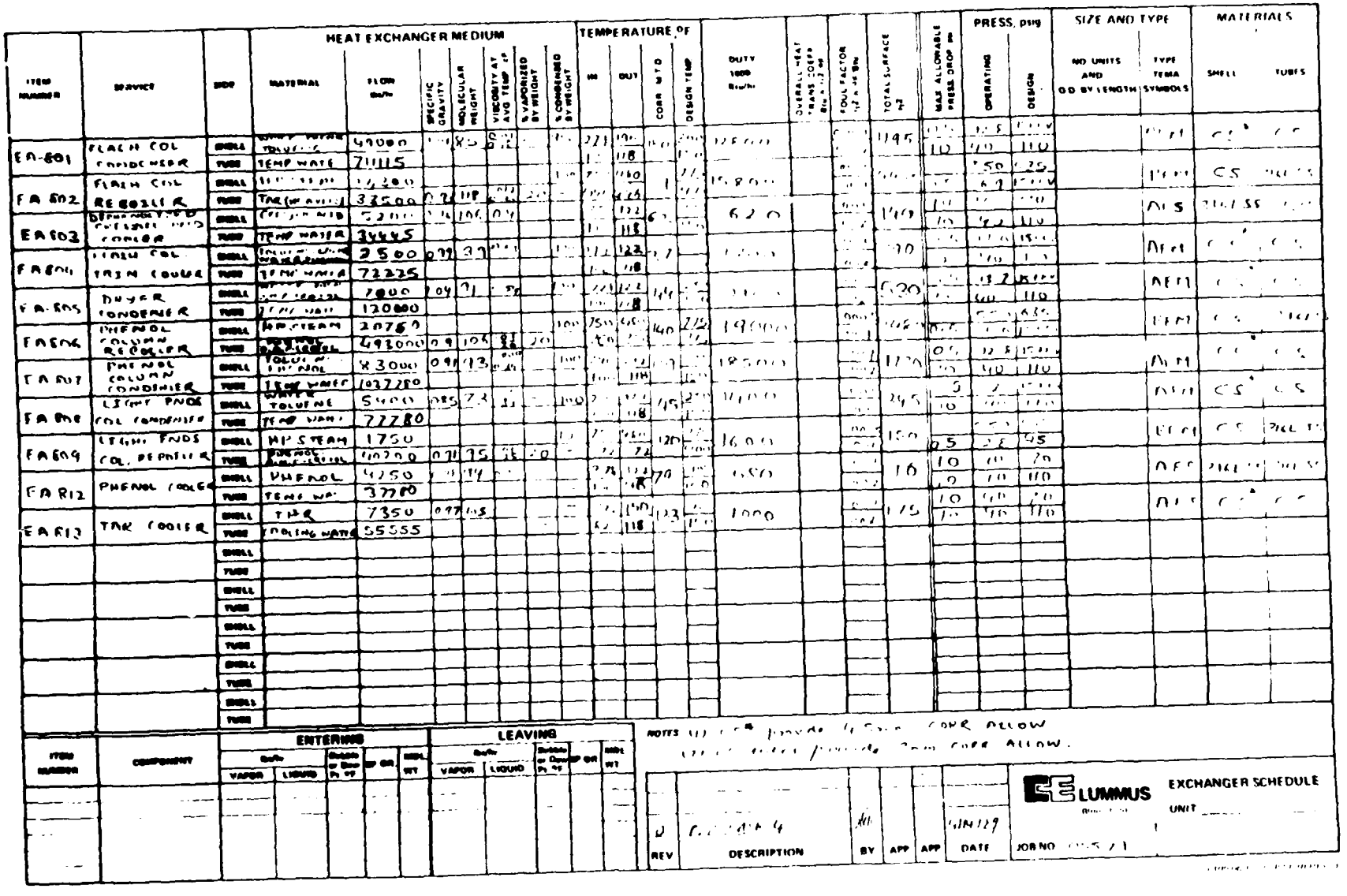
| | | |
|---|---|---|
| [illegible] | (NOTE 1) | 5.000 |
| [illegible] | (NOTE 3) | .750 |
| [illegible] | (NOTE 4) | .000 |
| | | 5.000 |
| | (NOTE 2) | 29.326 |

NOTE 1 -[illegible] NOTE 2 -PER DOWNCOMER PLATE, NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

[illegible] SPECIAL TRAY FEATURE

VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY [illegible]

F-112



| ITEM NUMBER | SERVICE | SIDE | HEAT EXCHANGER MEDIUM: MATERIAL | FLOW lb/hr | SPECIFIC GRAVITY | MOLECULAR WEIGHT | VISCOSITY AT AVG TEMP cP | % VAPORIZED BY WEIGHT | % CONDENSED BY WEIGHT | TEMPERATURE °F: IN | OUT | CORR MTD | DESIGN TEMP | DUTY 1000 Btu/hr | OVERALL HEAT TRANS COEFF Btu/hr ft² °F | FOUL FACTOR (ft² hr °F/Btu) | TOTAL SURFACE ft² | MAX ALLOWABLE PRESS DROP psi | PRESS, psig: OPERATING | PRESS, psig: DESIGN | SIZE AND TYPE: NO UNITS AND OD BY LENGTH | SIZE AND TYPE: TYPE TEMA SYMBOLS | MATERIALS: SHELL | MATERIALS: TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EA-501 | FLASH COL CONDENSER | SHELL | | 49000 | | 85 | 0.2 | | | 221 | 190 | 100 | | 125 000 | | | 1195 | 10 | 40 | 110 | | | CS | CS |
| | | TUBE | TEMP WATER | 71115 | | | | | | 1 | 118 | | | | | | | | 150 | 225 | | | | |
| EA 502 | FLASH COL REBOILER | SHELL | | 33200 | | | | | | 221 | 240 | 1 | 225 | 15 800 | | | 500 | | 60 | 150 | | | CS | CS |
| | | TUBE | TAR (WARM) | 33500 | 0.92 | 118 | 0.2 | 20 | | 240 | 224 | | | | | | | | | | | | | |
| EA 503 | DEPROPANIZER OVERHEAD CONDENSER | SHELL | | 52000 | 0.56 | 106 | 0.1 | | | 122 | 122 | 67 | | 6 2 0 | | | 1469 | 10 | 40 | 110 | | AES | 316 SS | 316 SS |
| | | TUBE | TEMP WATER | 34445 | | | | | | 1 | 118 | | | | | | | | | | | | | |
| EA 504 | FLASH COL TRIM COOLER | SHELL | | 2500 | 0.99 | 39 | 0.2 | | | 122 | 123 | 17 | | | | | 90 | | 40 | 150 | | AEM | CS | CS |
| | | TUBE | TEMP WATER | 72225 | | | | | | 1 | 118 | | | | | | | | 40 | 110 | | | | |
| EA-505 | DRYER CONDENSER | SHELL | | 7000 | 1.04 | 91 | 0.2 | | | 221 | 122 | 144 | | | | | 530 | | 32 | 150 | | AEM | CS | CS |
| | | TUBE | TEMP WATER | 120000 | | | | | | 1 | 118 | | | | | | | | 40 | 110 | | | | |
| EA 506 | PHENOL COLUMN REBOILER | SHELL | HP STEAM | 20769 | | | | | 100 | 750 | 650 | 140 | 775 | 19 000 | | | 106 | 85 | 450 | 485 | | TEM | CS | 316 SS |
| | | TUBE | PHENOL | 493000 | 0.9 | 106 | 0.2 | 20 | | 650 | 700 | | | | | | | | | | | | | |
| EA 507 | PHENOL COLUMN CONDENSER | SHELL | TOLUENE & PHENOL | 8300 | 0.91 | 93 | 0.2 | | 100 | 220 | 220 | 9 | | 18 500 | | | 1120 | 05 | 32 | 150 | | AEM | CS | CS |
| | | TUBE | TEMP WATER | 1037280 | | | | | | 1 | 118 | | | | | | | | 40 | 110 | | | | |
| EA 508 | LIGHT ENDS COL CONDENSER | SHELL | WATER TOLUENE | 5400 | 0.85 | 73 | 0.2 | | 100 | 2 | 122 | 145 | 2 | 3 400 | | | 245 | 5 | 2 | 150 | | AEM | CS | CS |
| | | TUBE | TEMP WATER | 72780 | | | | | | 1 | 118 | | | | | | | 10 | | | | | | |
| EA 509 | LIGHT ENDS COL REBOILER | SHELL | HP STEAM | 1750 | | | | | 100 | 221 | 221 | 120 | | 16 000 | | | 150 | 05 | 32 | 95 | | EEM | CS | 316 SS |
| | | TUBE | PHENOL & HEAVIES | 40200 | 0.91 | 95 | 0.2 | 20 | | 275 | 224 | | | | | | | | | | | | | |
| EA R12 | PHENOL COOLER | SHELL | PHENOL | 4150 | 1.0 | 94 | 0.2 | | | 221 | 122 | 70 | | 650 | | | 16 | 10 | 40 | 70 | | AEM | 316 SS | 316 SS |
| | | TUBE | TEMP WATER | 37780 | | | | | | 1 | 118 | | | | | | | 10 | 40 | 110 | | | | |
| EA R13 | TAR COOLER | SHELL | TAR | 7350 | 0.97 | 115 | 0.2 | | | 221 | 150 | 123 | | 1000 | | | 175 | 10 | 40 | 110 | | AEM | CS | CS |
| | | TUBE | COOLING WATER | 55555 | | | | | | 60 | 118 | | | | | | | 10 | 40 | 110 | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |

| ITEM NUMBER | COMPONENT | ENTERING: Duty VAPOR | ENTERING: Duty LIQUID | ENTERING: Outside or Shell lb/hr | ENTERING: TEMP IN | ENTERING: MOL WT | LEAVING: Duty VAPOR | LEAVING: Duty LIQUID | LEAVING: Outside or Shell lb/hr | LEAVING: TEMP OUT | LEAVING: MOL WT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

NOTES (1) [illegible] provide 1/8 in. CORR ALLOW
(2) [illegible] provide 2mm CORR ALLOW.

| REV | DESCRIPTION | BY | APP | APP | DATE |
|---|---|---|---|---|---|
| 0 | [illegible] | [illegible] | | | 6/N/79 |

LUMMUS

EXCHANGER SCHEDULE

UNIT _____

JOB NO [illegible]

VESSEL NO FA-801 ODMB WITH

VESSEL NAME FLASH COLUMN REFLUX DRUM

DIAMETER 3-0" ID & in

VERT HT in OVER/SHORT in

HORIZ LENGTH 9-0" in

OPER TEMP TOP °F BOTT °F DRUM 194 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL 1/8 in & DECKS in

DES TEMP 220 °F

DES PRESS 45 psig VAC FULL VAC psia

HEADS ELIP DISHED ✓ CONE FLAT

CODE ASME VIII API OTHER

STRESS RELIEVED YES ✓ CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in

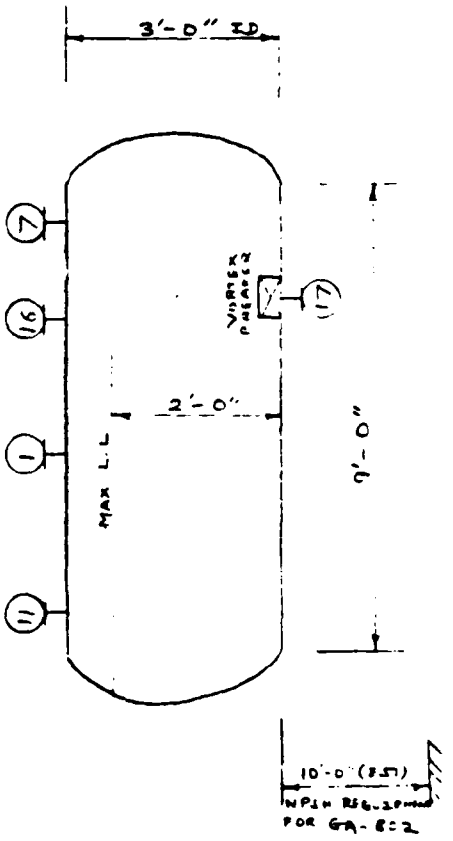
INSULATION CONSERV'N ✓ PROTECT'N NONE

DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | 6 | VAPOR OUTLET TO EA-EC4 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 4 | FEED FROM EA-EC1 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH EA-EC1 |
| 17 | 1 | 4 | BOTTOM OUTLET TO GA-EC2 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




IG SP GR = 1.01 @ operating temp

| REV | ISSUE DATE | DESCRIPTION | PREPD BY | PREPD BY | APPD | APPD |
|---|---|---|---|---|---|---|
| 1 | 4/87 | FOR TASK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE - GREAT PLAINS SYNFUELS PLANT LOCATION BEULAH, NORTH DAKOTA

PROJ NO 055 71

PROCESS VESSEL SKETCH

VESSEL NO FA-801 DWG SIZE -

VESSEL NO. FA-EC2 — DRIER REBOIL

| | | | |
|---|---|---|---|
| DIAMETER | 3'-6" | | |
| VERT HT | | | |
| HORIZ LENGTH | 10'-5" | | |
| OPER TEMP: VAP | | EQPT | BRINE 182 |
| MAX TEMP: VAP | | EQPT | BRINE |
| NORM OPER PRESS | | psig OR | 1.0 |
| MAX OPER PRESS | | psig OR | |
| CORROSION ALLOW: SHELL | 45 | EQUIP | |

DES TEMP 150 ; DES PRESS 45 psig VAC FULL

HEADS: ELIP — DISHED — CONE — FLAT

CODE: ASME VIII — NPR — OTHER

STRESS RELIEVED: YES — CODE

RADIOGRAPHED: YES — CODE

EARTHQUAKE — WIND

MATL: SHELL CS — LINER — THK

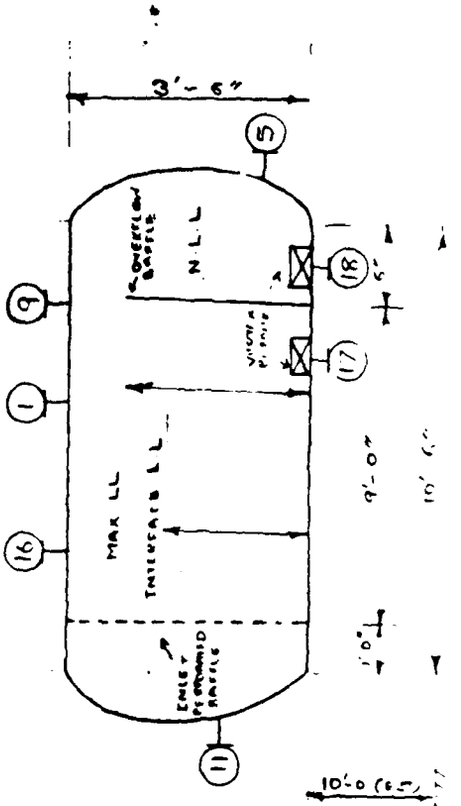
INSULATION: CONSERVTN — PROTECTN — WORK

GASK MATL:

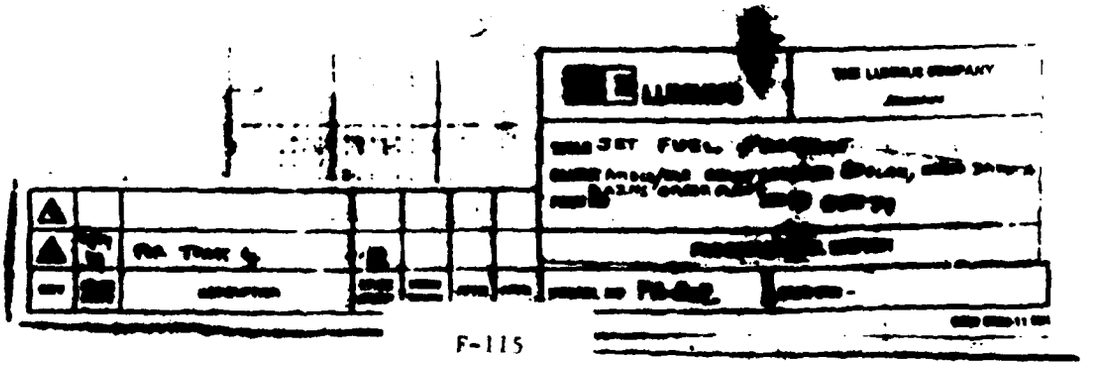
NOZZLES: FLG CLASS 150 — COUPL CLASS

| ITEM NO. | NO. REQD | SIZE | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | 1 | 5 | MANHOLE |
| 5 | | | VAPOR OUTLET TO |
| 6 | | | VENT |
| 7 | 1 | 2 | TO VACUUM EQUIPMENT |
| 8 | | | REFLUX IN FROM |
| 9 | 1 | 3 | FEED FROM FA-105 |
| 10 | | | FEED FROM |
| 11 | | | FEED FROM |
| 12 | | | TO (REBOILER) (REB. PUMP) |
| 13 | | | FROM REBOILER |
| 14 | 1 | 1½ | REBOILING LINE WITH FA-105 |
| 15 | 1 | 2 | BOTTOM OUTLET TO GA-112 |
| 16 | 1 | 1½ | LIQUID OUTLET TO GA-111 |
| 17 | | | DRAWOFF TO |
| 18 | | | RETURN FROM |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | REFLUX DRAWOFF TO |
| 24 | | | REFLUX IN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | PROCESS STREAM |
| 28 | | | BOILED OUT (BO) |
| 29 | | | DRAIN |
| 30 | | | SAMPLE COIL (S), COOLER (SC) |
| 31 | | | SAFETY VALVE (SV) |
| 32 | | | SAFETY VALVE (FV) (NSV) |
| 33 | | | UTILITY CONNECTION |
| 34 | | | PRESSURE GAGE (PG) |
| 35 | | | PRESSURE CONTROLLER (P) (R) |
| 36 | | | PRESSURE TAP (PT) |
| 37 | | | TEMPERATURE INDICATOR (TI) |
| 38 | | | TEMPERATURE CONTROLLER (T) (R) |
| 39 | | | TEMPERATURE RECORDER (TR) |
| 40 | | | TEMPERATURE WELL (TW) |
| 41 | | | GAUGE GLASS (LG) |
| 42 | 1 | | INTERFACE LEVEL |
| 43 | | | INTERFACE LEVEL |
| 44 | | | LEVEL ALARM (LA) |

FLANGED NOZZLES ARE WELDING NECK. FOR COUPLING ADD 30 TO NOZZLE NO.




LIQUID SP. GR. = 1.013 (avg) @ operating temp.



VESSEL NO FA-802 COMB WITH

VESSEL NAME PREFRACT COL REFLUX DRUM

DIAMETER 4'-0" Rqd A Rqd

VERT HT Rqd SKIRT Rqd

HD TAN LENGTH 12'-0" Rqd

OPER TEMP TOP °F BOTT °F DRUM °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 93 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL 4.5mm W DECKS in

DES TEMP 340 °F

DES PRESS 45 psig VAC FULL psia

HEADS ELIP DISHED CONE FLAT

CODE ASME VIII API OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL C.S LINER THK in

INSULATION CONSERVTN PROTECTN MORE

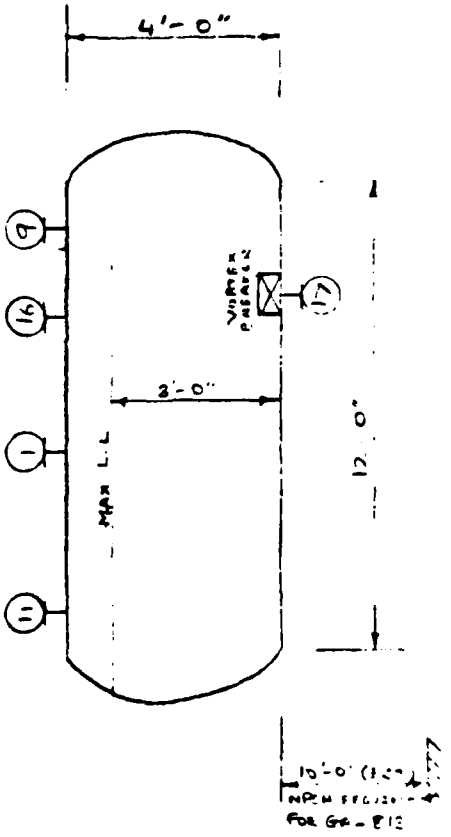
DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | 1 | — | VAPOR OUTLET TO |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM |
| 11 | 1 | 6 | FEED FROM FA-807 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | — | — | TO REBOILER (RES PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | 1 | 1" | EQUALIZING LINE WITH FA-807 |
| 17 | 1 | 1" | BOTTOM OUTLET TO GF-802 |
| 18 | — | — | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (SL COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVBV) (VBV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | |
| 45 | — | — | GAUGE GL ASS (LG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | ✓ | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | |
| 50 | — | — | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.

LIQUID SP GR = 0.91 @ operating temp




| REV | ISSUE DATE | DESCRIPTION | PREP'D | PROJ MGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/19 | FOR TASK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT PUBLIC SERVICE CO OF COLO LOCATION EVELAN, NORTH DAKOTA

PROJ NO 08571

PROCESS VESSEL SKETCH

VESSEL NO FA-802

VESSEL NO FA 805 COMB WITH

VESSEL NAME LIGHT ENDS COLUMN REFLUX DRUM

DIAMETER 2'-6" I.D.

VERT HT 7'-6" SEAM

HORIZ LENGTH

OPER TEMP TOP °F BOTT °F DRUM 120 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 14.5 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 1/8" in. HEADS in.

DES TEMP 150 °F

DES PRESS 65 psig VAC FULL psia

HEADS: ELIP DISHED ✓ CONE FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES ✓ CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL C.S. LINER THK in.

INSULATION: CONSERV'N ✓ PROTECTN MORE

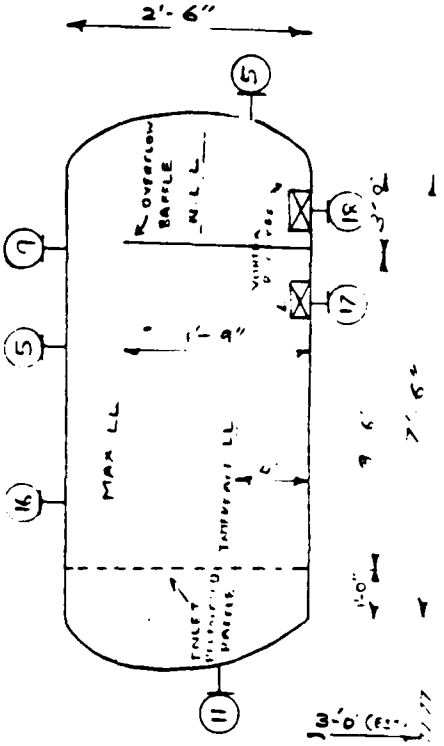
DECK MATL:

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | | | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 16 | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | 1 | 2 | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | | FEED FROM FA-802 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO REBOILER (FEED PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH FA-802 |
| 17 | 1 | 1½ | BOTTOM OUTLET TO GA- |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-803 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN. (S), COOLER (SR) |
| 33 | | | SAFETY VALVE (SV) |
| 34 | | | SAFETY VALVE-(PVENT) (VENT) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAGE GLASS (LG) |
| 46 | | | EXTERNAL CAGE |
| 47 | 2 | | EXTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE RAISED FACE 1/16 IN. FOR DIMENSIONS ADD 25 TO NOZZLE NO.

LIQUID CP GR ± 0.92 (avg) °F operating temp




| REV | | DESCRIPTION | | |
|---|---|---|---|---|
| 1 | 5/14/74 | FOR MFR'S | SR | |

THE LUMMUS COMPANY

TULE JET FUEL PROJECT

PROCESS VESSEL SECTION

FA-805

VESSEL NO FA-806 DRAWN WITH
VESSEL NAME CRUDE PHENOL SURGE DRUM
DIAMETER 6'-6" SAN
VERT HT 20'-0" TAN-TAN
HORIZ LENGTH
OPER TEMP: TOP to BOTT °F DRUM °F
MAX TEMP: TOP to BOTT °F DRUM °F
NORM OPER PRESS psig OR
MAX OPER PRESS psig OR psig
CORROSION ALLOW: SHELL .125in in BEARING in

DES TEMP 230 °F
DES PRESS 45 psig VAC psig
HEADS: ELIP DISHED CONE FLAT
CODE: ASME VIII DIV 1 OTHER
STRESS RELIEVED: YES NO CODE
RADIOGRAPHED: YES NO CODE
EARTHQUAKE: SEISMIC

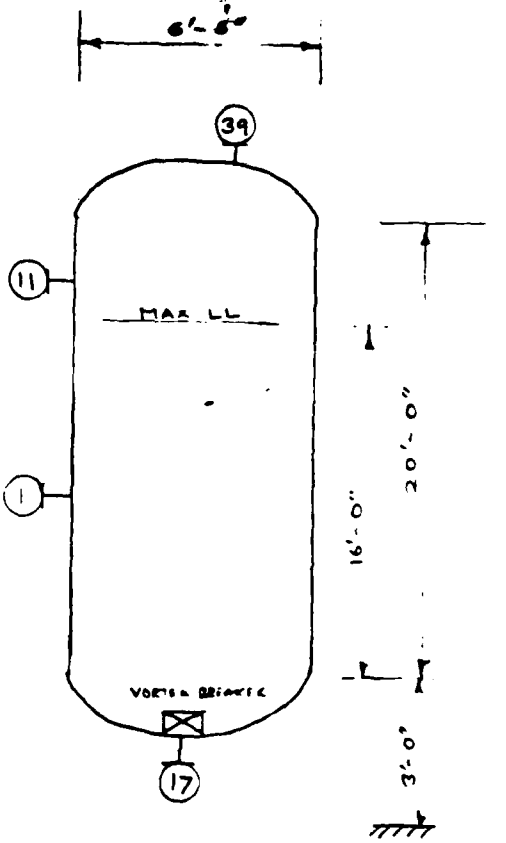
MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N PROTECTN NONE
SKIRT MATL:

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO. | REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IS FROM |
| 11 | 1 | 2 | FEED FROM |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (RES PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | 3 | BOTTOM OUTLET TO GFA-803 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VBV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P in |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 18 | NO BLANK FLANGE |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T in |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 2 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.

LIQUID SP GR = 1.02 @ operating temp




| REV | ISSUE DATE | REVISION | PREP'D BY |
|---|---|---|---|
| 1 | 4/14/93 | FOR TANK 4 | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROFILE

CLIENT AMOCO/ENR BROATLOBATION BISMARCK, ND
PLANT ALL GRASS PLANT
PROJ NO 05571

PROCESS VESSEL SKETCH

FA-806 | DWG NO -

VESSEL NO FA-E07 COMB WITH

VESSEL NAME CREVLTL ACID DRUM

DIAMETER 2'-0" IN

VENT HT IN SHELL IN

NO 'EE LENGTH 5'-0" IN

OPER TEMP: TOP °F BOTT °F DRUM 295 °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 4.3 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 2 mm in DISCHS in

DES TEMP 320 °F

DES PRESS 45 psig VAC FULL psia

HEADS: ELIP DISHED CONIC FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER THK in

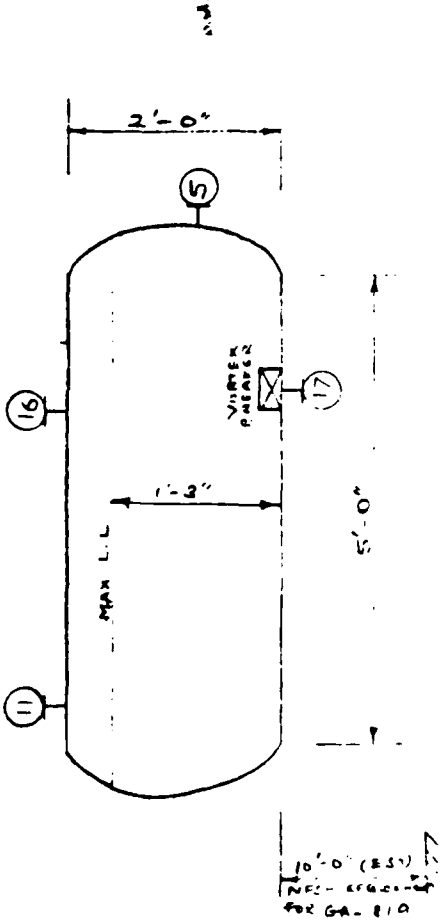
INSULATION: CONSERV'N PROTECT'N HOWE

BRICK MATL

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | | | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 8 | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 3 | FEED FROM DA-E01/LIGHT ENDS |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (RES. PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 2 | 2 | EQUALIZING LINE WITH DA-E01 |
| 17 | 1 | 3 | BOTTOM OUTLET TO FA-P07 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVBV) (VBV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P [ ] C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T [ ] C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GL (GG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

NOTES: FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO.




LIQUID SP. GR: 0.94 @ operating temp.

| REV | ISSUE DATE | DESCRIPTION | DRAWN | CHKD | APPD | APPD |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14 88 | FOR TASK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE - SYNTHOIL STRIPPER ULAH, NORTH DAKOTA

PROCESS VESSEL SKETCH

VESSEL NO FA-E07

VESSEL NO FA-808 COMB WITH
VESSEL NAME PHASE 1 PROP OFF LOAD
DIAMETER 2'-0" IN & IN
VERT HT IN & IN SKIRT IN
HORIZ LENGTH 4'-0" IN
OPER TEMP TOP °F BOTT °F DRUM 274 °F
MAX TEMP TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR 23 psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW SHELL in DECKS in

DES TEMP 300 °F
DES PRESS 45 psig VAC FULL psia
HEADS ELIP DISHED ✓ CONE FLAT
CODE ASME VIII API OTHER
STRESS RELIEVED YES ✓ CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

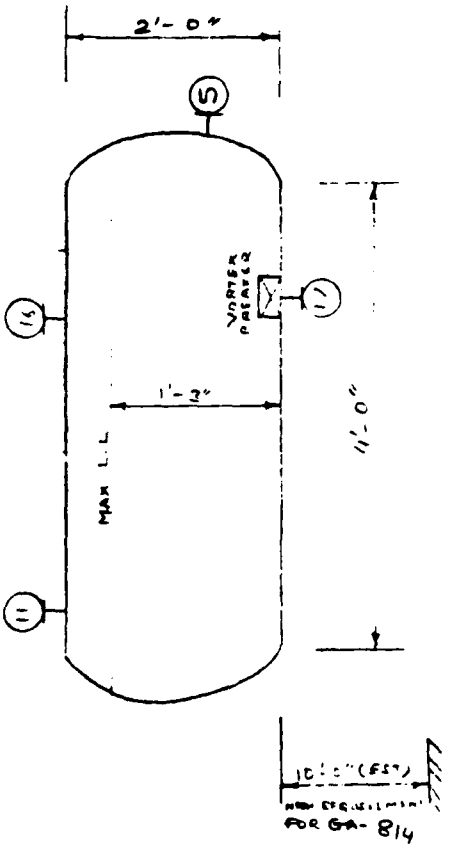
MATL SHELL CS LINER 316L SS CLAD THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | | | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 8 | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | | 2 | FEED FROM FA-802 (CJFE LINE) |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | 1/2 | EQUALIZING LINE WITH FA-803 |
| 17 | | | BOTTOM OUTLET TO GA-814 |
| 18 | ✓ | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ____ C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ____ C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

NOTE: FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

LIQ SP GR = 0.97 @ operating temp




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14 93 | FOR TANK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AND O/Dist. GRAMP LOCATION BAYOU LAH PLASNS GASES PLANT

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FA-808 DWG SKB -

VESSEL NO FA-809 COMB WITH

VESSEL NAME FLIGHT ENDS DRUM

DIAMETER I.D. 35 Rad S

VERT HT Rad SKIRT

HORIZ LENGTH 12'-0" Rad

OPER TEMP: TOP °F BOTT °F STEAM 135 °F

MAX TEMP: TOP °F BOTT °F STEAM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 4.5mm in RECKD in

DES TEMP 150 °F

DES PRESS 45 psig VAC FULL psia

HEADS: ELIP SPHRD DOME FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES X CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE WIND mph

MATL: SHELL CS LINER THK in

INSULATION: CONSERV'N PROTECT'N NONE

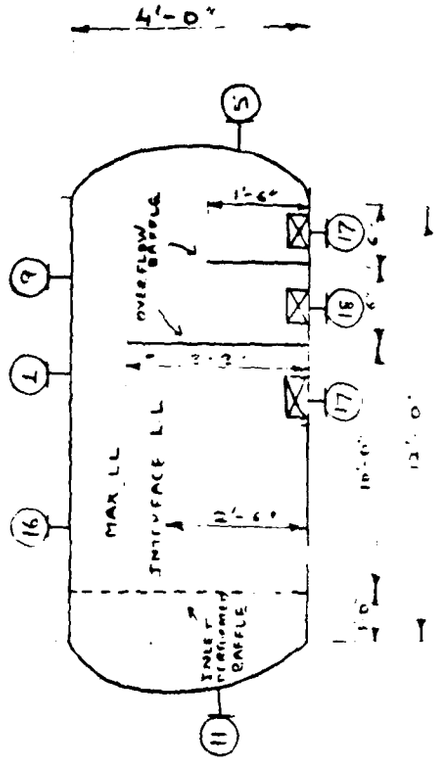
DECK MATL:

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | 1 | 8 | HANDHOLE |
| 5 | | | VAPOR OUTLET TO |
| 6 | 1 | 2 | VENT |
| 7 | 1 | | TO VACUUM EQUIPMENT |
| 8 | 1 | 1½ | REFLUX IN FROM |
| 9 | 1 | 1½ | FEED FROM EA-804 |
| 10 | | | FEED FROM |
| 11 | | | FEED FROM |
| 12 | | | TO (REBOILER FEED PUMP) |
| 13 | 1 | 1½ | FROM REBOILER |
| 14 | 1 | 1½ | EQUALIZING LINE WITH EA-804 |
| 15 | 2 | 1½ | BOTTOM OUTLET TO GA-804 |
| 16 | 1 | 1½ | LIQUID OUTLET TO GA-804 |
| 17 | | | DRAWOFF TO |
| 18 | | | RETURN FROM |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | REFLUX DRAWOFF TO |
| 24 | | | REFLUX IN, FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | PROCESS STEAM |
| 28 | | | STEAM OUT (SO) |
| 29 | | | DRAIN |
| 30 | | | SAMPLE CONN. (S), COOLER (SC) |
| 31 | | | SAFETY VALVE (SV) |
| 32 | | | SAFETY VALVE (SV) (NOV) |
| 33 | | | UTILITY CONNECTION |
| 34 | | | PRESSURE GAGE (PG) |
| 35 | | | PRESSURE CONTROLLER (P) |
| 36 | | | PRESSURE TAP (PT) |
| 37 | | | |
| 38 | | | TEMPERATURE INDICATOR (TI) |
| 39 | | | TEMPERATURE CONTROLLER (T) |
| 40 | | | TEMPERATURE RECORDER (TR) |
| 41 | | | TEMPERATURE WELL (TW) |
| 42 | | | |
| 43 | | | GAGE GLASS (LG) |
| 44 | | | EXTERNAL LEVEL |
| 45 | 2 | | INTERNAL LEVEL |
| 46 | | | LEVEL ALARM (LA) |
| 47 | | | |

NOTE: PLANNED NOZZLES ARE NUMBERED 1-8A. FOR DRAWING ADD 8 TO NOZZLE NO.

LIQ. SP. GR = 0.99 (avg) @ operating temp.




| | | | | |
|---|---|---|---|---|
| 1 | | | | |
| 0 | 4/17/84 | FOR TREK 4 | SR | |
| REV | ISSUE DATE | DESCRIPTION | PREP'D BY | CHK'D BY |

LUMMUS — THE LUMMUS COMPANY

TITLE: JET FUEL PROJECT

CLIENT AND LOCATION: GREAT NORTHERN BEULAH, ND

PLANT NO. 05571

PROCESS VESSEL SECTION

VESSEL NO FA-809

VESSEL NO FB-801 COMB WITH _____

VESSEL NAME SULFURIC ACID TANK (66 % $H_2SO_4$)

DIAMETER 9'-0" ft-in & _____ ft-in

VERT HT 8'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM AMB °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS _____ psig OR _____ psia

CORROSION ALLOW SHELL 2mm & DECKS _____ in

DES TEMP 220 °F

DES PRESS 9" $H_2O$ psig VAC -2 $H_2O$ psig

HEADS ELIP _____ DISHED _____ CONE 60° FLAT BOTTOM

CODE ASME _____ API ✓ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

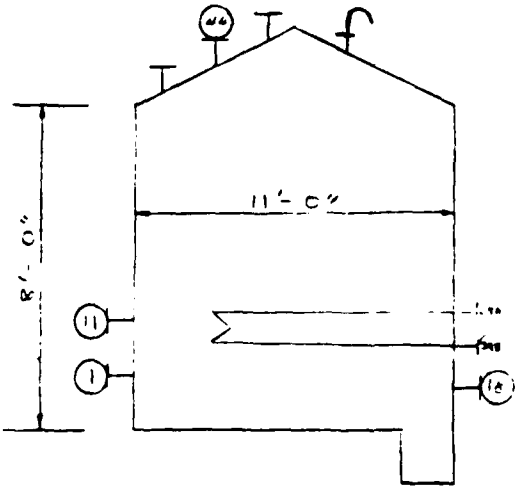
INSULATION CONSERV'N _____ PROTECT'N _____ NONE _____

DECK MATL _____

NOZZLES FLG CLASS 150 COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | _____ |
| 4 | — | — | _____ |
| 5 | — | — | HANDHOLE |
| 6 | — | — | _____ |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 3 | FEED FROM TANK TRUCK |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER) REB PUMP |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 1½ | LIQUID OUTLET TO GA-827 |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S); COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 2 | STEAM COIL |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 6 | GAUGE MAIN |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | 1 | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | _____ |
| 50 | — | — | _____ |

PLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES 1) SULFURIC ACID SP GR = 1.84

2) STEAM COIL TO MAINTAIN 50°F MIN

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/19/79 | FOR TANK 4 | EL | | | |

LUMMUS — THE LUMMUS COMPANY (Bloomfield)

TITLE JET FUEL PROJECT

CLIENT Petroleos del Estado LOCATION PLAINS, TEXAS PLANT

PROJ NO _____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-801 SHEET NO 4 OF 8

VESSEL NO FR-802 DOMED WITH

VESSEL NAME JET DAY TANK

DIAMETER 12'-0" R-in S

VERT HT 16'-0" R-in SKIRT R-in

HORIZ LENGTH R-in

OPER TEMP TOP °F BOTT °F DRUM 150 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL 1/16 in BL DECKS in

DES TEMP 230 °F

DES PRESS 8" H2O psig VAC -2" H2O psig

HEADS ELIP BEMED CONE FOR F FLAT TO TD M

CODE ASME API ✓ OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in

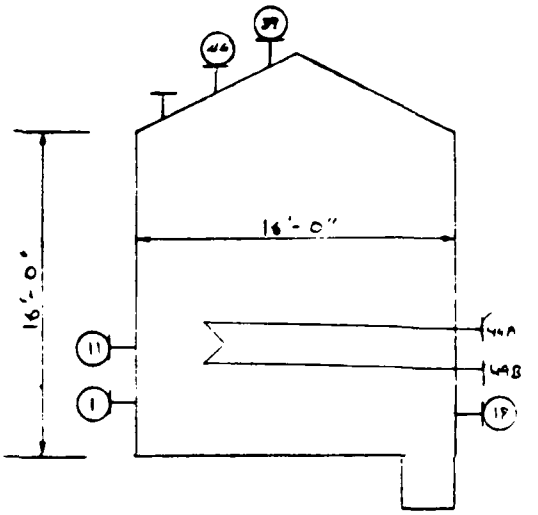
INSULATION CONSERV'N ✓ PROTECT'N NONE

DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM GA-824 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (RES PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-828 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE (SSHN) (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | NO CLINGING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE GLASS |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 2 | 2 | STEAM COIL |
| 50 | | | |

PLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES

1) LIQUID SP. GR = 0.96 @ operat.. temp.

2) STEAM COIL TO MAINTAIN 150°F TEMP.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | 4/84 JB | FOR TANK 4 | MK | | | | |
| REV | ISSUE DATE | REVISION | PREP'D BY | PREP'D BY | APPD | APPD | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

PLANT AMOCO OIL REFINERY BEULAH, N.D.

PROCESS VESSEL SKETCH

VESSEL NO FR-802

VESSEL NO FC-803 COMB WITH _____

VESSEL NAME PHENOL DAY TANK

DIAMETER 13'-0" ft-in ID _____ ft-in

VERT HT 16'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 122 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS _____ psig OR _____ psia

CORROSION ALLOW SHELL 1/8" in DECKS _____ in

DES TEMP 230 °F

DES PRESS 5" H2O psig VAC -2" H2O psia

HEADS ELIP _____ DISHED _____ CONE ROOF FLAT BOTTOM

CODE ASME _____ API _____ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

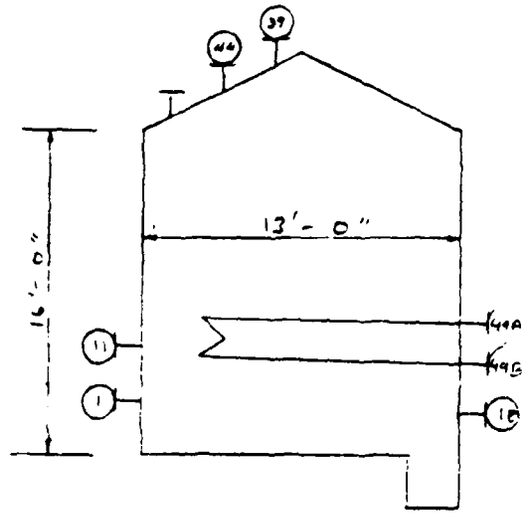
INSULATION CONSERV'N ✓ PROTECT'N _____ NONE _____

DECK MAT. _____

NOZZLES FLG CLASS 150 COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 20 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | — | — | VAPOR OUTLET TO |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM GA-E18 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | — | — | TO (REBOILER) (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH |
| 17 | — | — | BOTTOM OUTLET TO |
| 18 | — | 2 | LIQUID OUTLET TO GA-E19 |
| 19 | — | — | DRAWOFF TO |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | 1 | 1½ | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No. BLIND FLG |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | 1 | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | 2 | 2 | STEAM COIL |
| 50 | — | — | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES

1) LTG ID: SP GR = 1.03 @ operating temp

2) STEAM COIL TO MAINTAIN 122°F TEMP.

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 11/6/89 | For TASK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT ARNOLD/DOE GREAT PLAINS AREA JOB NO 0557I LOCATION BEULAH, ND PLANT

PROCESS VESSEL SKETCH

VESSEL NO FE-803 DWG SK B

VESSEL NO FR-804 A, B, C, D  COMB WITH _____

VESSEL NAME JET FUEL STORAGE

DIAMETER 20'-0" ft-in &  ft-in

VERT HT 32'-0" ft-in SHRT  ft-in

HORIZ LENGTH  ft-in

OPER TEMP TOP  °F BOTT  °F DRUM 150 °F

MAX TEMP TOP  °F BOTT  °F DRUM  °F

NORM OPER PRESS  psig OR  psia

MAX OPER PRESS  psig OR  psia

CORROSION ALLOW SHELL 1/8" in DECKS  in

DES TEMP 220 °F

DES PRESS F. H2O psig VAC -2" H2O psia

HEADS ELIP  DISHED  CONE  DOME ROOF FLAT BOTTOM

CODE ASME  API ✓ OTHER

STRESS RELIEVED YES  CODE

RADIOGRAPHED YES  CODE

EARTHQUAKE  WIND  mph

MATL SHELL  LINER  THK  in

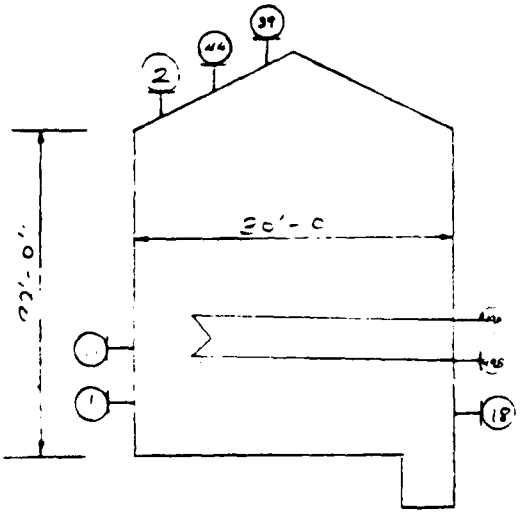
INSULATION CONSERV'N ✓ PROTECT'N  NONE

DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | 1 | 24 | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM GP-825 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1a | 3 | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC |
| 33 | | | SAFETY VALVE (PSV |
| 34 | | | SAFETY VALVE (PVSV (VSV |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG |
| 37 | | | PRESSURE CONTROLLER (P ____ C) |
| 38 | | | PRESSURE TAP (PT |
| 39 | 1 | 1½ | No CONNECTING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ____ C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | 1 | | LEVEL ALARM (LA) |
| 49 | 2 | 4 | STEAM COIL |
| 50 | | | |

PLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES

1) LIQUID SP GR = 0.98

2) STEAM COIL TO MAINTAIN 150°F

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | 4/14/82 | ADD TANK 4 | MKL | | | | |
| REV | ISSUE DATE | REVISION | PROJ ENGR | PROJ ENGR | APPR | APPR | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT ANTICO/DOE STORAGE/ALLOCATION BEULAH, N.D.

PLANT SASOL PLANT

PROJ NO  JOB NO 0587/

PROCESS VESSEL SKETCH

VESSEL NO FR-804

VESSEL NO FR-805 A,B COMB WITH _____

VESSEL NAME PHENOL MONTH STORAGE

DIAMETER 22'-0" Rdn & _____ Rdn

VERT HT 32'-0" Rdn SKIRT _____ Rdn

HORIZ LENGTH _____ Rdn

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 122 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS _____ psig OR _____ psia

CORROSION ALLOW SHELL 3 mm in DECKS _____ in

DES TEMP 230 °F

DES PRESS 5" H2O psig VAC -2" VAC psia

HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____

CODE ASME _____ API ✓ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

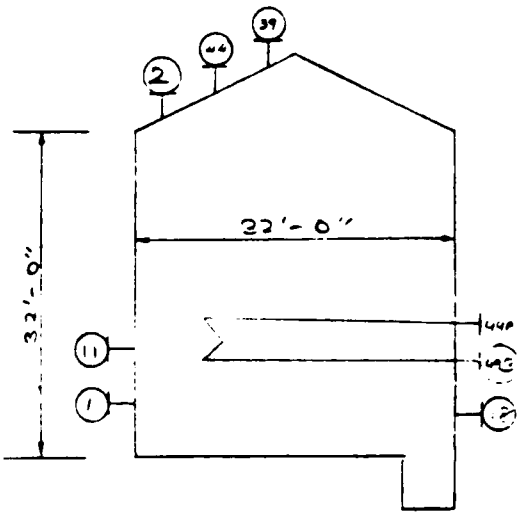
INSULATION CONSERV'N _____ PROTECT'N _____ NONE _____

DECK MATL 150

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | 1 | 24 | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 2 | FEED FROM GP-519 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER) (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 2 | LIQUID OUTLET TO _____ |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT ISO |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No BLANKING |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | 1 | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | 2 | 4 | STEAM COIL |
| 50 | — | — | |

FLANGED NOZZLES ARE NUMBERED 1-50
FOR COUPLING ADD 50 TO NOZZLE NO




NOTES

1) LIQUID SP GR = 1.03
2) STEAM COIL TO MAINTAIN 122°F TEMP

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ MGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/1/82 | FOR TANK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE LOCATION SOLAR, ND

AREA PLANT AREA PLANT

PROJ NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FR-805 PART SER

| ITEM NO. | SERVICE | PUMP TYPE | LIQUID | CORR./EROS. CAUSED BY | PUMPING TEMP °F | | SP GR AT P T | VAPOR PRESS AT P T PSIA | VISC AT P T CP | CAPACITY USGPM | | DISCH PRESS PSIG | SUCTION PRESS. PSIG | | DIFF PRESS. PSI | DIFF HEAD FT. | NPSH AVAIL FT | MATL CLASS | CORR. ALLOW IN | FLANGE RATING/FACING | | DRIVER TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NORM | MAX | | | | NORM | RATED | | RATED | MAX | | | | | | SUCT | DISCH | | |
| GA-B01A/S | CRUDE OIL FEED PUMP | CENTRIFUGAL | CRUDE OIL | | 122 | | 1.02 | 1.5 | 0.86 | 25.5 | 31 | 55 | -0.1 | | 55 | 123 | 29 | DI, CS | | | | MOTOR | |
| GA-B02A/S | REFLUX PUMP | CENTRIFUGAL | WATER, PHENOL, TOLUENE | | 194 | | 0.99 | 1.9 | 0.47 | 77 | 95 | 67 | -9.9 | | 77 | 178 | 67 | DI, CS | | | | MOTOR | |
| GA-B03A/S | BOTTOMS PUMP | CENTRIFUGAL | TAR, RESINS | | 446 | | 0.93 | 7.7 | 0.3 | 10 | 12 | 40 | -2.3 | | 42 | 95 | 115 | DI, CS | | | | MOTOR | |
| GA-B04A/S | ACID TANK PUMP | ROTARY | TAR | | 258 | | 0.95 | 1.65 | | | 1.0 | 39 | -1.0 | | 49 | 119 | 6.6 | DI, CS | | | | MOTOR | |
| GA-B05A/S | FLASH COLUMN HEATING PUMP | CENTRIFUGAL | WATER, PHENOL | | 122 | | 0.99 | 0.8 | 0.67 | | 1.5 | 42 | -1.0 | | 52 | 122 | 8 | DI, CS | | | | MOTOR | |
| GA-B06A/S | CRUDE OIL FEED PUMP | CENTRIFUGAL | TOLUENE, PHENOL, LIGHTS | | 122 | | 1.0 | 1.0 | 0.61 | 3.5 | 4.6 | 39 | -1.0 | | 49 | 113 | 8 | DI, CS | | | | MOTOR | |
| GA-B07A/S | SULFURIC ACID PUMP | CENTRIFUGAL | 66° Be $H_2SO_4$ | | 105 | | 1.8 | <0.1 | | | 0.2 | 39 | -1.0 | | 40 | 51 | 17.7 | CS | | | | MOTOR | |
| GA-B08A/S | CAUSTIC FEED PUMP | CENTRIFUGAL | CAUSTIC | | 295 | | 0.94 | 4.2 | 0.33 | 15 | 18 | 33 | -2.8 | | 41 | 100 | 6.5 | DI, CS | | | | MOTOR | |
| GA-B09A/S | CRUDE BENZ. FEED PUMP | CENTRIFUGAL | PHENOL, TOLUENE | | 122 | | 0.85 | 1.5 | 0.38 | 10 | 12 | 41.5 | -5 | | 42 | 114 | 34 | DI, CS | | | | MOTOR | |
| GA-B10A/S | CRUDE PHENOL PUMP | CENTRIFUGAL | NAPHTHALENE, CRESOL | | 372 | | 0.91 | 1.75 | 0.28 | 3.0 | 3.6 | 33 | 7.3 | | 26 | 66 | 115 | DI, CS | | | | MOTOR | |
| GA-B11A/S | PHENOL WATER PUMP | CENTRIFUGAL | WATER, PHENOL | | 122 | | 0.99 | 0.8 | 0.49 | | 1 | 42 | -10.1 | | 50 | 120 | 6.7 | DI, CS | | | | MOTOR | |
| GA-B12A/S | PHENOL KETTLE PUMP | CENTRIFUGAL | WATER, PHENOL, TOLUENE | | 122 | | 1.05 | 1.0 | 0.67 | 11 | 13 | 110 | 10.7 | | 51 | 113 | 6.8 | DI, CS | | | | MOTOR | |
| GA-B13A/S | PHENOL COL REFLUX PUMP | CENTRIFUGAL | TOLUENE, PHENOL | | 212 | | 0.91 | 1.9 | 0.36 | 140 | 168 | 74 | -10.3 | | 85 | 215 | 6.5 | DI, CS | | | | MOTOR | |
| GA-B14A/S | PHENOL DISTILLATE PUMP | CENTRIFUGAL | PHENOL | | 309 | | 0.95 | 6.1 | 0.31 | 8 | 9.6 | 70 | -5.9 | | 76 | 183 | 6.6 | DI, CS | | | | MOTOR | |
| GA-B15A/S | PHENOL COL REFLUX PUMP | CENTRIFUGAL | CRESYLIC ACID | | 315 | | 0.9 | 6.7 | 0.29 | 10 | 12 | 67 | -1.5 | | 69 | 176 | 11.4 | DI, CS | | | | MOTOR | |
| GA-B19A/S | PHENOL CONDENSATE RETURN COL. REFLUX PUMP | CENTRIFUGAL | PHENOL | | 122 | | 1.04 | ~0.5 | | | 1.8 | 42 | -1.0 | | 43 | 106 | 31.5 | DI, CS | | | | MOTOR | |
| GA-B20A/S | CRUDE PHENOL TANK PUMP | CENTRIFUGAL | CRESYLIC ACID | | 248 | | 0.97 | 0.8 | 0.4 | 16 | 19.2 | 53 | -8.2 | | 61 | 145 | 116 | DI, CS | | | | MOTOR | |
| GA-B21A/S | CAUSTIC WATER PUMP | CENTRIFUGAL | WASH WATER | | 122 | | 0.99 | | | | 60 | 25 | -0.6 | | 26 | 60 | 32 | DI, CS | 20 | | | MOTOR | |
| GA-B22A/S | TAR DISTILLATION PUMP | CENTRIFUGAL | TAR | | 122 | | 0.94 | 1.0 | | | 16 | 29 | -1.0 | | 30 | 74 | 2.[illegible] | [illegible] | 20 | | | MOTOR | |
| REV. NO. | ITEM NO. | | | | | | | | | | | | | | | | | | | | | | |

## UTILITIES

**STEAM:**
INLET PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
CON. PRESS., PSIG/VAC ____ NORM. ____ MIN. ____ MAX.

**ELECTRIC POWER:**
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
INSTRUMENTS: ____ V ____ PHASE ____ Hz/DC
HEATERS: ____ V ____ PHASE ____ Hz
AREA CLASS ____ GR ____ DIV ____

**COOLING WATER:**
SUPPLY PRESS. ____ PSIG, TEMP. ____ °F
RETURN PRESS. ____ PSIG, TEMP. ____ °F (MAX.)

**INSTRUMENT AIR:**
SUPPLY PRESS ____ PSIG, TEMP. ____ °F

| REV. NO | BY | DATE |
|---|---|---|
| 0 | JLK | 4/14/89 |

LUMMUS — THE LUMMUS COMPANY

PUMP SCHEDULE

ANG O/DOE - GPSA-I

CUSTOMER PLAINS GSSL. PLANT PROJECT JET FUEL

UNIT ____ AREA 800

JOB NO 05571

| ITEM NO. | SERVICE | PUMP TYPE | LIQUID | CORR./EROS. CAUSED BY | PUMPING TEMP °F NORM | PUMPING TEMP °F MAX | SP. GR. AT P.T. | VAPOR PRESS. AT P.T. PSIA | VISC. AT P.T. CP | CAPACITY USGPM NORM | CAPACITY USGPM RATED | DISCH. PRESS. PSIG | SUCTION PRESS. PSIG RATED | SUCTION PRESS. PSIG MAX | DIFF. PRESS. PSI | DIFF. HEAD FT | NPSH AVAIL. FT | MATL. CLASS | CORR. ALLOW. IN | PLANGE RATING/FACING SUCT. | PLANGE RATING/FACING DISCH. | DRIVER TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA-E23A,B | WASH WATER RECIRCULATING PUMP | CENTRIFUGAL | WASH WATER | | 121 | | 0.99 | | | | 60 | 25 | -0.1 | | 26 | 60 | 32 | CAST IRON 20 | | | | MOTOR | |
| GA-E24A,B | TAR PUMP | CENTRIFUGAL | TAR | | 121 | | 0.99 | | | | 16 | 23 | -0.1 | | 30 | 74 | 35 | CAST IRON 20 | | | | MOTOR | |
| GA-E25A,B | TAR STORAGE AND CRUDE OIL RECIRC. | CENTRIFUGAL | TAR | | 122 | | 0.99 | | | | 118 | 42 | -0.1 | | 42 | 106 | 31 | CAST IRON 20 | | | | MOTOR | |
| GA-E26A,B | WATER PUMP | CENTRIFUGAL | WATER EMULSION | | 122 | | 0.98 | 0.8 | 0.49 | | 10 | 112 | -0.3 | | 42 | 100 | 31 | CAST IRON 20 | | | | MOTOR | |

ITEM NO. | ITEM NO.

**UTILITIES**

STEAM:
INLET PRESS, PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
COND. PRESS., PSIG/INCHES ____ NORM. ____ MIN. ____ MAX.

COOLING WATER:
SUPPLY PRESS. ____ PSIG. TEMP. ____ °F
RETURN PRESS. ____ PSIG. TEMP. ____ °F (MAX.)

INSTRUMENT AIR:
SUPPLY PRESS. ____ PSIG. TEMP. ____ °F

ELECTRIC POWER:
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
INSTRUMENTS: ____ V ____ PHASE ____ Hz/D.C.
HEATERS: ____ V ____ PHASE ____ Hz
AREA CLASS ____ GR ____ DIV ____

| REV. NO. | BY | DATE |
|---|---|---|
| 0 | [illegible] | 6/16/89 |

THE LUMMUS COMPANY
Bloomfield

**PUMP SCHEDULE**

AMOCO/ROD - CRUDE
CUSTOMER FLASH GASOIL PROJECT JET FUEL
UNIT ____ AREA ROD

JOB NO. 01557 1

VESSEL NO FD-701 SIMILAR WITH

VESSEL NAME 1ST STAGE FLASH DRUM

DIAMETER ____ I.D. ____ O.D.

VERT HT ____ I.D. SKIRT ____ O.D.

HORIZ LENGTH ____ O.D.

OPER TEMP TOP ____ °F BOTT ____ °F SHLM 122 °F

MAX TEMP TOP ____ °F BOTT ____ °F SHLM ____ °F

NORM OPER PRESS 0 psig OR ____ psia

MAX OPER PRESS ____ psig OR ____ psia

CORROSION ALLOW SHELL ____ in HEADS ____ in

DES TEMP 160 °F

DES PRESS 40 psig VAC ____ psia

HEADS ELIP ____ DISHED ____ CONE ____ FLAT ____

SEISMIC ABOVE ____ API ____ OTHER ____

STRESS RELIEVED YES ____ CODE ____

RADIOGRAPHED YES ____ CODE ____

EARTHQUAKE ____ WIND ____ mph

MATL: SHELL CARBON STEEL PLATE ____ THK ____ in

INSULATION CONSERV'N ____ PROTECT'N ____ KIND ____

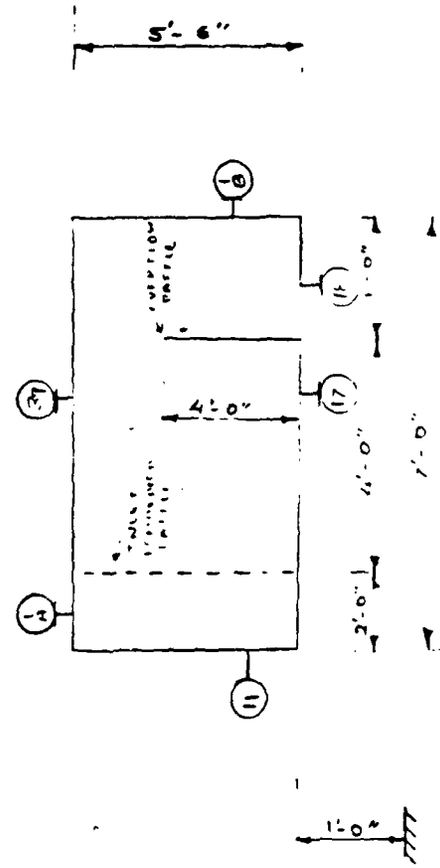
LINER MATL ____

NOZZLES FLG CLASS ____ COUPL CLASS ____

| ITEM NO. | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | | FEED FROM FA-112 & FA-122 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) FEED PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | SEALSWING LINE WITH |
| 17 | 1 | 2 | BOTTOM OUTLET TO FA-112 |
| 18 | | 2 | LIQUID OUTLET TO FA-122 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN. (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PSV) (NOV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ____ C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | 1½ | AS BLANKETING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ____ C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (GG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 2 | | EXTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

PLANGED NOZZLES ARE REMARKED 1-50. FOR COUPLING ADD 20 TO NOZZLE NO

LENGTH = 7'-0"
WIDTH = 4'-6"
DEPTH = 5'-6"




LIQUID SP GR = 0.97 (avg) @ operating temp

| REV | DATE | DESCRIPTION | PREP'D BY | FROM CHKD | APPR | APPR |
|---|---|---|---|---|---|---|
| 2 | 4/14/78 | For "As Built" | LR | | | |

LUMMUS — THE LUMMUS COMPANY

WILD JET FUEL PROJECT

CLIENT AMERADA/HESS CORPORATION BEULAH, ND
PLAINS GASOLINE PLANT

JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FD-701 DWG NO -

VESSEL NO FD-802 GOES WITH

VESSEL NAME 2ND STAGE WATER WASH TANK

DIAMETER Shell ID

VERT HT Shell Eq/T

HORIZ LENGTH

OPER TEMP TOP °F BOTT °F DRUM 127 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS 0 psig OR

MAX OPER PRESS psig OR

CORROSION ALLOW: SHELL in HEADS in

DES TEMP 160 °F

DES PRESS 60 psig VAC psia

HEADS: ELIP DISHED CONE FLAT

CODE: ASME API OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CARBON STEEL LINER THK in

INSULATION: CONSERVTN PROTECTN NONE

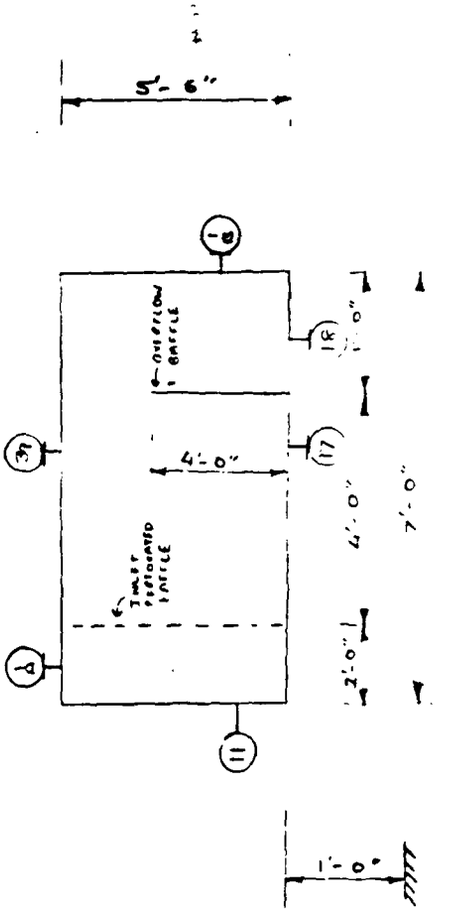
DECK MATL:

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM GA-822 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (RES. PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | 2 | BOTTOM OUTLET TO GA-823 |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-824 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE COND. (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PSV) NSW |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ) |
| 38 | 1 | 1½ | PRESSURE TAP (PT) N2 BLANKETING |
| 39 | | | TEMPERATURE INDICATOR (TI) |
| 40 | | | TEMPERATURE CONTROLLER (T ) |
| 41 | | | TEMPERATURE RECORDER (TR) |
| 42 | | | TEMPERATURE WELL (TW) |
| 43 | | | |
| 44 | | | GAUGE GLASS (LG) |
| 45 | 1 | | EXTERNAL LEVEL |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | LEVEL ALARM (LA) |
| 48 | | | |

FLANGED NOZZLES ARE NUMBERED 1 AND UP. FOR COUPLING ADD 50 TO NOZZLE NO.

LENGTH = 7'-0"
WIDTH = 4'-6"
DEPTH = 5'-6"




LIQUID SP. GR = 0.97 (avg) @ operating temp.

LUMMUS — THE LUMMUS COMPANY

WITH JET FUEL PROTECT

CLIENT ANCO/DOE CONSOLIDATION BEULAH, N.D.

PLAINS GASIFICATION PLANT JOB NO 05571

PROCESS VESSEL SKETCH

FD-802

| REV | REVISE DATE | DESCRIPTION | PROJ |
|---|---|---|---|
| 1 | 4/11/80 | FOR TANK 4 | |

STRIPPING COLUMN SECTION (PROPRIETARY DESIGN)

DA-804 STRIPPING COLUMN

COLUMN DIAMETER (ID) : 4'-6"

COLUMN HEIGHT (T-T) 100'-0"

60 VALVE TRAYS

SHELL MATL : CS LINER: 316L SS CLAD
VALVE MATL : 304 SS

FA-804 STRIPPING COL REFLUX DRUM

CAPACITY 135 ft³

MATL : CS CORR ALLOW: 4.5mm

EA-810 STRIPPING COL CONDENSER

SURFACE AREA : 1050 ft²

SHELL MATL : CS CORR ALLOW 4.5mm
TUBE MATL : CS 3mm

EF-814 : STRIPPING COL. SIDE REBOILER
(KETTLE TYPE)

SURFACE AREA : 450 ft²

SHELL MATL. CS CORR ALLOW 4.5mm
TUBE MATL: CS 3mm

| REV | DATE | MADE | CHKD | APPR. | Record | REV. | ISSUE | DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| 0 | 4/14/83 | SR | | | | | | |

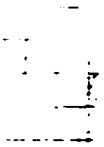
THE LUMMUS COMPANY
Bloomfield, N. J.

A106 03 0776-1 REV.1

EA-811 : STRIPPING COLUMN REBOILER

SURFACE AREA = 105 $ft^2$

SHELL MATL : 316L SS
TUBE MATL : 316L SS



GA-816 A,S : STRIPPING COL. REFLUX PUMP

20 GPM X 70 PSI

GA-817 A,S . STRIPPING COL. ORGANIC EXTRACTION PUMP

5 GPM X 30 PSI

GA-818 A,S . STRIPPING COL BTMS PUMP

9 GPM X 40 PSI

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | THE LUMMUS COMPANY Bloomfield, N. J. | |
| 0 | 4/14/84 | FR | | | | | | | | |
| REV. | DATE | MADE | CHKD. | APPR. | Record | REV. | ISSUE | | DWG. NO. | |

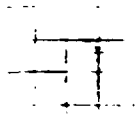
A106 03 0776-1 REV.1

DESIGN COMPUTATIONS FOR ED-801 (Thin Film Evaporator)

JOB JET FUEL PROJ ACCT. 05571

ED-801 (THIN FILM EVAPORATOR

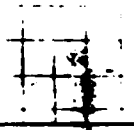
DUTY = $1.68 \times 10^6$ Btu/hr



SURFACE AREA, 180 $ft^2$

MP STEAM REQ : 1900 lb/hr.

MATL: 316L SS or CS WITH 316L SS CLAD



| REV. | DATE | MADE | CHKD. | APPR. | Record | REV. | ISSUE | DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| 0 | 4/14/89 | SR | | | | | | |

THE LUMMUS COMPANY
Bloomfield, N. J.

A106 03 0776-1 REV.1

LUMMUS

THE LUMMUS COMPANY
Bloomfield

| Always refer to this number | | | | |
|---|---|---|---|---|
| | Div. | Job | PO/Req. | Sup |
| | | | | |

**DATA SHEET- LIQUID RING VACUUM PUMP**

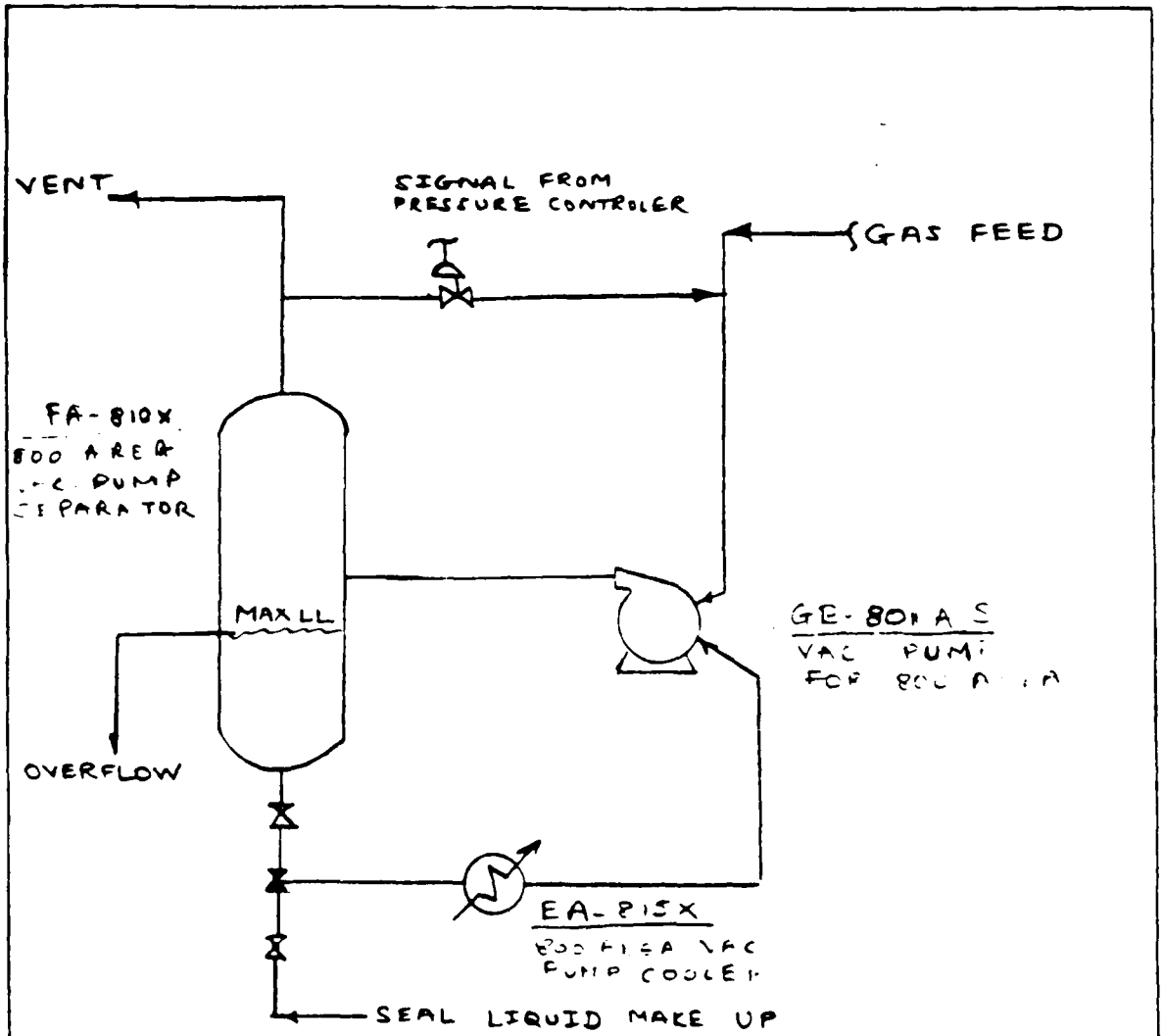
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | APPLICABLE TO ○ PROPOSAL ○ PURCHASE ○ AS BUILT | | | ITEM NO GR801A&S | | | |
| 2 | FOR AMOCO/LOF - JET FUEL PROTECT | | | UNIT | | | |
| 3 | SITE | | | DRIVER | | | |
| 4 | SERVICE VACUUM PUMP FOR 800 AREA | | | NO. REQUIRED | | | |
| 5 | MANUFACTURER | | MODEL | SERIAL NO. | | | |
| 6 | NOTE ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER | | | ☐ BY MANUFACTURER | | | |
| 7 | | | | | | | |
| 8 | **OPERATING CONDITIONS** | | | | | | |
| 9 | (ALL DATA ON PER UNIT BASIS) | | | OTHER CONDITIONS | | | |
| 10 | | NORMAL | RATED | A | B | C | RUN-IN |
| 11 | ○ GAS HANDLED (Also See Page 3 of 3) | | | | | | |
| 12 | ○ MMSCFD/SCFM (14.7 psia & 60°F dry) | | | | | | |
| 13 | ○ WEIGHT FLOW (lb/min) - (Wet) - (Dry) | | ≈ 2 | | | | |
| 14 | INLET CONDITIONS: | | | | | | |
| 15 | ○ PRESSURE (psia)* | | 0.97 | | | | |
| 16 | ○ TEMPERATURE (°F) | | 160 | | | | |
| 17 | ○ RELATIVE HUMIDITY (%) | | | | | | |
| 18 | ○ MOLECULAR WEIGHT (M) | | 29.9 | | | | |
| 19 | ☐ ~~$n_s$ (Path Exponent, PTC-10)~~ $(C_p/C_v)$ | | 1.39 | | | | |
| 20 | ☐ COMPRESSIBILITY ($Z_1$) OR ($Z_{avg}$) | | 1.0 | | | | |
| 21 | ☐ INLET VOLUME, (cfm-WET)* | | 724 | | | | |
| 22 | DISCHARGE CONDITIONS: | | | | | | |
| 23 | ○ PRESSURE (psia)* | | 22.1 | | | | |
| 24 | ☐ TEMPERATURE (°F) | | | | | | |
| 25 | ☐ $n_s$ (Path Exponent, PTC-10) | | | | | | |
| 26 | ☐ COMPRESSIBILITY ($Z_2$) OR ($Z_{avg}$) | | 1.0 | | | | |
| 27 | | | | | | | |
| 28 | ☐ bhp REQUIRED (All Losses Incl.) | | | | | | |
| 29 | ☐ SPEED (rpm) | | | | | | |
| 30 | ☐ PRESSURE RATIO (R) | | | | | | |
| 31 | ☐ VOLUMETRIC EFFICIENCY (%) | | | | | | |
| 32 | ☐ SILENCER ΔP (psi) INLET/DISCHARGE | / | / | / | / | / | / |
| 33 | ☐ PERFORMANCE CURVE NO. | | | | | | |
| 34 | PROCESS CONTROL: | | | | | | |
| 35 | METHOD ○ BYPASS FROM | TO | | ○ BYPASS: ○ MANUAL ○ AUTO | | | |
| 36 | ○ SPEED VARIATION FROM | | | TO | | | |
| 37 | ○ OTHER | | | | | | |
| 38 | SIGNAL ○ SOURCE | | | | | | |
| 39 | ○ TYPE | | | | | | |
| 40 | ○ RANGE FOR PNEUMATIC CONTROL | rpm AT | psig AND | rpm AT | psig | | |
| 41 | OTHER | | | | | | |
| 42 | | | | | | | |
| 43 | | | | | | | |
| 44 | | | | | | | |
| 45 | | | | | | | |
| 46 | | | | | | | |
| 47 | | | | | | | |
| 48 | | | | | | | |
| 49 | | | | | | | |
| 50 | | | | | | | |
| 51 | | | | | | | |
| 52 | *AT CUSTOMER CONNECTIONS TO SILENCERS | | | | | | |
| 53 | Prepared: SR | Approved: | Date: 4/14/15 A | Rev. △ | Rev. △ | Rev. △ | |

A109 04 0783-TP2 5.1/1 REV 4

PA-EU1

**DESIGN COMPUTATIONS FOR** VACUUM PACKAGE FOR 800 AREA

**JOB** _____ **ACCT.** 05571




A2.80

| REV. | DATE | MADE | CHKD | APPR | Record | REV. | ISSUE | DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| 0 | 4/14/89 | SR | | | | | | |

LUMMUS — THE LUMMUS COMPANY Bloomfield N. J.

A106 03 0776-1 REV 1

DESIGN COMPUTATIONS FOR PA-501 VACUUM PACKAGE FOR 800 AREA

JOB _____ ACCT. 05571

| COMPONENT | GAS FEED WT% |
|---|---|
| AIR | 85.0 |
| PHENOL | 1.0 |
| $H_2O$ | 3.0 |
| $SO_2$ | 11.0 |

| REV. | DATE | MADE | CHKD. | APPR. | Record | REV. | ISSUE |
|---|---|---|---|---|---|---|---|
| 0 | 4/4/79 | S/S | | | | | |

THE LUMMUS COMPANY
Bloomfield, N. J.

DWG. NO.

A105 03 0776-1 REV.1

AREA 850

CLIENT:DOE PROJECT:5571
LOCATION:BEULAH,ND.
PROJECT:JET FUEL DATE/BY: 21-Mar-89
08:54 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 4 | $115 | 100% | $115 |
| INTERNALS | | $281 | | |
| REACTORS | | | | |
| EXCHANGERS | 11 | $167 | 120% | $200 |
| VESSELS | 9 | $25 | 120% | $30 |
| TANKS | 3 | $127 | 80% | $102 |
| FILTERS | | | | |
| PUMPS | 23 | $173 | 110% | $190 |
| COMPRESSORS | | | | |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 50 | $888 | | $637 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $888 | |
| COMMODITIES | $637 | |
| LABOR | $471 | (10% EQUIP,60% COMM) |
| INDIRECTS | $471 | (100% LABOR) |
| ENGINEERING | $2,000 | (800/PC X $50) |
| SUBTOTAL | $4,468 | |
| CONTINGENCY | $894 | (20%) |
| TOTAL | $5,361 | |

| | | WEIGHT | MATL. | $/LB | $ | |
|---|---|---|---|---|---|---|
| DA-851 | EXTRACTOR COL. | 16000 | CS | $1.80 | $28,800 | |
| DA-852 | HEXANE COL. | 15000 | CS | $1.80 | $27,000 | |
| DA-853 | METHANOL COL. | 9000 | CS | $2.20 | $19,800 | |
| DA-854 | DRYING COL. | 6000 | SS | $6.50 | $39,000 | |
| | | | | TOTAL | $114,600 | |

| | | FT2 | MATL | $/FT2 | $ | |
|---|---|---|---|---|---|---|
| DB-851 | EXTRACTOR COL. | 16000 | CS | HOLD | $250,000 | (OTTO YORK PRORA |
| DB-852 | HEXANE COL. | 400 | CS | $40.00 | $16,000 | |
| DB-853 | METHANOL COL. | 150 | CS | $40.00 | $6,000 | |
| DB-854 | DRYING COL. | 100 | SS | $90.00 | $9,000 | |
| | | | | TOTAL | $281,000 | |

| | | FT2 | MATL | $/FT2 | $ |
|---|---|---|---|---|---|
| EA-851 | HEXANE REBOIL. | 665 | CS/CS | $29.00 | $19,285 |
| EA-852 | HEXANE COND. | 1320 | CS/CS | $15.00 | $19,800 |
| EA-853 | NEUTRAL OIL COOL. | 17 | CS/CS | $300.00 | $5,100 |
| EA-854 | METHANOL REBOIL | 737 | CS/18-2 | $28.00 | $20,636 |
| EA-855 | METHANOL COND | 910 | CS/CS | $15.00 | $13,650 |
| EA-856 | METHANOL COL. BTTMS. COOL | 192 | CS/CS | $42.00 | $8,064 |
| EA-857 | DRYING COL. REBOIL | 434 | SS/18-2 | $88.00 | $38,192 |
| EA-858 | DRYING COL. COND. | 129 | SS/SS | $175.00 | $22,575 |
| EA-859 | CRUDE CRESYLIC ACID COOL. | 91 | CS/CS | $75.00 | $6,825 |
| EA-860 | 65% METHANOL COOL. | 106 | CS/CS | $70.00 | $7,420 |
| EA-861 | METHANOL COL. INTERCHANGE. | 59 | CS/CS | $100.00 | $5,900 |
| | | | | TOTAL | $167,447 |

| | | WEIGHT | MATL | $/LB | $ |
|---|---|---|---|---|---|
| FA-851 | HEXANE REFLUX DRUM | 2000 | CS | $2.75 | $5,500 |
| FA-852 | METHANOL COL. REFLUX DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-853 | DRYING COL. REFLUX DRUM | 4000 | CS | $2.25 | $9,000 |
| FA-854 | METHANOL MAKEUP DRUM | 2000 | CS | $3.50 | $7,000 |
| | | | | TOTAL | $25,500 |

| | | BBLS | MATL | $/BBL | $ |
|---|---|---|---|---|---|
| FB-851 | HEXANE STORAGE TANK | 224 | CS | $55.00 | $12,320 |
| FB-852 | CRUDE CRESYLIC ACID DAY TANK | 327 | CS | $45.00 | $14,715 |
| FB-853A | CRUDE CRESYLIC ACID MONTH TANK | 2X4176 | CS | $12.00 | $100,224 |
| | | | | TOTAL | $127,259 |

| | | | | |
|---|---|---|---|---|
| **GA-851, EXTRACTOR BTTMS. PUMP** | <10HP | CS | | $15,000 |
| **GA-852, HEXANE COL. BTTMS.** | <10HP | CS | | $15,000 |
| **GA-853, HEXANE FEED** | <10HP | CS | | $15,000 |
| **GA-854, HEXANE MAKE UP** | <10HP | CS | | $15,000 |
| **GA-855, METHANOL COL. BTTMS** | <10HP | CS | | $15,000 |
| **GA-856, METHANOL COL. REFLUX** | <10HP | CS | | $15,000 |
| **GA-857, DRYING COL. FEED** | <10HP | CS | | $15,000 |
| **GA-858, DRYING COL. BTTMS** | <10HP | CS | | $15,000 |
| **GA-859 CRUDE CRESYLIC ACID** | <10HP | CS | | $7,500 |
| **GA-860, DRYING COL. COND.** | <10HP | CS | | $15,000 |
| **GA-861, 65% METHANOL FEED** | <10HP | CS | | $15,000 |
| **GA-862, CRUDE CRYSYLIC ACID FEED** | <10HP | CS | | $15,000 |
| | | | **TOTAL** | $172,500 |
| **GD-851 MIXER** | INCLUDED W/EXTRACTOR | | | |

VESSEL NO [illegible] COMB WITH _____
VESSEL NAME [illegible]
DIAMETER [illegible] ft-in & _____ ft-in
VERT HT [illegible] ft-in SKIRT _____ ft-in
HORIZ LENGTH _____ ft-in
OPER TEMP TOP [illegible] °F BOTT [illegible] °F DRUM _____ °F
MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F
NORM OPER PRESS [illegible] psig OR [illegible] psig
MAX OPER PRESS _____ psig OR _____ psig
CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP [illegible] °F
DES PRESS [illegible] psig VAC _____ psig
HEADS ELIP _____ DISHED [illegible] CONE _____ FLAT _____
CODE ASME _____ API _____ OTHER _____
STRESS RELIEVED YES _____ CODE _____
RADIOGRAPHED YES _____ CODE _____
EARTHQUAKE _____ WIND _____ mph

MATL SHELL [illegible] LINER _____ THK _____ in
INSULATION CONSERV'N [illegible] PROTECT'N _____ NONE _____
DECK MATL _____

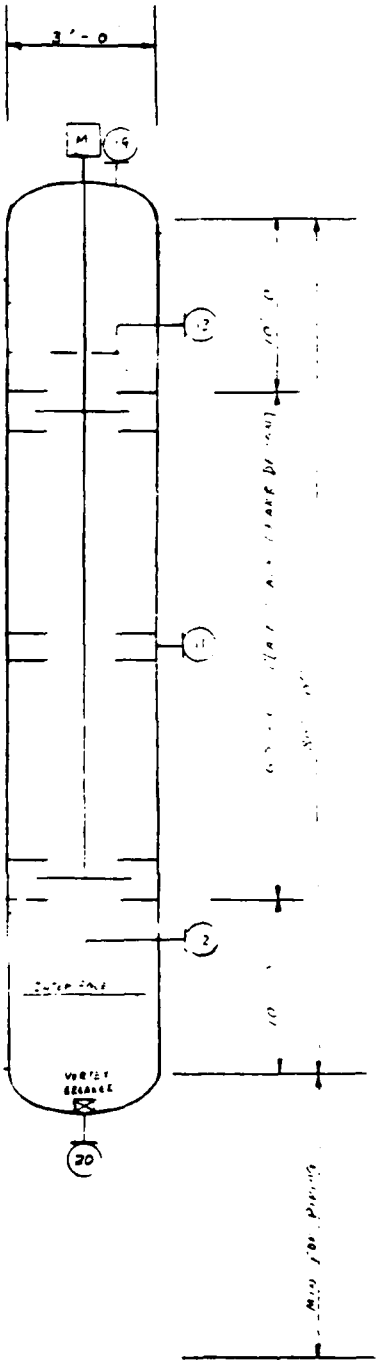
NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | | | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO _____ |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM _____ |
| 11 | | [illegible] | FEED FROM [illegible] |
| 12 | | [illegible] | FEED FROM [illegible] |
| 13 | | [illegible] | FEED FROM [illegible] |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH _____ |
| 17 | | | BOTTOM OUTLET TO _____ |
| 18 | | | LIQUID OUTLET TO _____ |
| 19 | | 2 | DRAWOFF TO [illegible] |
| 20 | | | RETURN FROM _____ |
| 21 | | 6 | DRAWOFF TO [illegible] |
| 22 | | | RETURN FROM _____ |
| 23 | | | DRAWOFF TO _____ |
| 24 | | | RETURN FROM _____ |
| 25 | | | REFLUX DRAWOFF TO _____ |
| 26 | | | REFLUX IN FROM _____ |
| 27 | | | REFLUX DRAWOFF TO _____ |
| 28 | | | REFLUX IN FROM _____ |
| 29 | | | PROCESS STEAM _____ |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES

[illegible]




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 0 | 11/14/ [illegible] | For Tank 4 | JH | | | |

THE LUMMUS COMPANY
Bloomfield

TITLE Jet Fuel Project
CLIENT [illegible] LOCATION [illegible]
PROJ NO [illegible] ABB NO [illegible]

PROCESS VESSEL SKETCH

VESSEL NO [illegible] DWG SKB –

0397 0382 11

VESSEL NO DA-252 COMB WITH _____

VESSEL NAME [illegible]

DIAMETER 5'-0" ft-in & _____ ft-in

VERT HT 4'-0" ft-in SKIRT 5'-0" ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP 450 °F BOTT 8[illegible] °F DRUM _____ °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS [illegible] psig OR [illegible] psig

MAX OPER PRESS _____ psig OR _____ psig

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 375 °F

DES PRESS 45 psig VAC _____ psig

HEADS ELIP _____ DISHED X CONE _____ FLAT _____

CODE ASME _____ API _____ OTHER _____

STRESS RELIEVED YES X CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERV'N X PROTECT'N _____ NONE _____

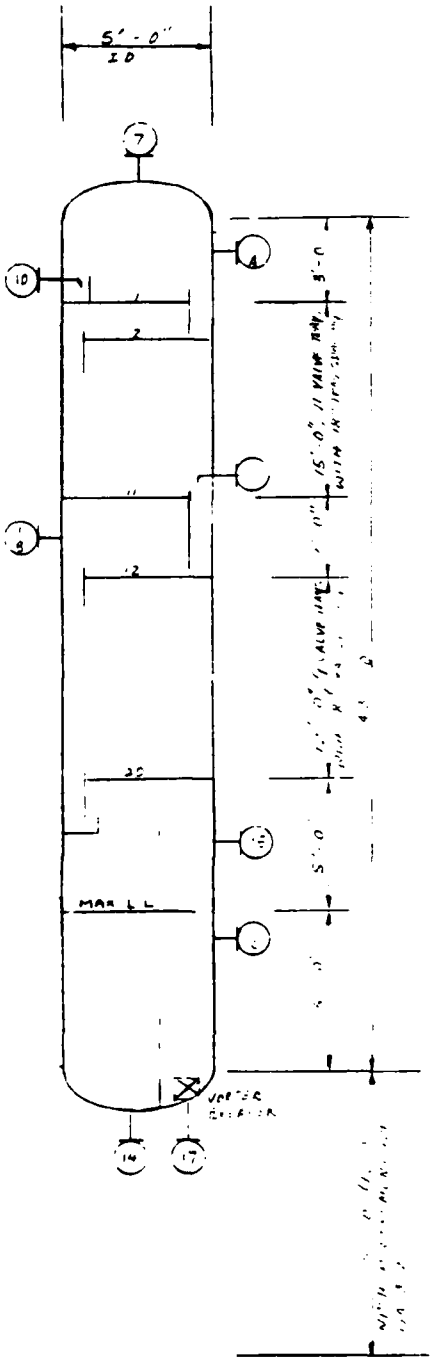
DECK MATL CS VALVES: BOVES

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | — |
| 4 | — | — | — |
| 5 | — | — | HANDHOLE |
| 6 | — | — | — |
| 7 | — | 1 | VAPOR OUTLET TO EA-252 |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | 4 | REFLUX IN FROM EA-252 |
| 11 | — | 2 | FEED FROM DA-25 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | — | — | TO (REBOILER) (~~RED PUMP~~) EA-25 |
| 15 | — | — | FROM REBOILER EA-25 |
| 16 | — | — | EQUALIZING LINE WITH |
| 17 | — | 6 | BOTTOM OUTLET TO [illegible] |
| 18 | — | — | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S) COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | — |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | — |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | 1 | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | — |
| 50 | — | — | — |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES [illegible]




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| | | | | | | |
| 0 | 6/81 W | FOR TANK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/CPC - SAUDI REFINING LOCATION [illegible]

PROJ NO [illegible] JOB NO 8507

PROCESS VESSEL SKETCH

VESSEL NO DA-252 DWG SKB -

8307 0382 11

VESSEL NO DA-255 COMB WITH _____

VESSEL NAME [illegible]

DIAMETER [illegible] ft-in & _____ ft-in

VERT HT 42' 6" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP 84 °F BOTT 229 °F DRUM _____ °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS 15 TOP _____ psig OR 18 BOTTOM psig

MAX OPER PRESS _____ psig OR _____ psig

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 250 °F

DES PRESS [illegible] psig VAC _____ psig

HEADS ELIP _____ DISHED X CONE _____ FLAT _____

CODE ASME _____ API _____ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERVN X PROTECTN _____ NONE _____

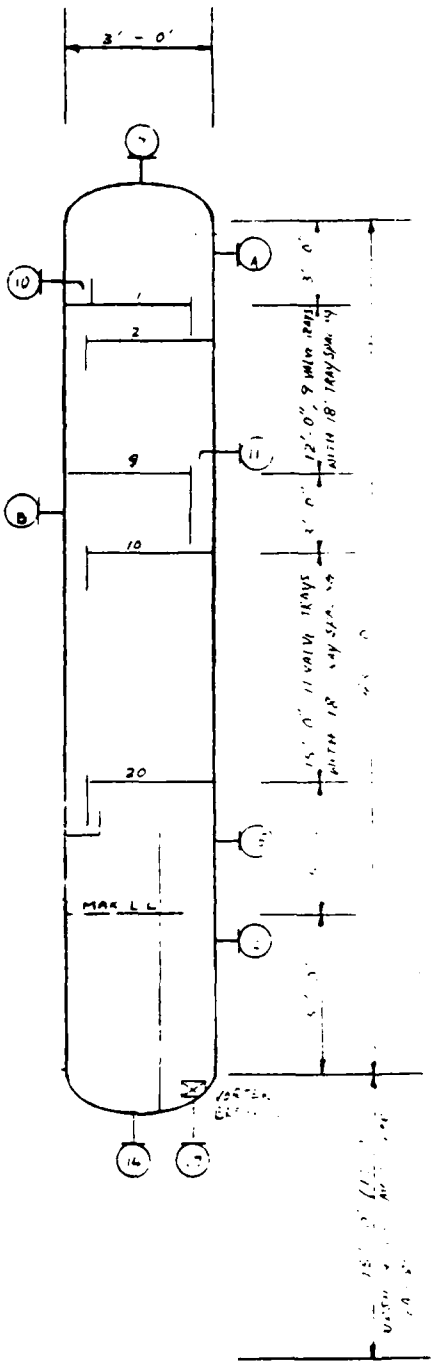
DECK MATL CS VALVES A216 WCB

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE IN | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | | VAPOR OUTLET TO EA-255 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | 1 | | REFLUX IN FROM EA-256 |
| 11 | 1 | | FEED FROM DA-25 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | 1 | | TO (REBOILER) EA-252 |
| 15 | 1 | | FROM REBOILER EA-252 |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | | BOTTOM OUTLET TO DA-257 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S, COOLER (SC |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV, (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1 50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES [illegible]




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 0 | 6/14/84 | FOR TANK 4 | JJ | | | |

THE LUMMUS COMPANY
Bloomfield

TITLE TEJ FUEL PROJECT

CLIENT [illegible] LOCATION [illegible]

PROJ NO _____ JOB NO 25571

PROCESS VESSEL SKETCH

VESSEL NO DA-255 DWG SK8 –

8301 0382 11

VESSEL NO DA - 858 COMB WITH _____
VESSEL NAME DRYING COLUMN
DIAMETER 2'-6" ID in & _____ in
VERT HT 58 - 4" in SKIRT 15'-0" in
HORIZ LENGTH _____ in
OPER TEMP TOP 349 °F BOTT 412 °F DRUM _____ °F
MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F
NORM OPER PRESS 10 TOR psig OR 13.80 PSIA psig
MAX OPER PRESS _____ psig OR _____ psia
CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 460 °F
DES PRESS 60 psig VAC _____ psig
HEADS ELIP _____ DISHED BOTTOM CONE _____ FLAT TOP
CODE ASME _____ API _____ OTHER _____
STRESS RELIEVED YES _____ CODE _____
RADIOGRAPHED YES _____ CODE _____
EARTHQUAKE _____ WIND _____ mph

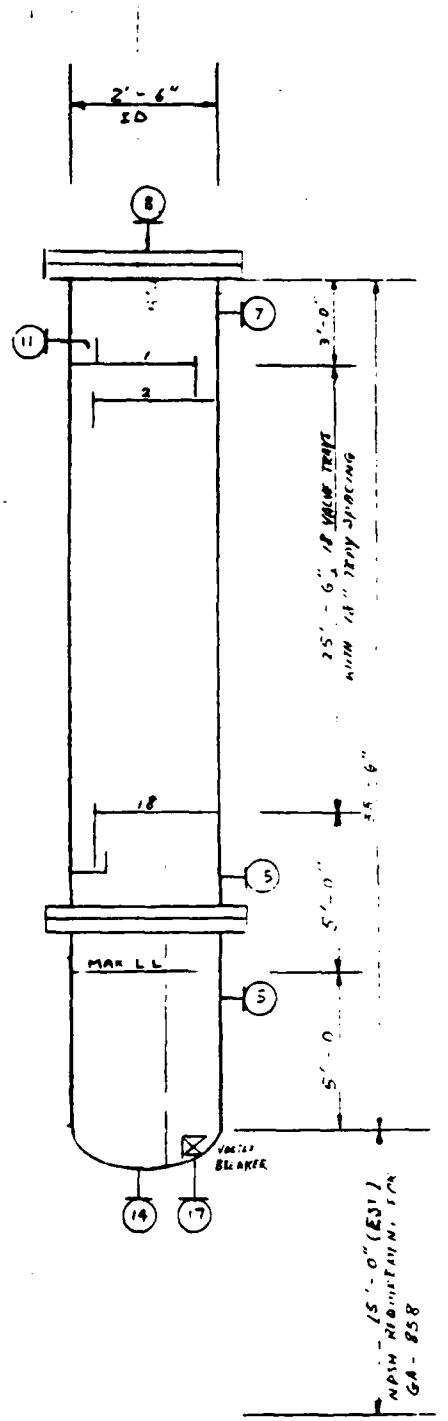
MATL SHELL 304 SS LINER _____ THK _____ in
INSULATION CONSERV'N X PROTECT'N _____ NONE _____
DECK MATL 304 SS WEIRS: 304 SS

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | — | — | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | 1 | 8 | HANDHOLE |
| 6 | — | — | |
| 7 | 1 | 4 | VAPOR OUTLET TO EA - 858 |
| 8 | 1 | 1½ | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 1½ | FEED FROM GA - 857 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | 1 | 4 | TO (REBOILER) EA - 857 |
| 15 | 1 | 8 | FROM REBOILER EA - 857 |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | 1 | 1½ | BOTTOM OUTLET TO _____ |
| 18 | — | — | LIQUID OUTLET TO _____ |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S) COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | |
| 50 | — | — | |

PLANGED NOZZLES ARE NUMBERED 1-50
FOR COUPLING ADD 50 TO NOZZLE NO

NOTES LIQ SP GR = 0.89 (Avg) @ operating TEMP




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4 MAY 89 | FOR TANK 4 | MJ | | | |

THE LUMMUS COMPANY
TITLE 3GT FINAL PROJECT
CLIENT ALIED/SIDE - GIANT REFG LOCATION BAYTOWN, TEXAS
PROCESS VESSEL SKETCH
VESSEL NO DA - 858 DWG SKD -

| ITEM NUMBER | SERVICE | SIDE | HEAT EXCHANGER MEDIUM: MATERIAL | FLOW lb/hr | SPECIFIC GRAVITY | MOLECULAR WEIGHT | VISCOSITY AT AVE TEMP cP | % VAPORIZED BY WEIGHT | % CONDENSED BY WEIGHT | TEMPERATURE °F: IN | OUT | CORR M.T.D. | DESIGN TEMP | DUTY 1000 Btu/hr | OVERALL HEAT TRANS. COEFF Btu/h·ft²·°F | FOUL FACTOR ft²·h·°F/Btu | TOTAL SURFACE ft² | MAX ALLOWABLE PRESS. DROP psi | PRESS. psig: OPERATING | PRESS. psig: DESIGN | SIZE AND TYPE: NO UNITS AND OD BY LENGTH | SIZE AND TYPE: TYPE TEMA SYMBOLS | MATERIALS: SHELL | MATERIALS: TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EA-851 | REBOILER | SHELL | HP STEAM | 9360 | | | | | 100 | 750 | 480 | 141 | 775 | 8560 | | 0.001 | 665 | | 650 | 635 | | AEM | CS | CS |
| | | TUBE | NEUTRAL OIL | 276500 | 0.79 | 198 | 0.49 | 20 | | 350 | 360 | | 375 | | | 0.001 | | | 15 | 45 | | | | |
| EA-852 | REBOILER CONDENSER | SHELL | VAPOR | 46700 | 0.61 | 86 | 0.01 | | 100 | 370 | 370 | 71 | 400 | 8430 | | 0.001 | 1320 | 15 | 20 | 40 | | AEM | CS | CS |
| | | TUBE | COOLING WATER | 235300 | | | | | | 82 | 118 | | 150 | | | 0.001 | | 10 | 60 | 110 | | | | |
| EA-853 | NEUTRAL OIL COOLER | SHELL | NEUTRAL OIL | 897 | 0.856 | | 0.92 | | | 350 | 113 | 100 | 375 | 102 | | 0.001 | 17 | 10 | 40 | 70 | | DuBAM | CS | CS |
| | | TUBE | COOLING WATER | 2830 | | | | | | 82 | 118 | | 150 | | | 0.001 | | 10 | 80 | 110 | | | | |
| EA-854 | METHANOL REBOILER | SHELL | HP STEAM | 7340 | - | - | - | | 100 | 337 | 337 | 98 | 360 | 6500 | | 0.0005 | 737 | | 100 | 140 | | BEM | CS | 18-2 |
| | | TUBE | METHANOL & CRUDE ALC | 36730 | 0.750 | 19.7 | 0.31 | 20 | | 211 | 211 | | 240 | | | 0.001 | | 0.15 | 13 | 45 | | | | |
| EA-855 | METHANOL CONDENSER | SHELL | METHANOL & WATER | 12320 | 0.76 | 198 | 0.49 | | 100 | 184 | 184 | 77 | 210 | 6800 | | 0.001 | 910 | 25 | 10 | 40 | | AEM | CS | CS |
| | | TUBE | COOLING WATER | 310000 | | | | | | 85 | 105 | | 120 | | | 0.001 | | 10 | 60 | 110 | | | | |
| EA 856 | METHANOL COLUMN BOTTOM COOLER | SHELL | CRESYLIC ACID & WATER | 6350 | 0.981 | | 0.91 | | | 209 | 113 | 61 | 265 | 536 | | 0.001 | 192 | 10 | 40 | 70 | | AES | CS | CS |
| | | TUBE | TREATED WATER | 63600 | | | | | | 100 | 110 | | 130 | | | 0.001 | | 10 | 40 | 110 | | | | |
| EA 857 | DRYING COLUMN REBOILER | SHELL | HP STEAM | 2350 | | | | | 100 | 350 | 350 | 55 | 375 | 2150 | | 0.0005 | 434 | | 550 | 635 | | AEM | 304SS | 18-2 |
| | | TUBE | CRESYLIC ACID | 61000 | 0.851 | 105 | 0.48 | 20 | | 412 | 422 | | 460 | | | 0.001 | | 0.15 | 13 | 45 | | | | |
| EA-858 | DRYING COLUMN CONDENSER | SHELL | CRESYLIC ACID VAPOR | 2030 | 1.05 | 33 | 0.015 | | 100 | 308 | 113 | 115 | 335 | 1360 | | 0.001 | 129 | 25 | 10 | 40 | | AES | 304SS | 304SS |
| | | TUBE | TREATED WATER | 136000 | - | - | - | | | 104 | 110 | | 130 | | | 0.001 | | 10 | 40 | 110 | | | | |
| EA-859 | CRUDE CRESYLIC ACID COOLER | SHELL | CRESYLIC ACID | 4434 | 0.995 | - | 1.28 | | | 210 | 113 | 39 | 240 | 216 | | 0.001 | 91 | 10 | 30 | 70 | | ABS | CS | CS |
| | | TUBE | TREATED WATER | 21600 | - | - | - | | | 100 | 110 | | 130 | | | 0.001 | | 10 | 40 | 110 | | | | |
| EA-860 | 65% METHANOL COOLER | SHELL | 65% METHANOL | 6650 | 0.835 | - | 0.938 | | | 150 | 113 | 90 | 171 | 194 | | 0.001 | 106 | 10 | 40 | 70 | | AES | CS | CS |
| | | TUBE | COOLING WATER | 6930 | | - | - | | | 82 | 110 | | 130 | | | 0.001 | | 10 | 40 | 110 | | | | |
| EA-861 | CRUDE COLUMN REFLUX CRESYLIC ACID INTERCOOLER | SHELL | CRESYLIC ACID | 4434 | 0.91 | - | 0.369 | | | 412 | 214 | 147 | 460 | 520 | | 0.001 | 59 | 10 | 20 | 50 | | AES | CS | CS |
| | | TUBE | MAIN & CRESYLIC ACID | 11100 | 0.878 | - | 0.990 | | | 116 | 183 | | 205 | | | 0.001 | | 10 | 40 | 70 | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |

| ITEM NUMBER | COMPONENT | ENTERING: lb/hr VAPOR | ENTERING: lb/hr LIQUID | ENTERING: Bubble or Dew Pt. °F | ENTERING: SP. GR. | ENTERING: MOL. WT. | LEAVING: lb/hr VAPOR | LEAVING: lb/hr LIQUID | LEAVING: Bubble or Dew Pt. °F | LEAVING: SP. GR. | LEAVING: MOL. WT. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

NOTES:

| REV | DESCRIPTION | BY | APP | APP | DATE |
|---|---|---|---|---|---|
| 0 | FOR TASK 4 | LH | | | 4/14/88 |

LUMMUS Broomfield

EXCHANGER SCHEDULE

UNIT DELTA 850

JOB NO [illegible]

F-147

VESSEL NO FA-251 COMB WITH

VESSEL NAME FEED/ PRIMARY DRUM

DIAMETER 4 - 6 ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HORIZ LENGTH 12 - 0 ft-in

OPER TEMP TOP °F BOTT °F DRUM 115 °F

MAX TEMP TOP °F BOTT °F DRUM 167 °F

NORM OPER PRESS 7.2 psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP 230 °F

DES PRESS 45 psig VAC psia

HEADS ELIP DISHED X CONE FLAT

CODE ASME API OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MAT'L SHELL C.S LINER THK in

INSULATION CONSERV'N K PROTECT'N NONE

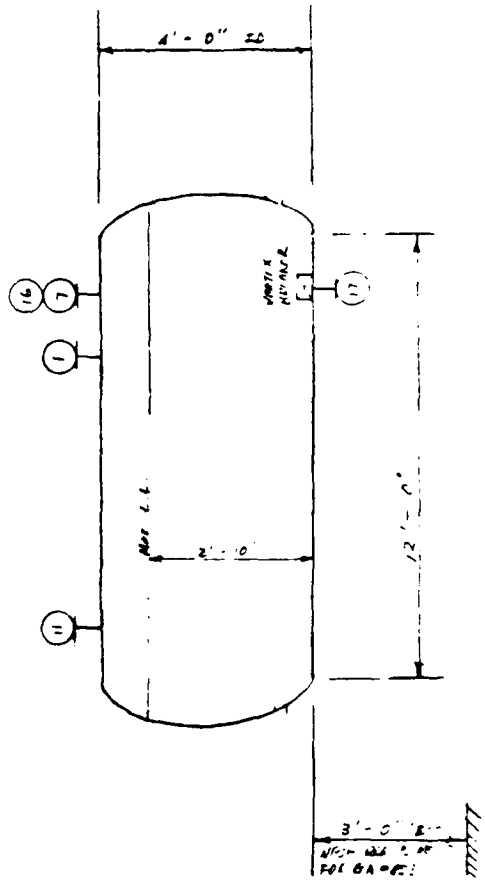
DECK MAT'L

NOZZLES FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | ½ | VAPOR OUTLET TO FLARE |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | | 4 | FEED FROM EA-852 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | ½ | EQUALIZING LINE WITH EA-852 |
| 17 | | 4 | BOTTOM OUTLET TO GA-853 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV, VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES Use SP Gr = 0.64 @ Operating Temp




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ MGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/14/78 | FOR TANK 4 | WJ | | | |

LUMMUS THE LUMMUS COMPANY Bloomfield

TITLE JET FUEL PROJECT

CLIENT Amerada Hess Corp LOCATION Bayonne, New Jersey

PROJ NO 6657 ENGR NO 6571

PROCESS VESSEL SKETCH

VESSEL NO FA-251 DWG SKS -

VESSEL NO FA-852 COMB WITH _____

VESSEL NAME NITRANIL FEED KNOCK OUT DRUM

DIAMETER 2'-6" ft-in & _____ ft-in

VERT HT _____ ft-in SKIRT _____ ft-in

HORIZ LENGTH 7'-0" ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 171 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM 182 °F

NORM OPER PRESS 7.0 psig OR _____ psig

MAX OPER PRESS _____ psig OR _____ psig

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 230 °F

DES PRESS 40 psig VAC _____ psig

HEADS ELIP _____ DISHED X CONE _____ FLAT _____

CODE ASME _____ API _____ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERV'N X PROTECT'N _____ NONE _____

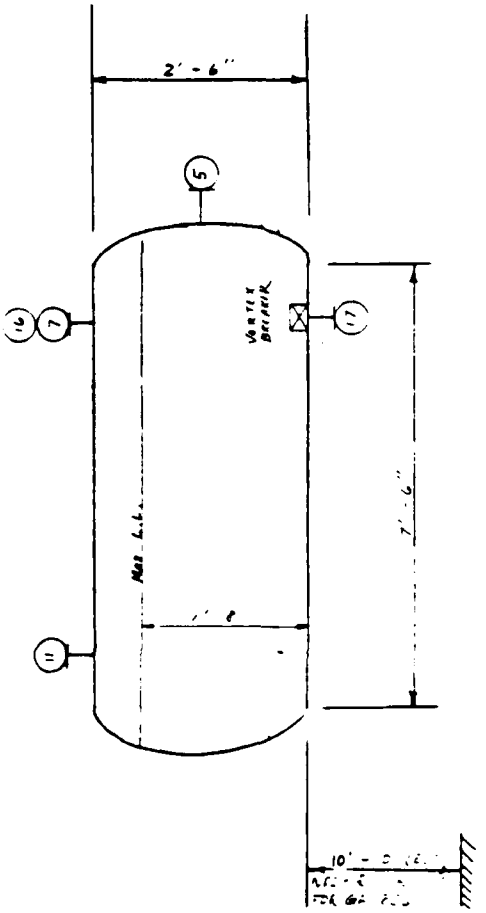
DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | | | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 8 | HANDHOLE |
| 6 | | | |
| 7 | 1 | 1½ | VAPOR OUTLET TO FLARE |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 4 | FEED FROM FA-855 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH FA-855 |
| 17 | | 2 | BOTTOM OUTLET TO GF 852 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG |
| 37 | | | PRESSURE CONTROLLER (P _____ C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T _____ C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

NOTES LIQUID Sp Gr = 0.76 @ Pumping Temp

FLANGED NOZZLES ARE NUMBERED 1-56 FOR COUPLING ADD 56 TO NOZZLE NO




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 0 | 4/10/85 | FOR TALK 4 | HH | | | |

LUMMUS — THE LUMMUS COMPANY Bloomfield

TITLE JET FUEL PROJECT

CLIENT ANWOIL - GRT. MIDDLEBURN LOCATION BEDIAN, NORTH JAVA GAS PLANT

PROJ NO _____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FA-852 DWG SKS -

VESSEL NO EA-853 COMB WITH

VESSEL NAME DA-NG COLUMN FEED DRUM

DIAMETER 5'-0" ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HORIZ LENGTH 15'-6" ft-in

OPER TEMP TOP °F BOTT °F DRUM 112 °F

MAX TEMP TOP °F BOTT °F DRUM 165 °F

NORM OPER PRESS 70 psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP 355 °F

DES PRESS 40 psig VAC psia

HEADS ELIP DISHED S CONE FLAT

CODE ASME API OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL C.S LINER THK in

INSULATION CONSERVTN X PROTECTN NONE

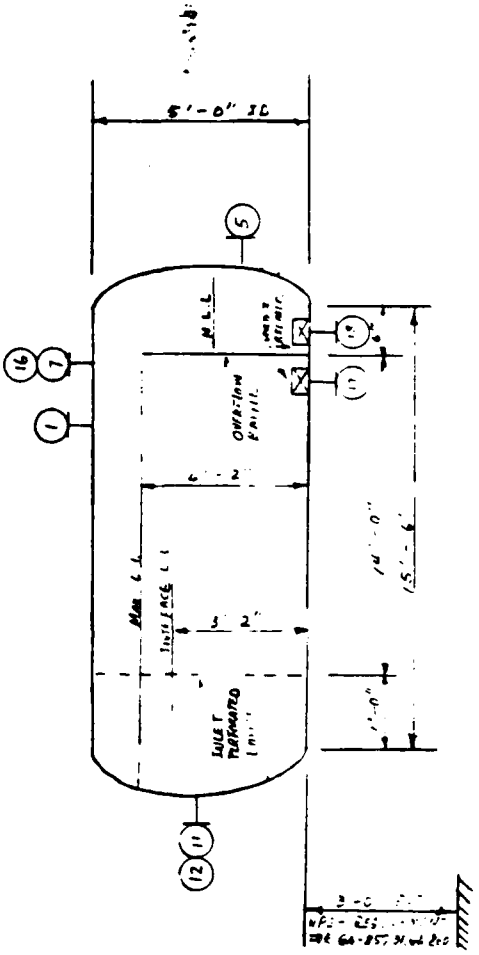
DECK MATL

NOZZLES FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | 1 | 8 | HANDHOLE |
| 6 | | | |
| 7 | 1 | 1½ | VAPOR OUTLET TO FLARE |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM EA-856 |
| 12 | 1 | 1½ | FEED FROM EA-852 |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH EA-858 |
| 17 | 1 | | BOTTOM OUTLET TO GA-P67 |
| 18 | 1 | 4 | LIQUID OUTLET TO GA-P40 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES LIQUID SP GR = 1.0 (AVG); @ operating temp




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/10/79 | FOR TASK 4 | MJ | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT ANCHOR-GRACE REFG. LOCATION BEULAH, WYO. 82716

PROJ NO ABS NO 06571

PROCESS VESSEL SKETCH

VESSEL NO EA-853 DWG SKD -

VESSEL NO FA 854 COMB WITH _____

VESSEL NAME [illegible]

DIAMETER 3'-6" ID ft-in S _____ ft-in

VERT HT _____ " ft-in SKIRT _____ ft-in

HORIZ LENGTH 10'-6" ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 150 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM 171 °F

NORM OPER PRESS 70 psig OR _____ psia

MAX OPER PRESS _____ psig OR _____ psia

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 230 °F

DES PRESS FV psig VAC _____ psia

HEADS ELIP _____ DISHED _____ CONE _____ FLAT _____

CODE ASME _____ API _____ OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERVTN X PROTECTN _____ NONE _____

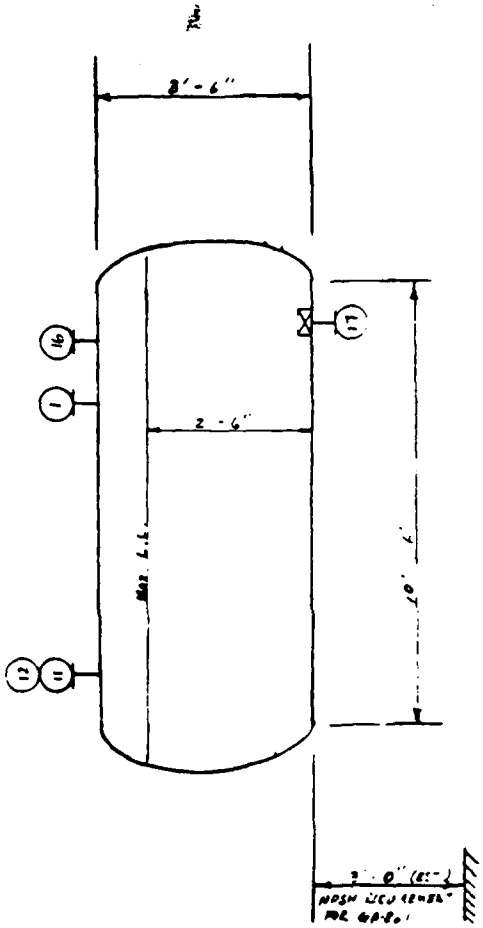
DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 12 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | _____ |
| 4 | — | — | _____ |
| 5 | — | — | HANDHOLE |
| 6 | — | — | _____ |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | — | 1½ | FEED FROM GA 854 |
| 12 | — | 1½ | FEED FROM GA-860 |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER) (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | 2 | BOTTOM OUTLET TO GA-861 |
| 18 | — | — | LIQUID OUTLET TO _____ |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S) COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | _____ |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | _____ |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | _____ |
| 50 | — | — | _____ |

PLANGED NOZZLES ARE NUMBERED 1 50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES Liquid Sp Gr = 0.816 @ Operating Temp C




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ MGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/84 | For TANK 4 | MJ | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT [illegible] LOCATION BEAUMONT, TEXAS

PROJ NO _____ JOB NO 0557 1

PROCESS VESSEL SKETCH

VESSEL NO FA-854 DWG SIZE –

VESSEL NO FB-851 COMB WITH _____

VESSEL NAME METHANE STORAGE TANK _____

DIAMETER 10'-0" ft-in & _____ ft-in

VENT HT 16'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM A-B °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 6" H2O psig OR _____ psia

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 250 °F

DES PRESS 8" H2O psig VAC -2" H2O psig

HEADS ELIP _____ DISHED _____ CONE FACE FLAT BOTTOM

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERV'N R PROTECT'N _____ NONE _____

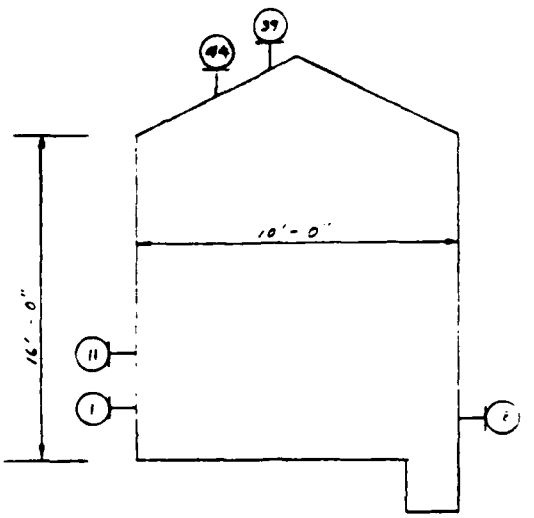
DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____ _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE (MH) |
| 2 | — | — | MANHOLE |
| 3 | — | — | _____ |
| 4 | — | — | _____ |
| 5 | — | — | HANDHOLE |
| 6 | — | — | _____ |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 3 | FEED FROM TANK TRUCK |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | _____ BOTTOM OUTLET TO _____ |
| 18 | — | 4 | _____ LIQUID OUTLET TO GA PPG |
| 19 | — | — | _____ DRAWOFF TO _____ |
| 20 | — | — | _____ RETURN FROM _____ |
| 21 | — | — | _____ DRAWOFF TO _____ |
| 22 | — | — | _____ RETURN FROM _____ |
| 23 | — | — | _____ DRAWOFF TO _____ |
| 24 | — | — | _____ RETURN FROM _____ |
| 25 | — | — | _____ REFLUX DRAWOFF TO _____ |
| 26 | — | — | _____ REFLUX IN FROM _____ |
| 27 | — | — | _____ REFLUX DRAWOFF TO _____ |
| 28 | — | — | _____ REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S) COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | AS CLADDING |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | _____ |
| 50 | — | — | _____ |

FLANGED NOZZLES ARE NUMBERED 1-60 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES Liquid SpGr = 0.66 @ Operating Temp




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/79 | For TANK 4 | M: | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JBF FUEL PROJECT

CLIENT ARGED/DOE - GEOREGIONATION BEULAH, NORTH DAKOTA

PROJ NO 6611-E PLANT JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-851 DWG SKD –

VESSEL NO FB-852 COMB WITH _____

VESSEL NAME CRUDE CAUSTIC ACID DAY TANK

DIAMETER 12'-6" ft-in & _____ ft-in

VERT HT 16'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM AMB °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM 115 °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 6" H2O psig OR _____ psia

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 350 °F

DES PRESS 2" H2O psig VAC -2" H2O psia

HEADS ELIP _____ DISHED _____ CONE 60° FLAT FLAT

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERV'N X PROTECT'N _____ NONE _____

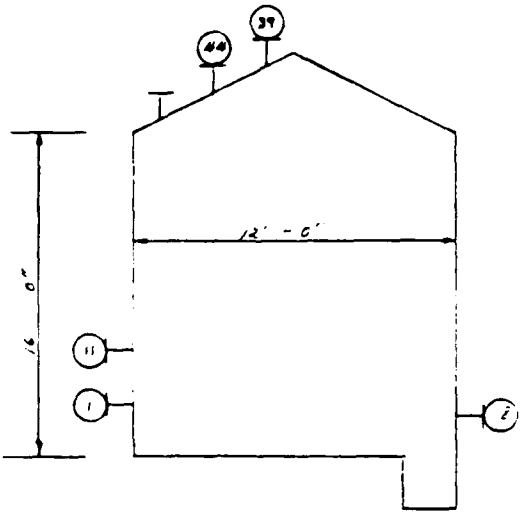
DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE (SHELL) |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM CA-P-5 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | | 6 | LIQUID OUTLET TO GA-P-9 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | NO FLANGE NG |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO

NOTES LC - 34-1102 @ Sensing Temp




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/8/90 | FOR TASK 4 | NI | | | |

LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/BP - WEST COAST LOCATION BEDLAM, NORTH CAROLINA

FROM SO GAS PLANT SHEET NO 06571

PROCESS VESSEL SKETCH

VESSEL NO FB-852 SHEET NO -

VESSEL NO GA-85: A & B  COMB WITH _____

VESSEL NAME CRUDE CAUSTIC & H2O WASH STORAGE TANK

DIAMETER 35'-0" ft-in &  ft-in

VENT HT 24'-0" ft-in SKIRT  ft-in

HORIZ LENGTH  ft-in

OPER TEMP: TOP  °F BOTT  °F SHELL 113 °F

MAX TEMP: TOP  °F BOTT  °F SHELL  °F

NORM OPER PRESS  psig OR  psia

MAX OPER PRESS 6" H2O psig OR  psia

CORROSION ALLOW SHELL  in DECKS  in

DES TEMP 230 °F

DES PRESS 8" H2O psig VAC -2" H2O psia

HEADS ELIP  DISHED  CONE 60°E PLAT FLAT

CODE ASME  API Y OTHER

STRESS RELIEVED YES  CODE

RADIOGRAPHED YES  CODE

EARTHQUAKE  WIND  mph

MATL SHELL C.S. LINER  THK  in

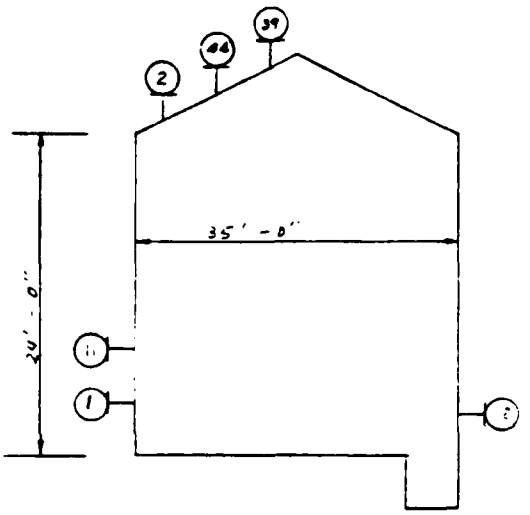
INSULATION CONSERV'N A PROTECT'N  NONE

DECK MATL

NOZZLES PLG CLASS  COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24" | MANHOLE (SHELL) |
| 2 | 1 | 24" | MANHOLE (ROOF) |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM GA-P-9 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 3 | | LIQUID OUTLET TO GA-P-62 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | NO PURCHASING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE MATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES Lo = 0 & G = 1.0 @ Operating Temp

| REV | ISSUE DATE | DESCRIPTION | PREP'D | CHK'D | APP'D | APP'D |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/82 | FOR TANK 4 | WJ | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT ARCADIAN-GENT REFG LOCATION BEULAH, NORTH DAKOTA

DESIGN PLANT

PROJ NO  ORD NO 0557/

PROCESS VESSEL SKETCH

VESSEL NO GA-85: A & B  DWG NO –

| ITEM NO | SERVICE | PUMP TYPE | LIQUID | CORR/EROS CAUSED BY | PUMPING TEMP °F NORM | PUMPING TEMP °F MAX | SP GR AT P.T. | VAPOR PRESS AT P.T. PSIA | VISC AT P.T. CP | CAPACITY USGPM NORM | CAPACITY USGPM RATED | DISCH PRESS. PSIG | SUCTION PRESS. PSIG RATED | SUCTION PRESS. PSIG MAX | DIFF PRESS. PSI | DIFF HEAD FT | NPSH AVAIL FT | MATL CLASS | CORR ALLOW IN | FLANGE RATING/FACING SUCT | FLANGE RATING/FACING DISCH | DRIVER TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA-P11 A/S | EXTRACTOR BOTTOMS LOOP | CENTRIFUGAL | BENZENE, AMINE & CERAMIC ACID | | 113 | | 0.84 | 4.0 | 0.43 | 21 | 25 | 63 | 33 | | 32 | 82 | 140 | D1 CS | | | | MOTOR | |
| GA-P12 A/S | WATER BOTTOMS PUMP | CENTRIFUGAL | CHLORINATED & CARBOXILIC ACID | | 350 | | 0.79 | 2.1 | 0.27 | 2.8 | 40 | 60 | 17 | | 43 | 126 | 11 | D1 CS | | | | MOTOR | |
| GA-P13 A/S | MIXED FEED PUMP | CENTRIFUGAL | METHANE | | 113 | | 0.64 | 6.4 | 0.12 | 4.7 | 33 | 68 | 7 | | 61 | 222 | 69 | D1 CS | | | | MOTOR | |
| GA-P14 A/S | MIXED AMINE WASH UP PUMP | CENTRIFUGAL | BENZENE | | 22 | | 0.85 | 2.7 | 0.30 | | 35 | 68 | 65 | | 685 | 193 | 40 | D1 CS | | | | MOTOR | |
| GA-P15 A/S | DEETHANIZER CAUSTIC RETURN PUMP | CENTRIFUGAL | WATER & CARBOXILIC ACID | | 139 | | 0.95 | 2.1 | 0.47 | 22 | 24 | 4 | 28 | | 25 | 61 | 11 | D1 CS | | | | MOTOR | |
| GA-P16 A/S | DEETHANIZER CAUSTIC RETURN PUMP | CENTRIFUGAL | METHANOL SOLUTION | | 121 | | 0.92 | 7.2 | 1.2 | 22 | 32 | 97 | 7 | | 91 | 126 | 6 | D1 CS | | | | MOTOR | |
| GA-P17 A/S | DEHYD COLUMN FEED PUMP | CENTRIFUGAL | WATER & CARBOXILIC ACID | | 113 | | 1.0 | 2 | 0.73 | 22 | 32 | 53 | 7 | | 46 | 105 | 14 | D1 CS | | | | MOTOR | |
| GA-P18 A/S | DEHYD COLUMN BOTTOMS PUMP | CENTRIFUGAL | CRUDE CARBOXILIC ACID | | 413 | | 0.82 | 2.1 | 0.45 | 9 | 11 | 102 | 17 | | 27 | 73 | 11 | D1 CS | | | | MOTOR | |
| GA-P19 | CRUDE CARBOXILIC ACID PUMP | CENTRIFUGAL | CRUDE CARBOXILIC ACID | | 112 | | 1.06 | 0.1 | 1.47 | | 20 | 43 | 0.2 | | 425 | 99 | 32 | D1 CS | | | | MOTOR | |
| GA-P20 A/S | DEHYD COLUMN CONDENSATE PUMP | CENTRIFUGAL | WATER & DISSOLVED CARBOXILIC ACID | | 113 | | 0.99 | 1.8 | 0.60 | 3.3 | 10 | 30 | 3 | | 23 | 58 | 42 | D1 CS | | | | MOTOR | |
| GA-P21 A/S | ESP BOTTOMS PUMP | CENTRIFUGAL | H2O/HYDROCARBONS | | 150 | | 0.97 | 2.5 | 0.91 | 14 | 16 | 25 | 3 | | 19 | 136 | 19 | D1 CS | | | | MOTOR | |
| GA-P22 A/S | CRUDE CARBOXYLIC ACID SURGE PUMP | CENTRIFUGAL | CRUDE CARBOXYLIC ACID | | 71 | | 1.05 | 0.1 | 2.0 | | 50 | 81 | 0.5 | | 81.5 | 123 | 32 | D1 CS | | | | MOTOR | |

| REV NO | ITEM NO |
|---|---|
| | |

## UTILITIES

**STEAM**
INLET PRESS, PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
EXH. PRESS., PSIG/IN.Hg ____ NORM. ____ MIN. ____ MAX.

**COOLING WATER:**
SUPPLY PRESS. ____ PSIG TEMP. ____ °F
RETURN PRESS. ____ PSIG TEMP. ____ °F (MAX.)

**INSTRUMENT AIR**
SUPPLY PRESS. ____ PSIG TEMP. ____ °F

**ELECTRIC POWER:**
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
INSTRUMENTS ____ V ____ PHASE ____ Hz/DC
HEATERS ____ V ____ PHASE ____ Hz
AREA CLASS ____ OR ____ DIV ____

| REV NO | BY | DATE |
|---|---|---|
| 0 | ML | 6/14/84 |

LUMMUS — THE LUMMUS COMPANY Bloomfield

**PUMP SCHEDULE**

Amoco/DOE - 4881

CUSTOMER Plant GAS-F PLANT PROJECT Tar Sands

UNIT ____ AREA 850

JOB NO 85-11

AREA 900

CLIENT:DOE
LOCATION:BEULAH,ND.
PROJECT:JET FUEL

PROJECT:5571
DATE/BY: 21-Mar-89 09:16 AM

| EQUIPMENT | # PCS. | $ EQUIP. | % COMM | $ COMM |
|---|---|---|---|---|
| HEATERS | | | | |
| TOWERS | 5 | $453 | 100% | $453 |
| INTERNALS | | $218 | | |
| REACTORS | | | | |
| EXCHANGERS | 16 | $220 | 110% | $242 |
| VESSELS | 4 | $19 | 120% | $23 |
| TANKS | 6 | $69 | 80% | $55 |
| FILTERS | | | | |
| PUMPS | 28 | $210 | 110% | $231 |
| COMPRESSORS | 2 | $50 | 110% | $55 |
| PACKAGE UNITS | | | | |
| | | | | |
| TOTAL | 61 | $1,239 | | $1,059 |

*SUMMARY*

| | | |
|---|---|---|
| EQUIPMENT | $1,239 | |
| COMMODITIES | $1,059 | |
| LABOR | $759 | (10% EQUIP,60% COMM) |
| INDIRECTS | $759 | (100% LABOR) |
| ENGINEERING | $2,440 | (800/PC X $50) |
| SUBTOTAL | $6,257 | |
| CONTINGENCY | $1,251 | (20%) |
| TOTAL | $7,508 | |

EQUIPMENT SUMMARY

| | WEIGHT | MATL | $/LB | $ |
|---|---|---|---|---|
| DA-901 PHENOL/ORTHO COL | 100000 | CS | $1.40 | $140,000 |
| DA-902 PHENOL COL | 35000 | CS | $1.60 | $56,000 |
| DA-902B PHENOL COL | 35000 | CS | $1.60 | $56,000 |
| DA-903 M,P-CRESOL COL. | 86000 | CS | $1.50 | $129,000 |
| DA-904 XYLENOL TOPPING COL. | 45000 | CS | $1.60 | $72,000 |
| | | | TOTAL | $453,000 |

| | FT2 | MATL | $/FT2 | $ |
|---|---|---|---|---|
| DB-901 PHENOL/ORTHO COL | 4800 | CS/SS VALVES | $18.00 | $86,400 |
| DB-902 PHENOL COL | 900 | CS/SS VALVES | $18.00 | $16,200 |
| DB-902B PHENOL COL | 1000 | CS/SS VALVES | $18.00 | $18,000 |
| DB-903 M,P-CRESOL COL. | 3500 | CS/SS VALVES | $18.00 | $63,000 |
| DB-904 XYLENOL TOPPING COL. | 1900 | CS/SS VALVES | $18.00 | $34,200 |
| | | | TOTAL | $217,800 |

EQUIPMENT SUMMARY

| | | FT2 | MATL | $/FT2 | $ |
|---|---|---|---|---|---|
| EA-901 | PHENOL/ORTHO COL. REBOIL | 790 | CS/CS | $27.00 | $21,330 |
| EA-902 | PHENOL/ORTHO COL. COND | 522 | CS/CS | $19.00 | $9,918 |
| EA-903 | PHENOL COL. REBOIL | 300 | CS/18-2 | $95.00 | $28,500 |
| EA-904 | PHENOL COL COND | 286 | CS/CS | $28.00 | $8,008 |
| EA-905 | M,P-CRESOL COL. REBOIL | 750 | CS/18-2 | $28.00 | $21,000 |
| EA-906 | M,P-CRESOL COL. COND | 520 | SS/SS | $60.00 | $31,200 |
| EA-907 | XYLENOL TOPPING COL REBOIL | 374 | CS/18-2 | $90.00 | $33,660 |
| EA-908 | XYLENOL TOPPING COL COND | 236 | SS/SS | $120.00 | $28,320 |
| EA-909 | PHENOL/ORTHO COL. INTER | 51 | CS/CS | $100.00 | $5,100 |
| EA-910 | PHENOL COL. BTTMS. COOL | 68 | CS/CS | $90.00 | $6,120 |
| EA-911 | XYLENOL TOPPING COL. BTTMS | 35 | CS/CS | $125.00 | $4,375 |
| EA-912 | M,P-CRESOL PRODUCT COOLER | 135 | CS/CS | $50.00 | $6,750 |
| EA-913 | O-CRESOL TOPPING COL OH. | 16 | CS/CS | $200.00 | $3,200 |
| EA-914 | O-CRESOL PRODUCT COOL. | 46 | CS/CS | $110.00 | $5,060 |
| EA-915 | XYLENOL COL.INTER. | 18 | CS/CS | $200.00 | $3,600 |
| EA-916 | 2,4/2,5 XYLENOL PROD. COOL | 22 | CS/CS | $200.00 | $4,400 |
| | | | | TOTAL | $220,541 |

EQUIPMENT SUMMARY

| | | WEIGHT | MATL | $/LB | $ |
|---|---|---|---|---|---|
| FA-901 | PHENOL/ORTHO REFLUX DRUM | 2000 | CS | $2.75 | $5,500 |
| FA-902 | PHENOL REFLUX DRUM | 1000 | CS | $4.00 | $4,000 |
| FA-903 | M/P-CRESOL REFLUX DRUM | 2000 | CS | $2.75 | $5,500 |
| FA-904 | XYLENOL TOPPING REFLUX | 1000 | CS | $4.00 | $4,000 |
| | | | | TOTAL | $19,000 |

EQUIPMENT SUMMARY

| | | BBLS | MATL | $/BBL | $ |
|---|---|---|---|---|---|
| FB-901 | O-CRESOL TOP. FEED DAY TANK | 224 | CS | $55 | $12,320 |
| FB-902 | XYLENOLS INT. DAY TANK | 135 | CS | $65 | $8,775 |
| FB-903 | O-CRESOL DAY TANK | 135 | CS | $65 | $8,775 |
| FB-905 | M,P-CRESOL DAY TANK | 430 | CS | $50 | $21,500 |
| FB-906 | 2,4/2,5-XYLENOL DAY TANK | 90 | CS | $90 | $8,100 |
| FB-907 | MIXED XYLENOLS DAY TANK | 135 | CS | $65 | $8,775 |
| | | | | | $68,155 |

EQUIPMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| GA-901&S | PHENOL/ORTHO BTTMS | <10HP | CS | | $15,000 |
| GA-902&S | PHENOL/ORTHO REFLUX | <10HP | CS | | $15,000 |
| GA-903&S | PHENOL BTTMS | <10HP | CS | | $15,000 |
| GA-904&S | PHENOL REFLUX | <10HP | CS | | $15,000 |
| GA-905&S | M,P CRESOL BTTMS | <10HP | CS | | $15,000 |
| GA-906&S | M,P CRESOL REFLUX | <10HP | CS | | $15,000 |
| GA-908 | O-CRESOL TOPPING | <10HP | CS | | $7,500 |
| GA-909 | MIXED XYLENOL | <10HP | CS | | $7,500 |
| GA-910 | 2,4/2,5-XYLENOL | <10HP | CS | | $7,500 |
| GA-911 | M,P-CRESOL | <10HP | CS | | $7,500 |
| GA-912 | XYLENOLS | <10HP | CS | | $7,500 |
| GA-913 | O-CRESOL | <10HP | CS | | $7,500 |
| GA-914&S | PHENOL COL. INTERM. | <10HP | CS | | $15,000 |
| GA-915&S | XYLENOL TOPPING | <10HP | CS | | $15,000 |
| GA-916&S | XYLENOL TOPPING REFLUX | <10HP | CS | | $15,000 |
| GA-917&S | O-CRESOL TOP. COL. FEED | <10HP | CS | | $15,000 |
| GA-918&S | XYLENOL COL. FEED | <10HP | CS | | $15,000 |
| | | | | TOTAL | $210,000 |
| GB-901,S | VACUUM PUMP | | | TOTAL | $50,000 |

VESSEL NO DA-901 COMB WITH
VESSEL NAME PHENOL/ORTHO COLUMN/O-CRESOL TOPPING COL. (AIR. SERVICE)
DIAMETER 7'-0" ID
VERT HT 172'-8" TAN TANT 15'-0" OD
HORIZ LENGTH OD
OPER TEMP TOP 262 °F BOTT 380 °F SHELL °F
MAX TEMP TOP °F BOTT °F SHELL °F
NORM OPER PRESS -12.5 (TOP) psig OR -2.7 (Bottom) psig
MAX OPER PRESS psig OR psig
CORROSION ALLOW SHELL 3mm in DECKS in

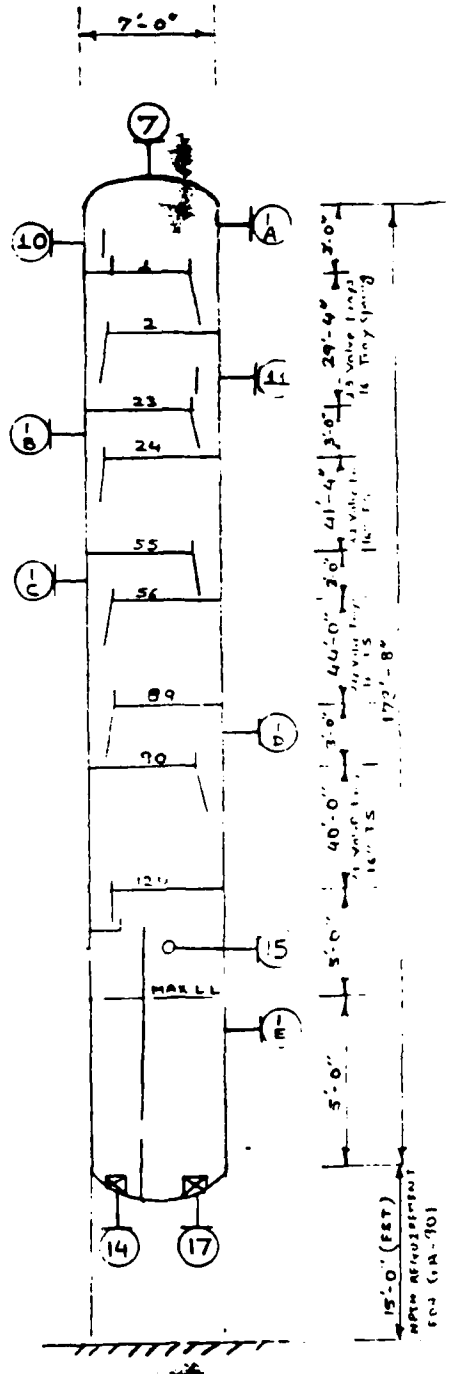
DES TEMP 405 °F
DES PRESS 45 psig VAC FULL psia
HEADS ELIP DISHED CONE FLAT
CODE ASME VIII AR OTHER
STRESS RELIEVED YES ✓ CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in
INSULATION CONSERVTN ✓ PROTECTN NONE
DECK MATL CS VALVE MATL 304 SS

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 5 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | 18 | VAPOR OUTLET TO EA-902 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | 1 | 3 | REFLUX IN FROM FA-901 |
| 11 | 1 | 1½ | FEED FROM GA-883 or GA-917 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | 1 | 8 | TO REBOILER (RECIRC) EA-901 |
| 15 | 1 | 16 | FROM REBOILER EA-901 |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | 1½ | BOTTOM OUTLET TO GA-901 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN |
| 33 | | | SAFETY VALVE |
| 34 | | | SAFETY VALVE (PVSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

NOTES LIQ SP GR = 0.91 (avg) @ operating temp.




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/83 | FOR TAB 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
SUBSTANCE BASE - GREAT LOCATION BEULAH, NORTH DAKOTA
PLANT GREAT PLANT
PROJ NO ASB NO 0657/

PROCESS VESSEL SKETCH

VESSEL NO DA-901 DWG NO -

CE LUM VALVE TRAY COMPUTER PROGRAM 4-2/19 [illegible] DAT D APR 25 1986 BATCH

BY SUNIL JSED AT 10.11.09 ON 04/11/11. [illegible] JMMJS JOB OR ESTIMATE 5571

COLUMN 906 CRESYLIC ACID RECOVERY DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING, INCHES [illegible] TOWER DIAMETER, INCHES 84.00

TYPE OF FLOW SXF (1-PASS)

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM * | 33262.03 | .02910 | 30284.00 | 60.00000 | 27.37 | .36900 |
| (BASED ON OVERDESIGN TO 100.0 O/D OF VAPOR AND TO 100.0 O/D OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| MINIMUM * | 33100.00 | .13300 | 35213.50 | 54.20000 | 19.30 | .27203 |
| (BASED ON DOWNDOWN TO 30.0 O/D OF VAPOR AND TO 70.0 O/D OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION 1=SIDE, 2= SLOPING

DOWNCOMER TYPE *INLET WEIR

DIMENSIONS, INCHES

| | | |
|---|---|---|
| [illegible] | (NOTE 1) | 8.503 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 8.503 |
| OUTLET WEIR HEIGHT | | 1.303 |
| [illegible] | | 1.503 |
| [illegible] | (NOTE 2) | 50.666 |
| [illegible] | (NOTE 2) | 50.665 |

DIMENSIONS AT BOTTOM OF DOWNCOMER, INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 5.253 |
| [illegible] | (NOTE 3) | .753 |
| [illegible] | (NOTE 4) | 2.253 |
| [illegible] | | 1.253 |
| [illegible] | (NOTE 2) | 50.665 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 5.253 |
| LENGTH OF DOWNCOMER PLATE | (NOTE 2) | 44.388 |
| [illegible] TO SHELL DISTANCE | | 8.503 |
| [illegible] | (NOTE 2) | 43.888 |

[illegible] PER DOWNCOMER PLATE. NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 -[illegible] 0.) REFER TO THE APPLICABLE MESSAGES ON THE DIAGNOSTICS SHEET . NOTE 6 - * INDICATES SPECIAL TRAY FEATURE

[illegible] THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY.

F-163

VESSEL NO DA-902A COMP WITH

VESSEL NAME T-END, CO-VAP /CO-CAT SEP COLUMN (Alternate Concept)

DIAMETER 5'-0" ID & ___ ID/OD

VERT HT 93'-4" TAN/TAN 15'-0" ID/OD

HORIZ LENGTH ___ ID/OD

OPER TEMP: TOP 312 °F BOTT 365 °F DRUM ___ °F

MAX TEMP: TOP ___ °F BOTT ___ °F DRUM ___ °F

NORM OPER PRESS -8 [7.5] psig @ 3.5/[8.5+0] psig

MAX OPER PRESS ___ psig @ ___ psig

CORROSION ALLOW: SHELL 2mm in HEADS ___ in

DES TEMP 380 °F

DES PRESS 45 psig VAC FULL ___ psig

HEADS: ELIP ✓ DISHED ___ CONE ___ FLAT ___

CODE: ASME VOLL ✓ API ___ OTHER ___

STRESS RELIEVED: YES ✓ CODE ___

RADIOGRAPHED: YES ___ CODE ___

EARTHQUAKE: ___ WIND ___ mph

MATL: SHELL CS LINER ___ THK ___ in

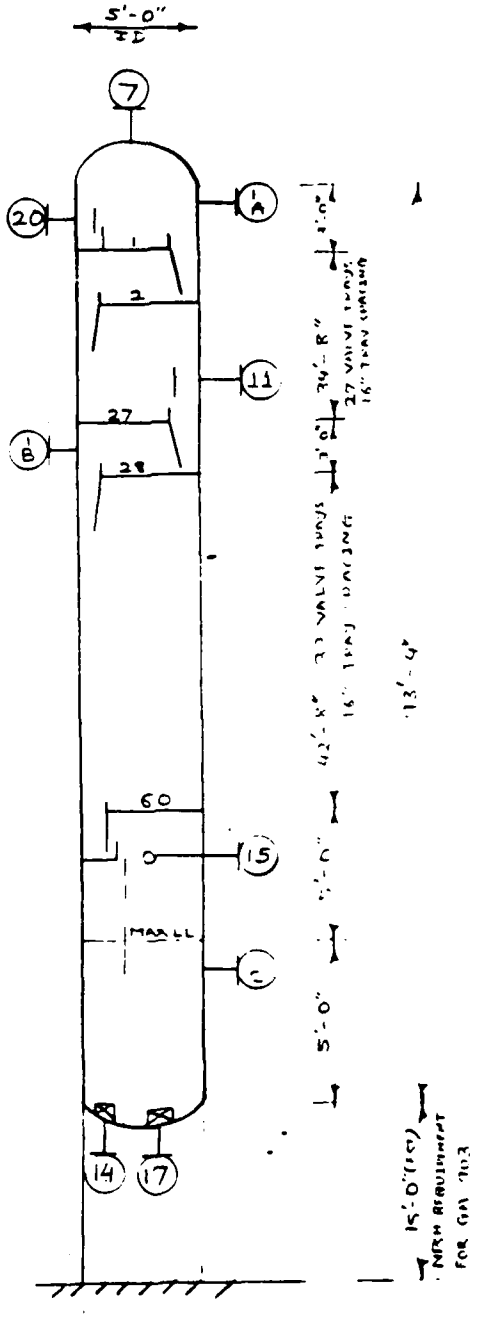
INSULATION: CONSERVTN ✓ PROTECTN ___ THK ___

DECK MATL CS VALVE MATL 316SS

NOZZLES: FLG CLASS 150 COUPL CLASS ___

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 2 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | 1 | 8 | VAPOR OUTLET TO DA-902B |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM |
| 11 | — | — | FEED FROM GA-902 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | 1 | 2 | TO REBOILER EA 903 |
| 15 | 1 | 2 | FROM REBOILER EA 903 |
| 16 | — | — | EQUALIZING LINE WITH |
| 17 | 1 | 1½ | BOTTOM OUTLET TO GA-903 |
| 18 | — | — | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO |
| 20 | — | 2 | RETURN FROM DA-902E |
| 21 | — | — | DRAWOFF TO |
| 22 | — | — | RETURN FROM |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VBV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P ___ C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T ___ C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | 2 | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | |
| 50 | — | — | |

PLANNED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO.




NOTES: 1) DA-902 consists of 2 shells (DA-902A&B) At the time of design a single shell configuration will be investigated.

2) LIQ SPGR = 0.92 (avg) @ operating temp

| REV | ISSUE DATE | DESCRIPTION | PROJ. ENGR. | PROJ. MGR. | APPR. | APPR. |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/16/86 | FOR TASK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE-GREATLOCATION REULAH, NORTH DAKOTA PLAINS GASIFICATION PLANT

PROJ NO 208 NO 05571

PROCESS VESSEL SKETCH

VESSEL NO DA-902A DWG NO

VESSEL NO DA-902B COMB WITH _____

VESSEL NAME BENZENE COLUMN / STEEL COLUMN (Alternate Service)

DIAMETER 5'-0" Skirt ID _____ Skirt

VESSEL HT 93'-4" Skirt SKIRT 15'-0" Skirt

NOZZLE LENGTH _____ Skirt

OPER TEMP: TOP 256 °F BOTT 312 °F DRUM _____ °F

MAX TEMP: TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS -12 S/TAN psig or -5 1/8 PSIG psig

MAX OPER PRESS _____ psig or _____ psig

CORROSION ALLOW: SHELL 3 mm % DESIGN _____ in

DES TEMP 340 °F

DES PRESS 45 psig VAC FULL psig

HEADS: ELIP ✓ DISHED _____ CONE _____ FLAT _____

CODE: ASME VIII API _____ OTHER _____

STRESS RELIEVED: YES ✓ CODE _____

RADIOGRAPHED: YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL: SHELL C S LINER _____ THK _____ in

INSULATION: CONSERVTN ✓ PROTECTN _____ NONE _____

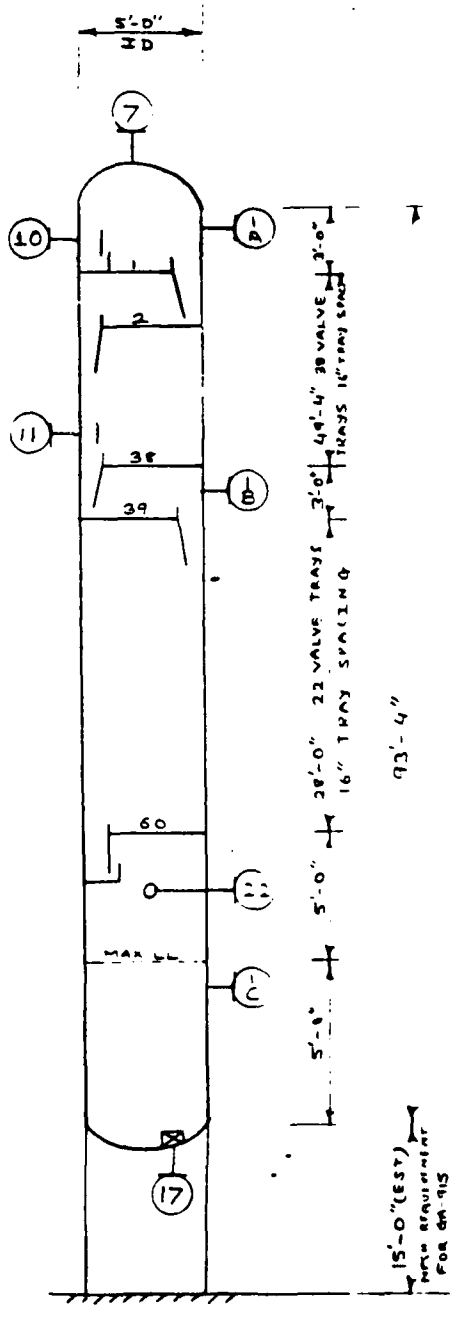
DECK MATL C S VALVE MATL 30465

NOZZLES: FLG CLASS _____ COUPL CLASS _____

| ITEM NO. | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 3 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | — |
| 4 | — | — | — |
| 5 | — | — | HANDHOLE |
| 6 | — | — | — |
| 7 | 1 | 10 | VAPOR OUTLET TO EA-904 |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | 1 | 1½ | REFLUX IN FROM EA-902 |
| 11 | — | 1½ | FEED FROM EA-901 |
| 12 | — | — | FEED FROM |
| 13 | — | — | FEED FROM |
| 14 | — | — | TO (REBOILER) (REB. PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH |
| 17 | — | 4 | BOTTOM OUTLET TO EA-911 |
| 18 | — | — | LIQUID OUTLET TO |
| 19 | — | — | DRAWOFF TO |
| 20 | — | — | RETURN FROM |
| 21 | — | — | DRAWOFF TO |
| 22 | 1 | 8 | RETURN FROM DA-902A |
| 23 | — | — | DRAWOFF TO |
| 24 | — | — | RETURN FROM |
| 25 | — | — | REFLUX DRAWOFF TO |
| 26 | — | — | REFLUX IN, FROM |
| 27 | — | — | REFLUX DRAWOFF TO |
| 28 | — | — | REFLUX IN, FROM |
| 29 | — | — | PROCESS STEAM |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN. (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P ____ D) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | — | — | — |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T ____ D) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | — | — | — |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL |
| 47 | 2 | — | INTERNAL LEVEL |
| 48 | — | — | LEVEL ALARM (LA) |
| 49 | — | — | — |
| 50 | — | — | — |

PLANGED NOZZLES ARE NUMBERED 1-6: FOR 3C UPLINK ADD 50 TO NOZZLE NO.

NOTES: LIQ SP GR = 0.97 (avg) @ operating temp




| REV | ISSUE DATE | DESCRIPTION | PREP'D | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/14/89 | FOR TANK 4 | | | | |
| 0 | | | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROTECT

CLIENT AND LOCATION BEULAH, NORTH DAKOTA

PLANT PROJECT

PROJ NO _____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO DA-902B DWG SKD -

CE LUMMUS VALVE TRAY COMPUTER PROGRAM 4-9219 RELEASE 03 DATED APR 25 1986 BATCH
BY SUNIL USED AT 12.49.00 ON 89/11/11. DESIGN - FIND ROUNDED TO SXF LUMMUS JOB OR ESTIMATE 5571
COLUMN 932 CRESYLIC ACID RECOVERY DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING,INCHES 15.000 INSIDE TOWER DIAMETER,INCHES 60.00
TYPE OF FLOW SXF (1-PASS)

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 15450.00 | .02740 | 14200.00 | 61.30000 | 27.95 | .36900 |
| (BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| MINIMUM = | 15172.50 | .13500 | 17104.50 | 56.55000 | 21.68 | .27400 |
| (BASED ON TURNDOWN TO 70.0 O/O OF VAPOR AND TO 70.0 O/O OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION 1=SIDE
DOWNCOMER TYPE 2= SLOPING
*INLET WEIR

| DIMENSIONS AT TOP OF DOWNCOMER,INCHES | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 6.000 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 6.000 |
| OUTLET WEIR HEIGHT | | 1.250 |
| *HEIGHT OF OUTLET WEIR NOTCH | | 1.500 |
| OUTLET WEIR LENGTH | (NOTE 2) | 36.000 |
| CHORD LENGTH AT DOWNCOMER PLATE | (NOTE 2) | 36.000 |

| DIMENSIONS AT BOTTOM OF DOWNCOMER,INCHES | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 4.250 |
| DOWNCOMER CLEARANCE | (NOTE 3) | .750 |
| DOWNCOMER BOTTOM TO TRAY INLET | (NOTE 4) | 1.750 |
| INLET WEIR HEIGHT | | 1.250 |
| INLET WEIR LENGTH | (NOTE 2) | 36.000 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 4.250 |
| LENGTH OF DOWNCOMER PLATE | (NOTE 2) | 30.785 |
| INLET WEIR TO SHELL DISTANCE | | 6.000 |
| CHORD LENGTH AT INLET WEIR | (NOTE 2) | 36.000 |

NOTE 1 -PER DOWNCOMER, NOTE 2 -PER DOWNCOMER PLATE, NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 - * INDICATES SPECIAL TRAY FEATURE

* * * * * * ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY * * * * * *

VESSEL NO DA-903 COMB WITH

VESSEL NAME M.P. CORE-A COLUMN

DIAMETER 7'-6" ID & 15'-0" OD

VERT HT 134'-6" TAN/TAN

HORIZ LENGTH

OPER TEMP: TOP 287 °F BOTT 370 °F DRUM °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR

MAX OPER PRESS psig OR

CORROSION ALLOW: SHELL in. HEADS in.

DES TEMP 395 °F

DES PRESS 45 psig VAC FULL psig

HEADS: ELIP DISHED CONE FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL C.S. LINER THK in.

INSULATION: CONSERVTN PROTECTN NONE

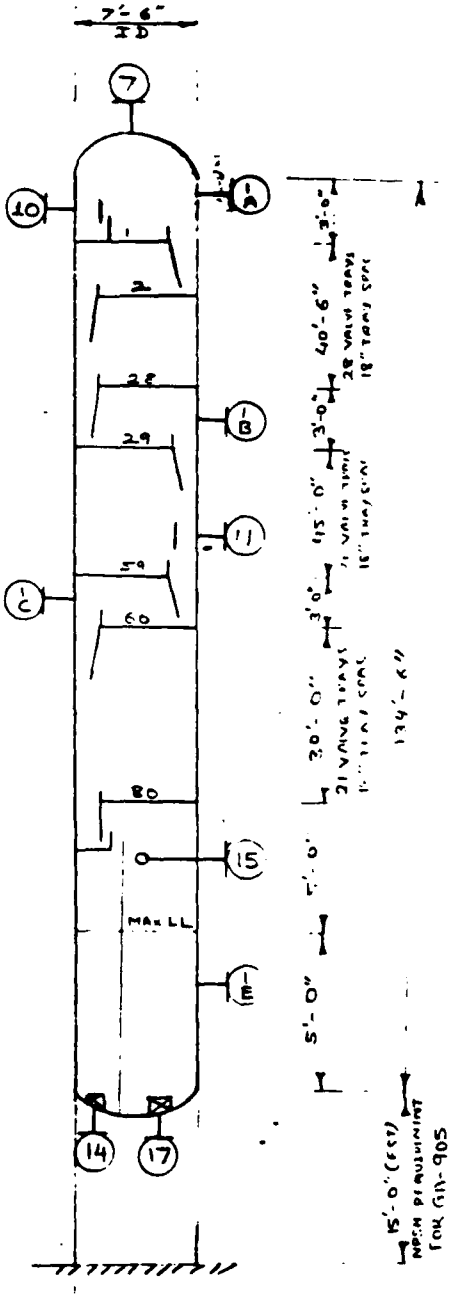
DECK MATL C.S. VALVE MATL 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 4 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | 18 | VAPOR OUTLET TO EA-906 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | 3 | | REFLUX IN FROM EA-903 |
| 11 | 1 | 12 | FEED FROM GA-901 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | 1 | 8 | TO (REBOILER) EA-905 |
| 15 | 1 | 18 | FROM REBOILER EA-905 |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | 12 | BOTTOM OUTLET TO GA-905 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P D) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T D) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 2 | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

PLANNED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.

NOTES: LIQ SP GR = 0.89 (avg) @ operating temp




| REV | DATE | DESCRIPTION | PREP'D | CHKD | APPD |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | 6/11/79 | For Task 4 | ML | | |

LUMMUS — THE LUMMUS COMPANY

WSB JET FUELS PROJECT

CLIENT AMOCO/ARCO - GREAT LAKES PROJECT — LOCATION BEULAH, NORTH DAKOTA

PROCESS VESSEL SKETCH

VESSEL NO DA-903 — DWG NO -

CE LUA  VALVE TRAY COMPUTER PROGRAM 4-9217  RELEASE 03 DATED APR 25 1986  BATCH
BY SUNIL  USED AT 12.56.01 ON 88/11/11.  DESIGN - FIND ROUNDED ID SXF  LUMMUS JOB OR ESTIMATE 5571
COLUMN 903 CRESYLIC ACID RECOVERY  DEPT 302  OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING,INCHES 14.000  INSIDE TOWER DIAMETER,INCHES 90.00
TYPE OF FLOW SXF (1-PASS)

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 39900.00 | .03000 | 34900.00 | 57.83000 | 25.20 | .36400 |
| (BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| MINIMUM = | 31171.70 | .09900 | 33346.50 | 53.60000 | 20.14 | .28600 |
| (BASED ON TURNDOWN TO 70.0 O/O OF VAPOR AND TO 70.0 O/O OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION 1=SIDE
DOWNCOMER TYPE 2= SLOPING
*INLET WEIR

| DIMENSIONS AT TOP OF DOWNCOMER,INCHES | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 9.000 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 9.000 |
| OUTLET WEIR HEIGHT | | 1.000 |
| *HEIGHT OF OUTLET WEIR NOTCH | | 1.500 |
| OUTLET WEIR LENGTH | (NOTE 2) | 54.000 |
| CHORD LENGTH AT DOWNCOMER PLATE | (NOTE 2) | 54.000 |

| DIMENSIONS AT BOTTOM OF DOWNCOMER,INCHES | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 6.500 |
| DOWNCOMER CLEARANCE | (NOTE 3) | .750 |
| DOWNCOMER BOTTOM TO TRAY INLET | (NOTE 4) | 2.500 |
| INLET WEIR HEIGHT | | 1.250 |
| INLET WEIR LENGTH | (NOTE 2) | 54.000 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 5.500 |
| LENGTH OF DOWNCOMER PLATE | (NOTE 2) | 46.596 |
| INLET WEIR TO SHELL DISTANCE | | 9.000 |
| CHORD LENGTH AT INLET WEIR | (NOTE 2) | 54.000 |

NOTE 1 -PER DOWNCOMER, NOTE 2 -PER DOWNCOMER PLATE, NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 - * INDICATES SPECIAL TRAY FEATURE

* * * * * * ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY * * * * * *

VESSEL NO DA-904 CONS WITH

VESSEL NAME EA-902 TOPPING COLUMN/XYLENOL COLUMN (ALTERNATE SERVICE)

DIAMETER 5'-6" ID & T/T

VENT HT 115'-3" T/T SKIRT 15'-0"

HORIZ LENGTH

OPER TEMP: TOP 375 °F BOTT 387 °F DRUM °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS -12.5 (TOP) psig OR -6.7 (BOTTOM) psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW: SHELL 3mm in, HEADS in

DES TEMP 415 °F

DES PRESS FULL psig VAC FULL psig

HEADS: ELIP X DISHED CONE FLAT

CODE: ASME VIII API OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER THK in

INSULATION: CONSERVTN PROTECTN NONE

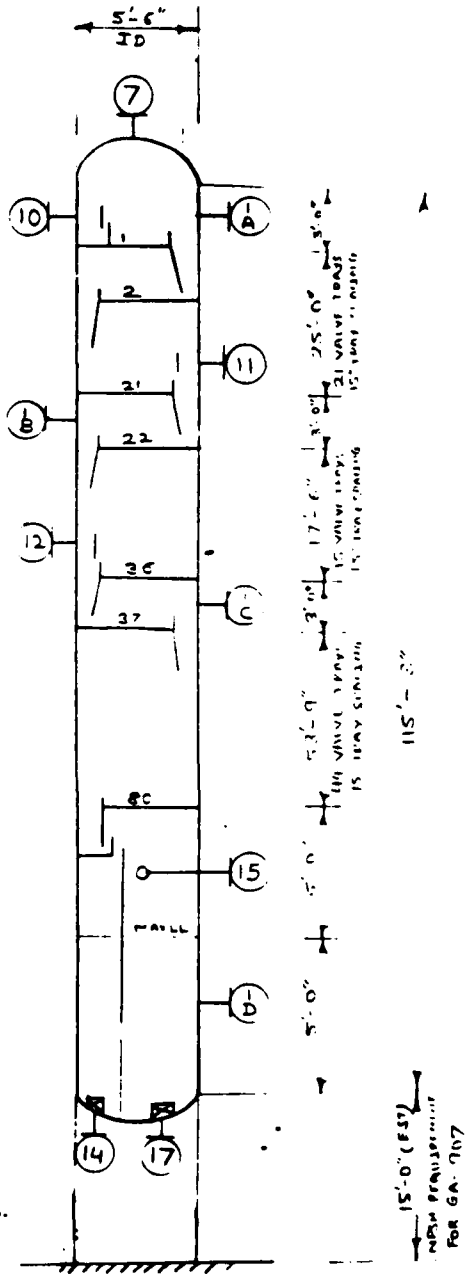
DECK MATL: CS VALVE MATL 30455

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO. | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24" | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | 1 | 14" | VAPOR OUTLET TO EA-908 |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | 1 | 3" | REFLUX IN FROM GA-914 |
| 11 | 1 | 1½" | FEED FROM GA-905 |
| 12 | 1 | 1½" | FEED FROM GA-918 |
| 13 | | | FEED FROM |
| 14 | 1 | 6" | TO REBOILER (THERMOSIPHON) EA-907 |
| 15 | | 12" | FROM REBOILER EA 907 |
| 16 | | | EQUALIZING LINE WITH |
| 17 | 1 | 1½" | BOTTOM OUTLET TO GT-907 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VBV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P D |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T CI |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM/SWITCH |
| 49 | | | |
| 50 | | | |

NOTES: LIQ SP. GR. 0.88 (avg) @ operating temp.

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.




| REV | ISSUE DATE | DESCRIPTION | PREP'D CHKD | PROJ | | | |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | 4/14/87 | FOR TANK 4 | SR | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/ROE-OPEC LOCATION BAGLAN, NORTH DAKOTA PLAINS PROJECT

PROJ NO JOB NO 06571

PROCESS VESSEL SKETCH

DWG NO DA-904

CE LUMMUS VALVE TRAY COMPUTER PROGRAM 4-9212 RELEASE 01 DATED APR 25 1986 BATCH
BY SUNIL JSED AT 12.59.26 ON 88/11/11. DESIGN - FLOW ROUNDED TO SXF LUMMUS JOB 04 ESTIMATE 4571
COLUMN 904 CRESYLIC ACID RECOVERY DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING,INCHES 15.000 (501) INSIDE TOWER DIAMETER,INCHES 66.00
TYPE OF FLOW SXF (1-PASS)

| DESIGN LOADS | VAPOR RATE LBS/HR | VAPOR DENSITY LBS/FT3 | LIQUID RATE LBS/HR | LIQUID DENSITY LBS/FT3 | SURFACE TENSION DYNES/CM | LIQUID VISCOSITY CENTIPOISE |
|---|---|---|---|---|---|---|
| MAXIMUM = | 18703.03 | .03050 | 17900.00 | 57.50000 | 25.30 | .36400 |
| (BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY) | | | | | | |
| MINIMUM = | 14318.53 | .10400 | 15517.70 | 52.00000 | 19.30 | .28100 |
| (BASED ON TURNDOWN TO 70.0 O/O OF VAPOR AND TO 70.0 O/O OF LIQUID NOMINAL RATES FOR MINIMUM LOADED TRAY) | | | | | | |

DOWNCOMER LOCATION 1=SIDE
DOWNCOMER TYPE 2= SLOPING
*INLET WEIR

DIMENSIONS AT TOP OF DOWNCOMER,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 6.750 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 6.750 |
| OUTLET WEIR HEIGHT | | 1.250 |
| *HEIGHT OF OUTLET WEIR NOTCH | | 1.500 |
| OUTLET WEIR LENGTH | (NOTE 2) | 39.997 |
| CHORD LENGTH AT DOWNCOMER PLATE | (NOTE 2) | 39.997 |

DIMENSIONS AT BOTTOM OF DOWNCOMER,INCHES

| | | |
|---|---|---|
| DOWNCOMER WIDTH | (NOTE 1) | 5.000 |
| DOWNCOMER CLEARANCE | (NOTE 3) | .750 |
| DOWNCOMER BOTTOM TO TRAY INLET | (NOTE 4) | 1.750 |
| INLET WEIR HEIGHT | | 1.250 |
| INLET WEIR LENGTH | (NOTE 2) | 39.997 |
| DOWNCOMER PLATE TO SHELL DISTANCE | | 5.000 |
| LENGTH OF DOWNCOMER PLATE | (NOTE 2) | 34.929 |
| INLET WEIR TO SHELL DISTANCE | | 6.750 |
| CHORD LENGTH AT INLET WEIR | (NOTE 2) | 39.997 |

NOTE 1 -PER DOWNCOMER, NOTE 2 -PER DOWNCOMER PLATE, NOTE 3 -DIMENSION ABOVE TRAY FLOOR, NOTE 4 -HORIZONTAL DISTANCE

NOTE 5 -NUMBERS IN ( ) REFER TO THE APPLICABLE MESSAGES ON THE DIAGNOSTICS SHEET , NOTE 6 - * INDICATES SPECIAL TRAY FEATURE

* * * * * * ATTACH THIS SHEET TO THE VALVE TRAY DATA SHEET TO MAKE A PROCESS SPECIFICATION FOR THIS TRAY * * * * * *

| ITEM NUMBER | SERVICE | SIDE | HEAT EXCHANGER MEDIUM: MATERIAL | FLOW lb/hr | SPECIFIC GRAVITY | MOLECULAR WEIGHT | VISCOSITY AT AVG TEMP cP | % VAPORIZED BY WEIGHT | % CONDENSED BY WEIGHT | TEMPERATURE °F: IN | OUT | CORR M.T.D | DESIGN TEMP | DUTY 1000 Btu/hr | OVERALL HEAT TRANS COEFF Btu/hr ft² °F | FOUL FACTOR (hr ft² °F)/Btu | TOTAL SURFACE ft² | MAX ALLOWABLE PRESS DROP psi | PRESS. psig: OPERATING | PRESS. psig: DESIGN | SIZE AND TYPE: NO UNITS AND OD BY LENGTH | SIZE AND TYPE: TYPE TEMA SYMBOLS | MATERIALS: SHELL | MATERIALS: TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EA 901 | PHENOL/XYLENOL COL REBOILER | SHELL | HP STEAM | 9635 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | [illegible] | 215320 | 0.84 | 11 | | 20 | 100 | | | | | 7900 | | | 790 | | | | | | | |
| EA 902 | PHENOL/XYLENOL COL CONDENSER | SHELL | Phenol Distillate | 228.0 | 0.97 | 110 | | | | | | | | | | | | | | | | | | |
| | | TUBE | TEMP WATER | 3833.5 | | | | | 100 | | | | | | | | | | | | | | | |
| EA 903 | PHENOL COL REBOILER | SHELL | HP STEAM | 4140 | | | | | | | | 47 | | 6900 | | | 522 | 0.5 | | | | AES | CS | CS |
| | | TUBE | O-CRESOL | 109875 | 0.98 | 108 | .81 | 20 | 100 | | 118 | | | | | | | 10 | | | | | | |
| EA 904 | PHENOL COL CONDENSER | SHELL | PHENOL | 15400 | 0.98 | 94 | .377 | | 100 | | | 96 | | 3200 | | | 700 | 0.5 | | | | PEM | CS | 18-2 |
| | | TUBE | TEMP WATER | 202500 | | | | | | | | | | | | | | 10 | | | | | | |
| EA 905 | M,P-CRESOL COL REBOILER | SHELL | HP STEAM | 8960 | | | | | | | | | | | | | | 0.5 | | | | | | |
| | | TUBE | [illegible] Xylenols | 23320 | 0.85 | 117 | .85 | 20 | 100 | | | 122 | | 8200 | | | 286 | 10 | | | | AES | CS | CS |
| EA 906 | M,P CRESOL COL CONDENSER | SHELL | M,P CRESOL | 39900 | 0.93 | 108 | .53 | | | | | | | | | | | | | | | | | |
| | | TUBE | TEMP WATER | 1941670 | | | .31 | | 100 | | | | | | | | 75 | - | | | | PEM | CS | 18-2 |
| EA 907 | XYLENOL TOPPING COL REBOILER | SHELL | HP STEAM | 4015 | | | | | | | | 70 | | 1950 | | | 520 | 0.5 | | | | | | |
| | | TUBE | XYLENOLS | 102100 | 0.88 | 122 | | 20 | | | | | | | | | | 10 | | | | AEM | 316L SS | 316L SS |
| EA 908 | XYLENOL TOPPING COL CONDENSER | SHELL | CRUDE XYLENOL | 18680 | 0.93 | 109 | | | 100 | | | 77 | | 2200 | | | 479 | | | | | | | |
| | | TUBE | TEMP WATER | 205555 | | | | | | | | | | | | | | 0.5 | | | | PEM | CS | 18-2 |
| EA 909 | Phenol Dime (Col Feed-Bems Trim Exchanger | SHELL | CRUDE CRESYLIC ACID | 102116 | 0.97 | 105 | 0.6 | | | | | 174 | | 3700 | | | 236 | 0.5 | | | | | | |
| | | TUBE | XYLENOLS | 6530 | 0.91 | 112 | 0.38 | | | | | | | | | | | 10 | | | | AEM | 316L SS | 316L SS |
| EA 910 | Phenol Col. Bems Cooler | SHELL | O CRESOL | 2416 | 0.97 | 105 | 0.43 | | | | | | | | | | | 10 | | | | | | |
| | | TUBE | TEM WATER | 32000 | | | | | | | | 79 | | 320 | | | 68 | 10 | | | | AES | CS | CS |
| EA 911 | Xylenol Topping Col Bems Cooler | SHELL | XYLENOLS | 1260 | 0.98 | 122 | 0.96 | | | | | | | | | | | 10 | | | | | | |
| | | TUBE | TEMP WATER | 17000 | | | | | | | | 84 | | 170 | | | 35 | 10 | | | | AES | CS | CS |
| EA 912 | M,P CRESOL PRODUCT COOLER | SHELL | M,P CRESOL | 5250 | 0.96 | 107 | 0.63 | | | | | 56 | | 450 | | | 125 | 10 | | | | | | |
| | | TUBE | TEMP WATER | 45000 | | | | | | | | | | | | | | 10 | | | | AES | CS | CS |
| EA 913 | O-CRESOL TOPPING COL O/H COOLER | SHELL | PHENOL/XYLENOL | 541 | 0.99 | 105 | 0.6 | | | | | 56 | | 55 | | | 16 | 10 | | | | | | |
| | | TUBE | TEMP WATER | 5530 | | | | | | | | | | | | | | 10 | | | | DOUBLE PIPE | CS | CS |
| EA-914 | O-CRESOL PRODUCT COOLER | SHELL | O-CRESOL | 1945 | 0.97 | 108 | 0.6 | | | | | 51 | | 150 | | | 46 | 10 | | | | AES | CS | CS |
| | | TUBE | TEMP WATER | 15020 | | | | | | | | | | | | | | 10 | | | | | | |
| EA 915 | 2M/2P XYLENOL COL FEED BTMS INTERCHANGER | SHELL | XYLENOLS | ~360 | 0.91 | 122 | 0.76 | | | | | 110 | | 130 | | | 18 | 10 | | | | | | |
| | | TUBE | XYLENOLS | 1190 | 0.97 | 122 | 0.64 | | | | | | | | | | | 10 | | | | DOUBLE PIPE | CS | CS |
| EA-916 | 2M/2P XYLENOL PRODUCT COOLER | SHELL | 2M/2P XYLENOL | 913 | 0.97 | 122 | 0.72 | | | | | 69 | | 82 | | | 22 | 10 | | | | | | |
| | | TUBE | TEMP WATER | 8200 | | | | | | | | | | | | | | 10 | | | | DOUBLE PIPE | CS | CS |

| ITEM NUMBER | COMPONENT | ENTERING: lb/hr VAPOR | ENTERING: lb/hr LIQUID | ENTERING: Bubble or Dew Pt °F | ENTERING: SP GR | ENTERING: MOL WT | LEAVING: lb/hr VAPOR | LEAVING: lb/hr LIQUID | LEAVING: Bubble or Dew Pt °F | LEAVING: SP GR | LEAVING: MOL WT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

NOTES

| REV | DESCRIPTION | BY | APP | APP | DATE |
|---|---|---|---|---|---|
| 0 | [illegible] TANK | [illegible] | | | [illegible] |

CUMMUS

EXCHANGER SCHEDULE

UNIT AREA 900

JOB NO 05571

| ITEM NUMBER | ALTERNATE SERVICE FOR TOO AREA EXCHANGERS | SIDE | HEAT EXCHANGER MEDIUM: MATERIAL | FLOW lbs/hr | SPECIFIC GRAVITY | MOLECULAR WEIGHT | VISCOSITY AT AVG TEMP cP | % VAPORIZED BY WEIGHT | % CONDENSED BY WEIGHT | TEMPERATURE °F: IN | OUT | CORR MTD | DESIGN TEMP | DUTY 1000 Btu/hr | OVERALL HEAT TRANS COEFF Btu/hr ft² °F | FOUL FACTOR ft² hr °F/Btu | TOTAL SURFACE ft² | MAX ALLOWABLE PRESS DROP psi | PRESS, psig: OPERATING | DESIGN | SIZE AND TYPE: NO UNITS AND OD BY LENGTH | TYPE TEMA SYMBOLS | MATERIALS: SHELL | TUBES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EA 901 | O-CRESOL TOPPING COL REBOILER | SHELL | HP STEAM | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | O-CRESOL | 89000 | | | | | | | | | | | | | | | | | | | | |
| EA 902 | O CRESOL TOPPING COL CONDENSER | SHELL | PHENOL - O-CRESOL | 8190 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | TEMP WATER | | | | | | | | | | | | | | | | | | | | | |
| EA 903 | O-CRESOL COL. REBOILER | SHELL | HP STEAM | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | [illegible] XYLENOL | 78200 | | | | | | | | | | | | | | | | | | | | |
| EA 904 | O CRESOL COL CONDENSER | SHELL | O-Cresol | 20297 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | TEMP WATER | | | | | | | | | | | | | | | | | | | | | |
| EA 907 | 2,4/2,5 XYLENOL COL REBOILER | SHELL | HP STEAM | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | XYLENOLS | 94850 | | | | | | | | | | | | | | | | | | | | |
| EA 908 | 2,4/2,5 XYLENOL COL CONDENSER | SHELL | 2,4/2,5 XYLENOL | 16910 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | TEMP WATER | | | | | | | | | | | | | | | | | | | | | |
| EA 909 | O-Cresol Topping Col Reid-Stone Exchanger | SHELL | O-CRESOL PHENOL | 2016 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | O-CRESOL | 1870 | | | | | | | | | | | | | | | | | | | | |
| EA 910 | O-Cresol Col Brine Cooler | SHELL | Slop cut | 25 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | Temp Water | | | | | | | | | | | | | | | | | | | | | |
| EA 911 | 2,4/2,5 XYLENOL COL BRINE COOLER | SHELL | Xylenol | 1490 | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | Temp Water | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |
| | | SHELL | | | | | | | | | | | | | | | | | | | | | | |
| | | TUBE | | | | | | | | | | | | | | | | | | | | | | |

| ITEM NUMBER | COMPONENT | ENTERING: lbs/hr VAPOR | lbs/hr LIQUID | Bubble or Dew Pt °F | °API OR SP GR | MOL WT | LEAVING: lbs/hr VAPOR | lbs/hr LIQUID | Bubble or Dew Pt °F | °API OR SP GR | MOL WT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

NOTES

| REV | DESCRIPTION | BY | APP | APP | DATE |
|---|---|---|---|---|---|
| 1 | 1 1 1 2 | MA | | | |

LUMMUS

EXCHANGER SCHEDULE

UNIT EXEA 900

JOB NO 05571

VESSEL NO FA-901 COMB WITH

VESSEL NAME PHENOL-CRMO REFLUX DRUM / ORTHO TOPPING REFLUX DRUM (Alternate Service

DIAMETER 3'-6" IN

VERT HT IN

HORIZ LENGTH 5'-6" IN

OPER TEMP: TOP °F BOTT °F DRUM 255 °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 193 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 1/8" in BL DECKS in

DES TEMP 280 °F

DES PRESS 45 psig VAC FULL psig

HEADS: ELIP DISHED CONE FLAT

CODE: ASME NPR OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: WIND mph

MATL: SHELL CS LINER THK in

INSULATION: CONSERVTN PROTECTN NONE

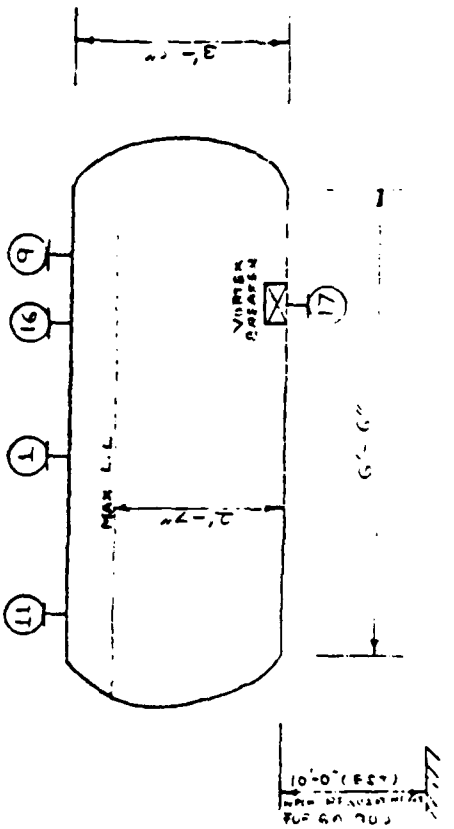
DECK MATL:

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | 1 | 2 | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 3 | FEED FROM EA-902 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB. PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUILIZING LINE WITH EA 902 |
| 17 | 1 | 4 | BOTTOM OUTLET TO EA-902 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P ) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T ) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 2 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO

NOTES: L/D = 2 SP GR = 0.87 @ operating temp.




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 9/14/59 | FOR TANK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE - DEVILLE LOCATION BEULAH, NORTH DAKOTA

PROJ NO JOB NO 0557

PROCESS VESSEL SKETCH

VESSEL NO FA-901

VESSEL NO FA-902 COMB WITH

VESSEL NAME PHENOL REFLUX DRUM/O-CRESOL REFLUX DRUM (Alternate Service)

DIAMETER 5'-0" ft-in & ft-in

VENT HT ft-in SKIRT ft-in

HORIZ LENGTH 5'-0" ft-in

OPER TEMP TOP °F BOTT °F DRUM 250 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 1.93 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL 2.1 mm ID DECKS in

DES TEMP 285 °F

DES PRESS 45 psig VAC FULL psia

HEADS ELIP DISHED ✓ CONE FLAT

CODE ASME VIII API OTHER

STRESS RELIEVED YES ✓ CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in

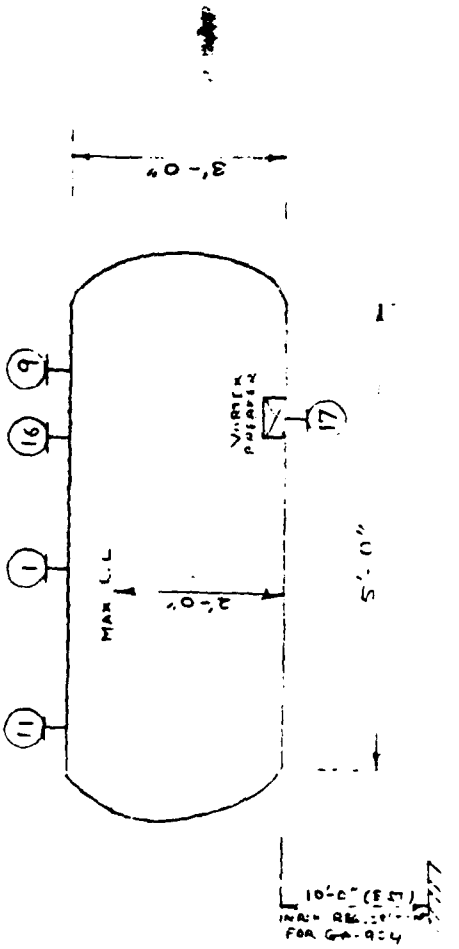
INSULATION CONSERV'N ✓ PROTECT'N NONE

DECK MATL CSD

NOZZLES FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | 1 | 2 | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 3 | FEED FROM EA 904 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB. PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH EA 904 |
| 17 | 1 | 3 | BOTTOM OUTLET TO GA-904 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S) COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50
FOR COUPLING ADD 50 TO NOZZLE NO




NOTES LIQUID SP GR = 0.98 @ operating temp.

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/84 | For TANK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE-SYNTHOLOCATION BEULAH NORTH DAKOTA
RAPID GULF PROJECT

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FA-902 DWG SKD -

VESSEL NO FA 903 DOME WITH
VESSEL NAME M.P. CARBOL REFLUX DRUM
DIAMETER 3'-6" I.D. IN A
VERT HT I.D. IN SKIRT
HORIZ LENGTH 7'-6" I.D.
OPER TEMP: TOP °F BOTT °F DRUM 295 °F
MAX TEMP TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR 1.93 psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW SHELL 1/8 in DECKS in

DES TEMP 310 °F
DES PRESS 45 psig VAC FULL psig
HEADS ELIP DISHED CONE PLAT
CODE ASME VIII API OTHER
STRESS RELIEVED YES ✓ CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

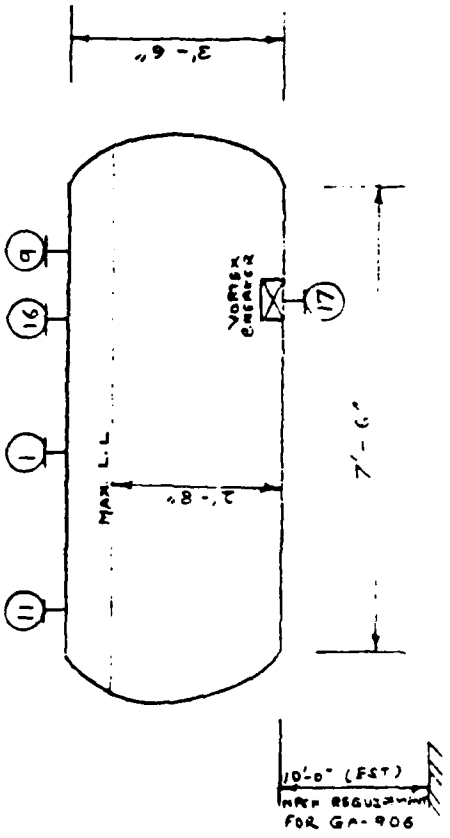
MATL: SHELL CS LINER THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO | NO. REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | 1 | 2 | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 4 | FEED FROM EA 906 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (FEED PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH EA 906 |
| 17 | 1 | 4 | BOTTOM OUTLET TO GA-906 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | EL SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Q |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Q |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 1 | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.

NOTES LIQUID SP GR = 0.93 @ operating temp.




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/78 | FOR TANK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE GREAT PLAINS SYN. GAS PROJ. LOCATION BEULAH, NORTH DAKOTA

PROJ NO 08571

PROCESS VESSEL SKETCH

VESSEL NO FA-903 DWG NO -

VESSEL NO FA 904 COMB WITH

VESSEL NAME XYLENOL TOPPING FEED/3,4-3,5 XYLENOL REFLUX DRUM (AIR SERVICE)

DIAMETER 3'-0" in ID in

VERT HT in OVER SKIRT in

HORIZ LENGTH 5'-0" in

OPER TEMP: TOP °F BOTT °F DRUM 25-5 °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 1.43 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 3mm HP DISCHS in

DES TEMP 320 °F

DES PRESS 45 psig VAC FULL psia

HEADS: ELIP DISHED CONE FLAT

CODE: ASME X-RAY API OTHER

STRESS RELIEVED: YES ✓ CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE WIND mph

MATL: SHELL CS LINER THK in

INSULATION: CONSERV'N ✓ PROTECT'N NONE

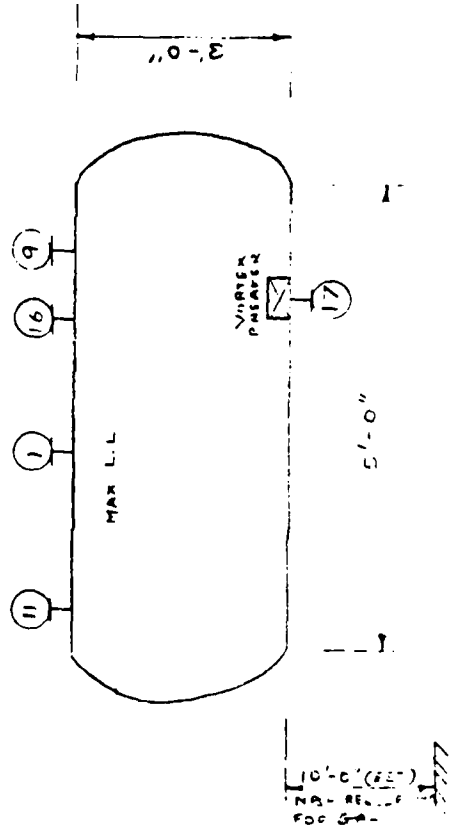
DECK MATL

NOZZLES: FLG CLASS 150 COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 18 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | 1 | 2 | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 3 | FEED FROM FA 9:8 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | 1 | 1½ | EQUALIZING LINE WITH FA-908 |
| 17 | 1 | 2 | BOTTOM OUTLET TO GF-9:5 |
| 18 | | | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P °C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | | | |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T °C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | | | |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | ✓ | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

NOTES LIQUID SP GR = 0.87 @ operating temp

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/14/84 | FOR TANK 4 | PJ | | | |

THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE GRAT LOCATION BEULAH, NORTH DAKOTA

PROJ NO PLANT GASES PROJ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FA 904 DWG NO -

| ITEM NO. | SERVICE | PUMP TYPE | LIQUID | CORR./EROS. CAUSED BY | PUMPING TEMP °F NORM. | PUMPING TEMP °F MAX. | SP GR AT P.T. | VAPOR PRESS AT P.T. PSIA | VISC AT P.T. CP | CAPACITY USGPM NORM. | CAPACITY USGPM RATED | DISCH PRESS. PSIG | SUCTION PRESS. PSIG RATED | SUCTION PRESS. PSIG MAX. | DIFF PRESS. PSI | DIFF HEAD. FT | NPSH AVAIL FT | MATL CLASS | CORR ALLOW IN | FLANGE RATING/FACING SUCT | FLANGE RATING/FACING DISCH | DRIVER TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA-901A/S | Phenol / Xylenol Extract Pump | CENTRIFUGAL | M-CRESOL / XYLENOLS | | 380 | | 0.86 | 10.5 | 0.27 | 15.2 | 20 | 415.3 | 0 | | 415.3 | 120 | 12 | D.I. CS | | | | MOTOR | |
| Alt Service | O-Cresol Topping Strip. Pump | CENTRIFUGAL | O-CRESOL | | 355 | | 0.91 | 10.5 | 0.38 | 42 | 50 | 43 | 0 | | 43 | 109 | 12 | D.I. CS | | | | | |
| GA-902A/S | Phenol / Xylenol Recycle Pump | CENTRIFUGAL | PHENOL O-CRESOL | | 254 | | 0.97 | 1.93 | 0.38 | 68 | 81 | 89 | -10 | | 99 | 236 | 6.6 | D.I. CS | | | | MOTOR | |
| Alt Service | O-Cresol Topping Recycle Pump | CENTRIFUGAL | PHENOL O-CRESOL | | 253 | | 0.97 | 1.93 | 0.38 | 17 | 20.3 | 89 | -10 | | 99 | 236 | 6.6 | D.I. CS | | | | | |
| GA-903A/S | Phenol Stripper Pump | CENTRIFUGAL | PHENOL O-Cresol | | 254 | | 0.90 | 11.2 | 0.27 | 5.5 | 6.5 | 44 | 1.0 | | 43 | 111 | 11.4 | D.I. CS | | | | MOTOR | |
| Alt. Service | O-CRESOL COL. STRIP. PUMP | CENTRIFUGAL | Xylenols | | 377 | | 0.87 | 11.2 | 0.27 | 0.06 | 0.1 | 41 | 0.8 | | 40 | 105 | 11.3 | D.I. CS | | | | | |
| GA-904A/S | PHENOL REFLUX PUMP | CENTRIFUGAL | PHENOL | | 249 | | 0.99 | 1.9 | 0.38 | 41 | 49 | 58.5 | -10 | | 68.5 | 161 | 6.7 | D.I. CS | | | | MOTOR | |
| Alt Service | O-Cresol Col Strip. Pump | CENTRIFUGAL | O-CRESOL | | 260 | | 0.95 | 1.92 | 0.38 | 4.2 | 5.1 | 55 | -10 | | 65 | 158 | 6.6 | D.I. CS | | | | | |
| GA-906A/S | M-CRESOL REFLUX PUMP | CENTRIFUGAL | Xylenol M,P-CRESOL | | 369.5 | | 0.86 | 7.7 | 0.28 | 5.5 | 6.6 | 118.5 | -2.8 | | 513 | 138 | 11.3 | D.I. CS | | | | MOTOR | |
| GA-907A/S | M,P-CRESOL RECYCLE PUMP | CENTRIFUGAL | M,P-CRESOL | | 281 | | 0.93 | 1.93 | 0.37 | 86 | 102 | 69.5 | -10.2 | | 79.7 | 198 | 6.5 | D.I. CS | | | | MOTOR | |
| GA-908 | O-CRESOL TOPPING PUMP | CENTRIFUGAL | O-Cresol Phenol | | 113 | | 1.02 | 0.08 | 0.90 | | 22 | 43 | -0.5 | | 43.5 | 99 | 32 | D.I. CS | | | | MOTOR | |
| GA-909 | M-and Xylenol Pump | CENTRIFUGAL | Xylenols | | 113 | | 0.95 | <0.01 | 1.09 | | 12 | 38.6 | -0.5 | | 39.1 | 95 | 35 | D.I. CS | | | | MOTOR | |
| GA-910 | 3,4/2,5-Xylenol Pump | CENTRIFUGAL | Xylenols | | 113 | | 0.95 | <0.01 | 0.98 | | 10 | 39 | -0.5 | | 39.1 | 95 | 35 | D.I. CS | | | | MOTOR | |
| GA-911 | M,P-Cresol Pump | CENTRIFUGAL | M,P-CRESOL | | 113 | | 1.01 | 0.02 | 0.91 | | 45 | 43.5 | -0.5 | | 43 | 98 | 42.5 | D.I. CS | | | | MOTOR | |
| GA-912 | Xylenol Pump | CENTRIFUGAL | Xylenols | | 113 | | 0.95 | <0.9 | 1.06 | | 14 | 42 | -0.5 | | 42.5 | 103 | 35 | D.I. CS | | | | MOTOR | |
| GA-913 | O-Cresol Pump | CENTRIFUGAL | O-Cresol | | 113 | | 1.02 | 0.06 | 0.92 | | 15 | 43 | -0.5 | | 43.5 | 99 | 32 | D.I. CS | | | | MOTOR | |
| GA-914A/S | Phenol Col. Reflux Pump | CENTRIFUGAL | Phenol O-Cresol | | 333 | | 0.89 | 6.6 | 0.30 | | 37 | 45 | -3.7 | | 51.7 | 134 | 11.4 | D.I. CS | | | | MOTOR | |

| REV. NO. | ITEM NO. |
|---|---|

**UTILITIES**

**STEAM:**
INLET PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
EXH. PRESS., PSIG/VAC ____ NORM. ____ MIN. ____ MAX.

**COOLING WATER:**
SUPPLY PRESS. ____ PSIG. TEMP ____ °F
RETURN PRESS. ____ PSIG. TEMP ____ °F (MAX.)

**INSTRUMENT AIR:**
SUPPLY PRESS ____ PSIG. TEMP. ____ °F

**ELECTRIC POWER:**
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
MOTORS: ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL. ____
INSTRUMENTS ____ V ____ PHASE ____ Hz/D.C.
HEATERS: ____ V ____ PHASE ____ Hz
AREA CLASS ____ DIV ____

| REV. NO. | BY | DATE |
|---|---|---|
| 0 | JM | 4/14/89 |

THE LUMMUS COMPANY
Bloomfield

**PUMP SCHEDULE**

CUSTOMER AMOCO/DOE-GREAT PLAINS GASIF. PROJECT GRT PUBLIC PROJECT

UNIT ____ AREA 900

JOB NO. 05571

F-177

| ITEM NO | SERVICE | PUMP TYPE | LIQUID | CORR/EROS CAUSED BY | PUMPING TEMP °F NORM | PUMPING TEMP °F MAX | SP GR AT P.T | VAPOR PRESS AT P.T PSIA | VISC AT P.T CP | CAPACITY USGPM NORM | CAPACITY USGPM RATED | DISCH PRESS PSIG | SUCTION PRESS PSIG RATED | SUCTION PRESS PSIG MAX | DIFF PRESS PSI | DIFF HEAD FT | NPSH AVAIL FT | MATL CLASS | CORR ALLOW IN | FLANGE RATING/FACING SUCT | FLANGE RATING/FACING DISCH | DRIVER TYPE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA 915 AS | Xylenol Tower Reflux Pump | CENTRIFUGAL | Xylenols, 2,4-/2,5-Xylenol | | 361 | | 0.83 | 7.7 | 0.28 | 31 | 38 | 522 | -1.0 | | 523 | 120 | 11.2 | | | | | MOTOR | |
| GA-916 AS | Xylenol Col Reflux Pump | CENTRIFUGAL | MIXED XYLENOL | | 286 | | 0.83 | 2.7 | 0.38 | 36 | 40 | 523 | -1.0 | | 433 | 121 | 11.2 | | | | | | |
| GA-916 AS | Xylenol Topping Column Pump | CENTRIFUGAL | M.P. TYPICAL XYLENOLS | | 285 | | 0.93 | 1.93 | 0.27 | 39 | 47 | 61.8 | 10.2 | | 72 | 179 | 6.5 | | | | | MOTOR | |
| GA-917 AS | Xylenol Col Reflux Pump | CENTRIFUGAL | 2,4-/2,5 XYLENOL | | 295 | | 0.87 | 1.93 | 0.27 | 38 | 45 | 60 | 10.4 | | 70.4 | 187 | 6.3 | | | | | | |
| GA 917 AS | O-TOLUIDINE TOPPER Col Reflux Pump | CENTRIFUGAL | O-TOLUIDINE | | AMB | | 1.03 | 0.06 | 0.79 | 47 | 60 | 110 | -0.5 | | 110.5 | 248 | 32 | | | | | MOTOR | |
| GA-918 AS | Xylenol Col Reflux Pump | CENTRIFUGAL | Xylenol | | AMB | | 0.96 | < 0.1 | 1.06 | 62 | 80 | 76 | -0.5 | | 76.5 | 184 | 35 | | | | | MOTOR | |
| | | | | | | | | | | | | | | | | | | | | | | MOTOR | |

| REV. NO. | ITEM NO. |
|---|---|
| | |

## UTILITIES

**STEAM**

INLET PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
COND. PRESS., PSIG/deg F ____ NORM. ____ MIN. ____ MAX.

**COOLING WATER:**

SUPPLY PRESS. ____ PSIG, TEMP. ____ °F
RETURN PRESS. ____ PSIG, TEMP. ____ °F (MAX.)

**INSTRUMENT AIR:**

SUPPLY PRESS. ____ PSIG, TEMP. ____ °F

**ELECTRIC POWER:**

MOTORS ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL ____
MOTORS ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL ____
MOTORS ____ TO ____ H.P. ____ V ____ PHASE ____ Hz ENCL ____
INSTRUMENTS ____ V ____ PHASE ____ Hz/DC
HEATERS ____ V ____ PHASE ____ Hz
AREA CLASS ____ GR ____ DIV ____

| REV. NO. | BY | DATE |
|---|---|---|
| 0 | [illegible] | 4/16/86 |

THE LUMMUS COMPANY
Bloomfield

LUMMUS

**PUMP SCHEDULE**

CUSTOMER AMOCO/DOE-GREAT PLAINS GASIF. PROJECT JET FUELS PROJECT

UNIT _____ AREA 900

JOB NO. 05571

VESSEL NO FB-701 COMB WITH _____

VESSEL NAME JET FUEL FEED DAY TANK

DIAMETER 10'-0" ft-in & _____ ft-in

VERT HT 16'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 113 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 6" H2O psig OR _____ psia

CORROSION ALLOW SHELL 2mm to DECKS _____ in

DES TEMP 230 °F

DES PRESS 8" H2O psig VAC -2" H2O psia

HEADS ELIP ___ DISHED ___ CONE ROOF FLAT BOTTOM

CODE ASME ___ API X OTHER ___

STRESS RELIEVED YES ___ CODE ___

RADIOGRAPHED YES ___ CODE ___

EARTHQUAKE ___ WIND ___ mph

MATL SHELL CS LINER ___ THK ___ in

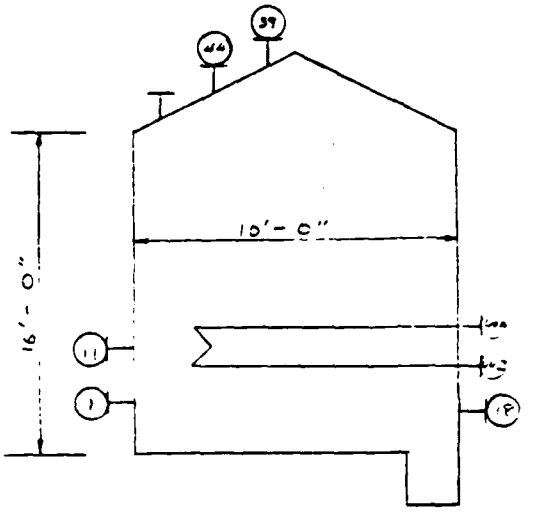
INSULATION CONSERV'N X PROTECT'N ___ NONE ___

DECK MATL ___

NOZZLES FLG CLASS ___ COUPL CLASS ___

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE (C.W.F.L.) |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM SF-902 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER, REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | LIQUID OUTLET TO DA 9-8 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S, COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | As Req'd/NS |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 1 | Dwg. No. |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 1 | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 2 | 2 | STEAM COIL |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES: 1) LIQ. ID SP GR = 1.03 @ operating temp

2) STEAM COIL TO MAINTAIN 100 F

| REV | REVISE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/83 | FOR TANK 4 | [illegible] | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT ANG/DOE LOCATION BEULAH, ND

PROJ NO ____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-901 DWG SKD -

VESSEL NO FB-902 COMB WITH _____

VESSEL NAME XYLENE INTERMEDIATE DAY TANK

DIAMETER 10'-0" mm & _____ mm

VERT HT 8'-0" mm SKIRT _____ mm

HORIZ LENGTH _____ mm

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 113 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 5" $H_2O$ psig OR _____ psia

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 230 °F

DES PRESS 5 $H_2O$ psig VAC -2" $H_2O$ psia

HEADS ELIP _____ DISHED _____ CONE ROOF FLAT BOTTOM

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERV'N X PROTECT'N _____ NONE _____

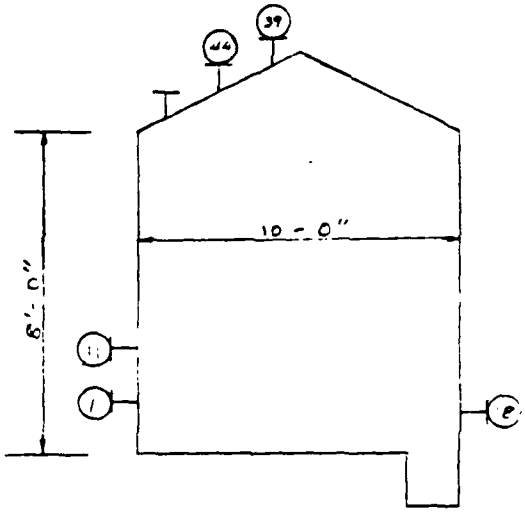
DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | _____ |
| 4 | — | — | _____ |
| 5 | — | — | HANDHOLE |
| 6 | — | — | _____ |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 1½ | FEED FROM FA-905 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER) (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 2 | LIQUID OUTLET TO FA-912 |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN, FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN, FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S), COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P_____C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No. 4 - A.S.M.E. |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T_____C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | 600# - MATL = |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | 1 | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | _____ |
| 50 | — | — | _____ |

NOTES LIQUID SP GR = 0.95 at operating temp

FLANGED NOZZLES ARE NUMBERED 1-50
FOR COUPLING ADD 50 TO NOZZLE NO




| REV | ISSUE DATE | DESCRIPT | PROJ ENGR | PROD ENGR | APVR | APVR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 6/14/79 | For TANK 4 | | | | |

LUMMUS — THE LUMMUS COMPANY Bloomfield

TITLE JET FUEL PROJECT

CLIENT ANCO/DOE LOCATION BEULAH, ND

PROJ NO _____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-902 DWG NO -

VESSEL NO FR-902 COMB WITH

VESSEL NAME OFFICIAL PROD. 2 DAY TANK

DIAMETER 11'-0" I.D. & O.D.

VERT HT 8'-0" I.D. SKIRT O.D.

HORIZ LENGTH I.D.

OPER TEMP: TOP °F BOTT °F STEAM 115 °F

MAX TEMP: TOP °F BOTT °F STEAM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS 5 H2O psig OR psia

CORROSION ALLOW: SHELL 1/8" in HEADS in

DES TEMP 230 °F

DES PRESS 8" H2O psig VAC -2" H2O psig

HEADS: ELIP DISHED CONE ROOF FLAT BOTTOM

CODE: ASME API X OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE SEISMO mph

MATL: SHELL CS LINER THK in

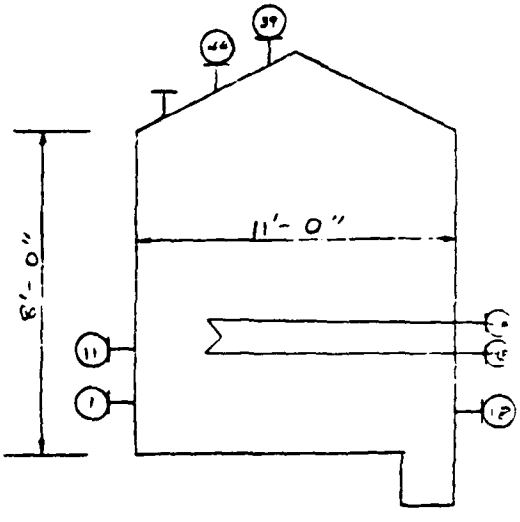
INSULATION: CONSERVTN Y PROTECTN SEISMO

DECK MATL:

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | VAPOR |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM GA-904 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 1½ | LIQUID OUTLET TO GA-913 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Q |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No BLANKETING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Q |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 3 | 2 | STEAM COIL |
| 50 | | | |

PLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD NOZZLE NO




NOTES: 1) LIQUID SP GR = 1.02 @ operating temp

2) STEAM COIL TO MAINTAIN 100°F

| REV | ISSUE DATE | DESCRIPTION | PREP'D BY | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/16/79 | FOR TANK 4 | JBL | | | |

LUMMUS | THE LUMMUS COMPANY

TITLE JET FUEL PROTECT

CLIENT AMOCO/DOE LOCATION BISMARCK, ND

PROJ NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FR-902 DWG NO -

VESSEL NO FB-905 COMB WITH _____

VESSEL NAME "B" JET FUEL DAY TANK

DIAMETER 14'-0" ID & _____ Blkt

VERT HT 16'-0" T-T SKIRT _____ Blkt

HORIZ LENGTH _____ Blkt

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 113 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ mmHg

MAX OPER PRESS 6" H2O _____ mmHg

CORROSION ALLOW SHELL 1/8" ID DECKS _____ in

DES TEMP 230 °F

DES PRESS 8" H2O psig VAC -2" H2O mmHg

HEADS ELIP _____ DISHED _____ CONE ROOF FLAT P-77 OPT

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL C.S LINER _____ THK _____ in

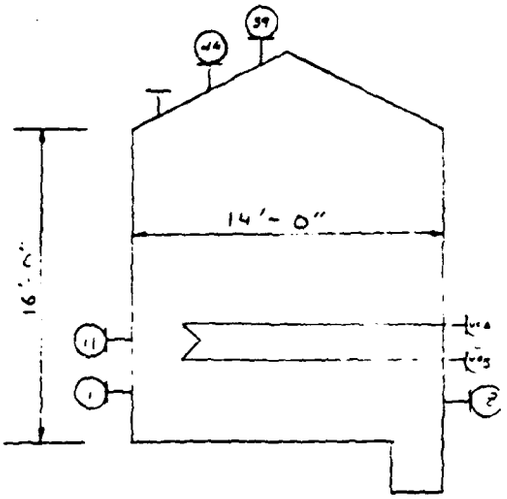
INSULATION CONSERV'N X PROTECT'N _____ NONE _____

DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR - LE |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM GA 906 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-911 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P_____C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | N2 BLANKING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T_____C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 1 | GAUGE - MATH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 2 | 2 | STEAM COIL |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES: 1) SP GR = 1.01 @ operating temp.

2) STEAM COIL TO MAINTAIN 60°F.

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/89 | For Talk | | | | |

LUMMUS - THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT Amoco/DOE LOCATION BEULAH, ND

PROJ NO JOB NO 0651

PROCESS VESSEL SKETCH

VESSEL NO FB-905 DWG NO -

VESSEL NO FB-906 COMB WITH

VESSEL NAME 24/2.5 XYLENE DAY TANK

DIAMETER 9'-0" INSIDE

VERT HT 8'-0" INSIDE SKIRT

HORIZ LENGTH

OPER TEMP TOP °F SKIRT °F SHEAR 117 °F

MAX TEMP TOP °F SKIRT °F SHEAR °F

NORM OPER PRESS psig OR psiga

MAX OPER PRESS 6 H2O psig OR psiga

CORROSION ALLOW SHELL in DECKS in

DES TEMP 230 °F

DES PRESS 5 H2O psig VAC -2 H2O psig

HEADS ELIP DISHED CONE 60° FLAT

CODE ASME API X OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE SEISMO

MATL SHELL CS LINER THK in

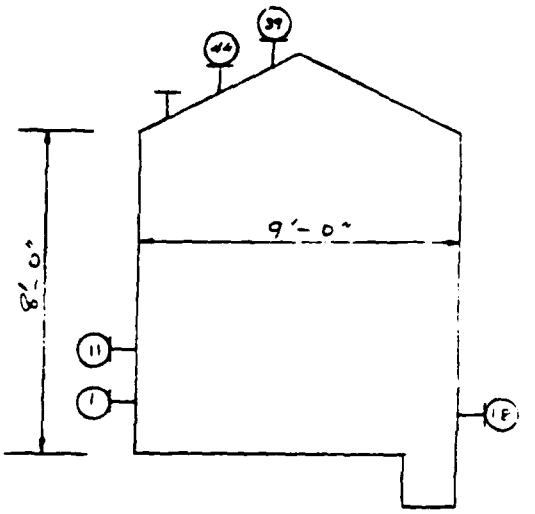
INSULATION CONSERVTN X PROTECTN NONE

DECK MATL

NOZZLES FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1" | FEED FROM GA-716 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2" | LIQUID OUTLET TO GA-910 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (SRV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Ω |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No BLANKETING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Ω |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAGE - MATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 2 | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES LIQUID SP GR = 0.855 @ operating temp

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROD ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/81 | For Track 4 | gl | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE-MFRC LOCATION BEULAH, N D

PLANT ENG FROM ENG JOB NO 08571

PROCESS VESSEL SKETCH

VESSEL NO FB-906 DWG NO -

VESSEL NO FB-907 COMB WITH _____

VESSEL NAME NITE / KEROSENE DAY TANK

DIAMETER 11'-0" INS ID _____ Units

VERT HT 8'-0" TAN TO TAN _____ Units

HORIZ LENGTH _____ Units

OPER TEMP: TOP _____ °F BOTT _____ °F DRUM 113 °F

MAX TEMP: TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 6" H2O psig OR _____ psia

CORROSION ALLOW: SHELL _____ in DECKS _____ in

DES TEMP 220 °F

DES PRESS 5" H2O psig VAC -2" H2O psig

HEADS: ELIP _____ DISHED _____ CONE ROOF PLAT BOTTOM

CODE: ASME _____ API X OTHER _____

STRESS RELIEVED: YES _____ CODE _____

RADIOGRAPHED: YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL: SHELL CS LINER _____ THK _____ in

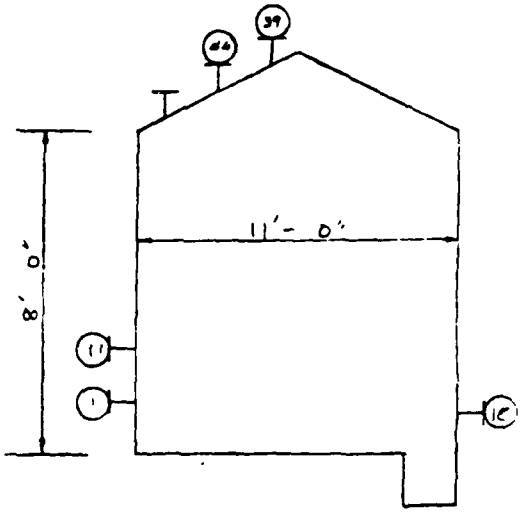
INSULATION: CONSERVTN X PROTECTN _____ HOW _____

DECK MATL _____

NOZZLES: FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM GA-915 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB. PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-909 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN. (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (SRV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P _____ C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | NO FLANGE/PLUG |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T _____ C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAGE - MAIN |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

PLANGED NOZZLES ARE NUMBERED 1-49. FOR COUPLING ADD 50 TO NOZZLE NO.




NOTES: LIG SP GR = 0.96 @ operating temp

| REV | ISSUE DATE | DESCRIPTION | FUEL ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | 4/14/83 | For Tank 4 | MK | | | |
| 0 | | | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO / DOE - SPR LOCATION BEULAH, ND

PLANT SPRIFF PLANT

PROJ NO _____ JOB NO 0557 1

PROCESS VESSEL SKETCH

VESSEL NO FB-907 DWG SIZE -

VESSEL NO FC-906 COMB WITH
VESSEL NAME CYCLOL TOPPING FEED MONTH STORAGE
DIAMETER 26'-0" IN OR OUT
VERT HT 24'-0" IN OR SKIRT
HORIZ LENGTH
OPER TEMP TOP °F BOTT °F DRUM 100 °F
MAX TEMP TOP °F BOTT °F DRUM 112 °F
NORM OPER PRESS
MAX OPER PRESS 6" H2O psig OR
CORROSION ALLOW SHELL 3 mm & DECKS in

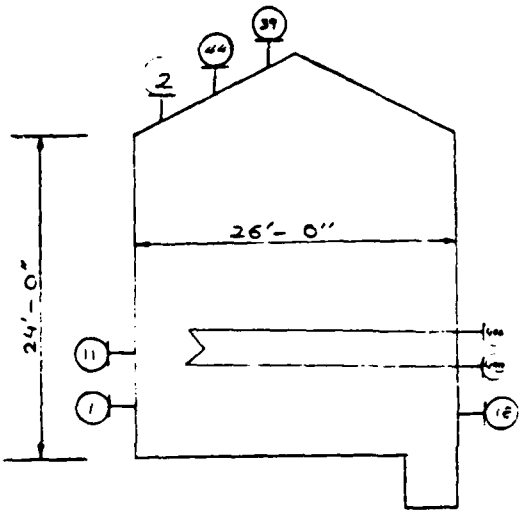
DES TEMP 230 °F
DES PRESS 8" H2O psig VAC -2" H2O
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API X OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in
INSULATION CONSERV'N X PROTECT'N NONE
DECK MATL

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE (SHELL) |
| 2 | 1 | 24 | MANHOLE (ROOF) |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM GA 908 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-917 |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P C) |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No 6 - INSTRUM |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T C) |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | DRAW - MAIN |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 1 | 4 | STEAM COIL |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO.




NOTES: 1) FUEL OIL SG = 1.04 @ operating temp.

2) STEAM COIL TO MAINTAIN 100°F TEMP

| REV | ISSUE DATE | DESCRIPTION | PREPD BY | FROM CHKD | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/21/76 | FOR TASK 4 | MK | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BRULAH, ND
JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FC-906 DWG NO -

VESSEL NO FB 909 DOMB WITH _____

VESSEL NAME XYLENE INTERMEDIATE MONTH STORAGE

DIAMETER 20 3" nom ID _____ ft-in

VERT HT 24'-0" nom SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM AMB °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM 113 °F

NORM OPER PRESS _____ psig OR _____ mbar

MAX OPER PRESS 5" $H_2O$ _____ mbar

CORROSION ALLOW SHELL _____ in DECKS _____ in

DES TEMP 230 °F

DES PRESS 8" $H_2O$ psig VAC -2" $H_2O$ mbar

HEADS ELIP _____ DISHED _____ CONE ROOF FLAT BOTTOM

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

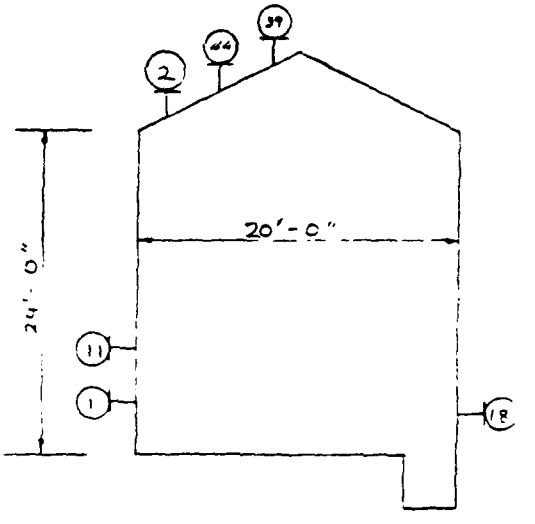
INSULATION CONSERV'N X PROTECTN _____ NONE _____

DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE (SHELL) |
| 2 | 1 | 24 | MANHOLE (ROOF) |
| 3 | — | — | |
| 4 | — | — | |
| 5 | — | — | HANDHOLE |
| 6 | — | — | |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 2 | FEED FROM GA 912 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER, REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 2 | LIQUID OUTLET TO GA-918 |
| 19 | — | — | DRAW OFF TO _____ |
| 20 | — | — | REFLUX IN FROM _____ |
| 21 | — | — | DRAW OFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAW OFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAW OFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAW OFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (SL, COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P _____ C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 16 | MANWAY |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T _____ C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | VAPOR RETURN |
| 45 | — | — | GAUGE GLASS (GG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | 1 | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | |
| 50 | — | — | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES LIQUID SP GR = 0.96 @ operating temp.

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/94 | FOR TANK 4 | MAK | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROTECT

CLIENT AMOCO/DOE LOCATION BEULAH, ND

PROJ NO _____ JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-909 DWG SKE -

VESSEL NO FR-910 COMB WITH _____

VESSEL NAME JET FUEL MAIN STORAGE

DIAMETER 22'-0" ft-in & _____ ft-in

VERT HT 24'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM 100 °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM _____ °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS ATM H.C. psig OR _____ psia

CORROSION ALLOW SHELL 1/8" in DECKS _____ in

DES TEMP 220 °F

DES PRESS ATM H.C. psig VAC -2" H2O psia

HEADS ELIP _____ DISHED _____ CONE FLUE FLAT 80° SPH

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LIN _____ HA _____ in

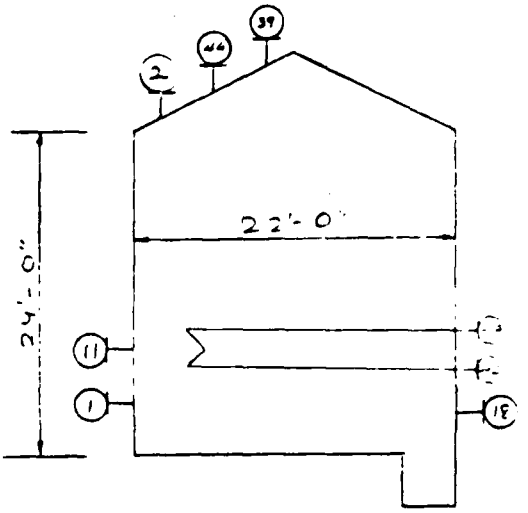
INSULATION CONSER. N X PROTECTION _____ NONE _____

DECK MATL _____

NOZZLES FLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | 1 | 20 | MANHOLE |
| 3 | — | — | _____ |
| 4 | — | — | _____ |
| 5 | — | — | HANDHOLE |
| 6 | — | — | _____ |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 4 | FEED FROM FP-912 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO (REBOILER) (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 2 | LIQUID OUTLET TO PUMP |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (SL COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VSV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P _____ C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No. 6 MIN. LUG |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T _____ C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE - MAIN |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | — | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | 2 | 4 | STEAM COIL |
| 50 | — | — | _____ |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES: 1) LIQUID SP GR = 1.03 @ operating temp.

2) STEAM COIL TO MAINTAIN 100°F

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/10/89 | FOR TANK 4 | M.C. | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROTECT

CLIENT AMOCO/DOE - FOUR PLASMA SYSTEM — LOCATION BEULAH, ND

PROJ NO — JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FR-910 — DWG SKB -

VESSEL NO FB-911 COMB WITH

VESSEL NAME SLOP CUT NAPHTHA STORAGE

DIAMETER 5'-0" Adj ID Adj

VERT HT 8'-0" Adj BSMT Adj

HORIZ LENGTH Adj

OPER TEMP TOP °F BOTT °F SEAM AMB °F

MAX TEMP TOP °F BOTT °F SEAM 112 °F

NORM OPER PRESS psig OR psig

MAX OPER PRESS 6" H2O vacuum psig

CORROSION ALLOW: SHELL in HEADS in

DES TEMP 230 °F

DES PRESS 8" H2O MIN VAC -2" H2O psig

HEADS: SLIP SEAMED CONE ELLIP FLAT BOTTOM

CODE: ASME X API OTHER

STRESS RELIEVED: YES CODE

RADIOGRAPHED: YES CODE

EARTHQUAKE: SEISMO psig

MATL: SHELL CS LINER THK in

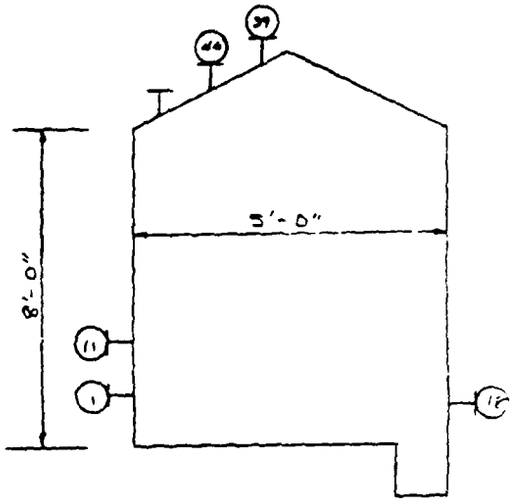
INSULATION: CONSERV'N X PROTECT'N HEIGHT

DECK MATL

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO. | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM GA-903 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (FEED PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 1½ | LIQUID OUTLET TO PUMP |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Q |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | No Connection |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Q |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 6 | GAUGE HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO




NOTES: LIQUID SP GR = 1.006 at operating temp

| REV | ISSUE DATE | DESCRIPTION | PREPD BY | CHKD BY | APPD | APPD |
|---|---|---|---|---|---|---|
| 1 | 5/14/92 | FOR TANK 4 | | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROTECT

CLIENT AMOCO/DSE LOCATION BEULAH, ND

PROJ NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-911 DWG NO -

VESSEL NO FB-912 COMD WITH
VESSEL NAME MF-CRUDE PRODUCT MANIA STORAGE
DIAMETER 25'-0" Sub A Sub
VERT HT 24'-0" Sub SKIRT Sub
HORIZ LENGTH Sub
OPER TEMP: TOP °F BOTT °F SKIRT 60 °F
MAX TEMP: TOP °F BOTT °F SKIRT 113 °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS 5" H2O psig OR psia
CORROSION ALLOW: SHELL 1/8" in SKIRT in

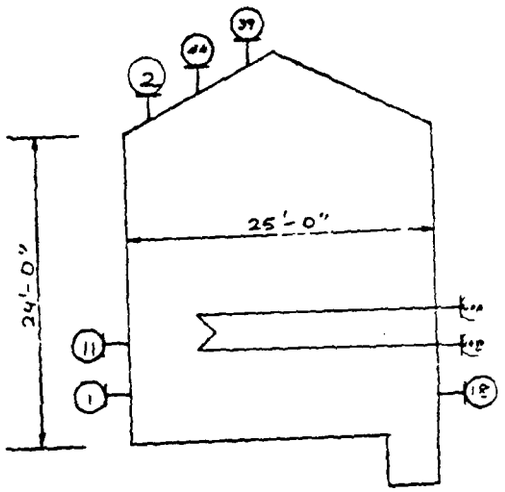
DES TEMP 220 °F
DES PRESS 5" H2O psig VAC -2" H2O psia
HEADS: ELIP SPHER CONE ROOF FLAT BOTTOM
CODE: ASME API X OTHER
STRESS RELIEVED: YES CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE: WIND mph

MATL: SHELL CS LINER THK in
INSULATION: CONSERVTN X PROTECTN NONE
BRICK MATL:

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO. | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | 2 | 20 | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | MANHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 2 | FEED FROM 9A-91 |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO PUMP |
| 18 | 1 | 3 | LIQUID OUTLET TO |
| 19 | | | DRAWOFF TO |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STEAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (S), COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVBV) (VBV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER P D |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | N2 BLANKETING |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T D |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUGE HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 1 | | EXTERNAL LEVEL |
| 47 | | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | 2 | 4 | STEAM COIL |
| 50 | | | |

FLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO




NOTES: 1) LIQUID SP GR = 1.02 @ operating temp.
2) STEAM COIL TO MAINTAIN 60°F TEMP MIN

| REV | ISSUE DATE | DESCRIPTION | PREPD CHKD | APPD | DATE |
|---|---|---|---|---|---|
| 1 | 4/14/93 | FOR TANK 4 | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION ZEULAN, ND
FROM 100 JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-912 SHEET NO -

VESSEL NO FB-913 COMB WITH

VESSEL NAME [illegible]

DIAMETER 14'-0" ft-in & in

VERT HT 16'-0" ft-in SKIRT in

HORIZ LENGTH in

OPER TEMP: TOP °F BOTT °F DRUM AMB °F

MAX TEMP: TOP °F BOTT °F DRUM 113 °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS FULL VAC psig/psia

CORROSION ALLOW: SHELL in HEADS in

DES TEMP 230 °F

DES PRESS FULL VAC psig VAC -2" Hg 2 psia

HEADS ELIP SPHER CONE FLAT FLAT 2:1 TORI

CODE: ASME ADR X OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL: SHELL C.S LINER THK in

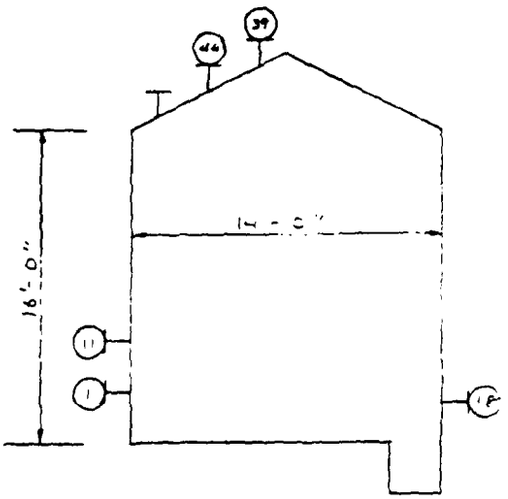
INSULATION CONSERVTN X PROTECTN NONE

DECK MATL

NOZZLES: FLG CLASS COUPL CLASS

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | | | MANHOLE |
| 3 | | | |
| 4 | | | |
| 5 | | | HANDHOLE |
| 6 | | | |
| 7 | | | VAPOR OUTLET TO |
| 8 | | | VENT |
| 9 | | | TO VACUUM EQUIPMENT |
| 10 | | | REFLUX IN FROM |
| 11 | 1 | 1½ | FEED FROM FA-9.D |
| 12 | | | FEED FROM |
| 13 | | | FEED FROM |
| 14 | | | TO (REBOILER) (REB PUMP) |
| 15 | | | FROM REBOILER |
| 16 | | | EQUALIZING LINE WITH |
| 17 | | | BOTTOM OUTLET TO |
| 18 | 1 | 2 | [illegible] PUMP |
| 19 | | | [illegible] |
| 20 | | | RETURN FROM |
| 21 | | | DRAWOFF TO |
| 22 | | | RETURN FROM |
| 23 | | | DRAWOFF TO |
| 24 | | | RETURN FROM |
| 25 | | | REFLUX DRAWOFF TO |
| 26 | | | REFLUX IN, FROM |
| 27 | | | REFLUX DRAWOFF TO |
| 28 | | | REFLUX IN, FROM |
| 29 | | | PROCESS STREAM |
| 30 | | | STEAM OUT (SO) |
| 31 | | | DRAIN |
| 32 | | | SAMPLE CONN (SL COOLER (SC) |
| 33 | | | SAFETY VALVE (PSV) |
| 34 | | | SAFETY VALVE (PVSV) (VSV) |
| 35 | | | UTILITY CONNECTION |
| 36 | | | PRESSURE GAGE (PG) |
| 37 | | | PRESSURE CONTROLLER (P Q |
| 38 | | | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | TO BLOWDOWN |
| 40 | | | TEMPERATURE INDICATOR (TI) |
| 41 | | | TEMPERATURE CONTROLLER (T Q |
| 42 | | | TEMPERATURE RECORDER (TR) |
| 43 | | | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUG - HATCH |
| 45 | | | GAUGE GLASS (LG) |
| 46 | 1 | | EXTERNAL LEVEL |
| 47 | 1 | | INTERNAL LEVEL |
| 48 | | | LEVEL ALARM (LA) |
| 49 | | | |
| 50 | | | |

PLANGED NOZZLES ARE NUMBERED 1-50. FOR COUPLING ADD 50 TO NOZZLE NO




NOTES LIQUID SP GR = 0.96 @ operating temp.

| REV | ISSUE DATE | DESCRIPTION | PROJ ENGR | PROJ ENGR | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 6/14/93 | FOR TASK 4 | [illegible] | | | |

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE LOCATION BEULAH, ND

PROJ NO JOB NO 0557I

PROCESS VESSEL SKETCH

VESSEL NO FB-913 DWG NO -

VESSEL NO FB-914 COMB WITH _____

VESSEL NAME MIST KNOCK OUT DRUM STORAGE

DIAMETER 18'-0" ft-in & _____ ft-in

VERT HT 16'-0" ft-in SKIRT _____ ft-in

HORIZ LENGTH _____ ft-in

OPER TEMP TOP _____ °F BOTT _____ °F DRUM AMB °F

MAX TEMP TOP _____ °F BOTT _____ °F DRUM 110 °F

NORM OPER PRESS _____ psig OR _____ psia

MAX OPER PRESS 50.0 psig OR _____ psia

CORROSION ALLOW SHELL _____ HEADS _____ DECKS _____ in

DES TEMP 220 °F

DES PRESS 50.0 psig VAC -2" H2O psia

HEADS ELIP _____ DISHED _____ CONE 60° E FLAT BOTTOM

CODE ASME _____ API X OTHER _____

STRESS RELIEVED YES _____ CODE _____

RADIOGRAPHED YES _____ CODE _____

EARTHQUAKE _____ WIND _____ mph

MATL SHELL CS LINER _____ THK _____ in

INSULATION CONSERVN X PROTECTN _____ NONE _____

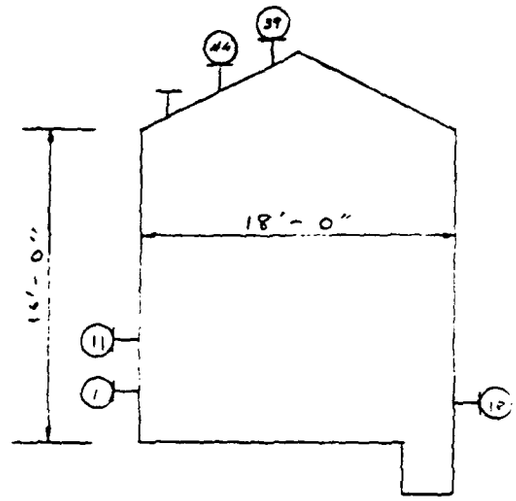
DECK MATL _____

NOZZLES PLG CLASS _____ COUPL CLASS _____

| ITEM NO | NO REQD | SIZE in | SERVICE & SYMBOL |
|---|---|---|---|
| 1 | 1 | 24 | MANHOLE |
| 2 | — | — | MANHOLE |
| 3 | — | — | — |
| 4 | — | — | — |
| 5 | — | — | HANDHOLE |
| 6 | — | — | — |
| 7 | — | — | VAPOR OUTLET TO _____ |
| 8 | — | — | VENT |
| 9 | — | — | TO VACUUM EQUIPMENT |
| 10 | — | — | REFLUX IN FROM _____ |
| 11 | 1 | 2 | FEED FROM GF 9-9 |
| 12 | — | — | FEED FROM _____ |
| 13 | — | — | FEED FROM _____ |
| 14 | — | — | TO REBOILER (REB PUMP) |
| 15 | — | — | FROM REBOILER |
| 16 | — | — | EQUALIZING LINE WITH _____ |
| 17 | — | — | BOTTOM OUTLET TO _____ |
| 18 | 1 | 2 | LIQUID OUTLET TO P-MP |
| 19 | — | — | DRAWOFF TO _____ |
| 20 | — | — | RETURN FROM _____ |
| 21 | — | — | DRAWOFF TO _____ |
| 22 | — | — | RETURN FROM _____ |
| 23 | — | — | DRAWOFF TO _____ |
| 24 | — | — | RETURN FROM _____ |
| 25 | — | — | REFLUX DRAWOFF TO _____ |
| 26 | — | — | REFLUX IN FROM _____ |
| 27 | — | — | REFLUX DRAWOFF TO _____ |
| 28 | — | — | REFLUX IN FROM _____ |
| 29 | — | — | PROCESS STEAM _____ |
| 30 | — | — | STEAM OUT (SO) |
| 31 | — | — | DRAIN |
| 32 | — | — | SAMPLE CONN (S) COOLER (SC) |
| 33 | — | — | SAFETY VALVE (PSV) |
| 34 | — | — | SAFETY VALVE (PVSV) (VBV) |
| 35 | — | — | UTILITY CONNECTION |
| 36 | — | — | PRESSURE GAGE (PG) |
| 37 | — | — | PRESSURE CONTROLLER (P _____ C) |
| 38 | — | — | PRESSURE TAP (PT) |
| 39 | 1 | 1½ | MS Bushing/NS |
| 40 | — | — | TEMPERATURE INDICATOR (TI) |
| 41 | — | — | TEMPERATURE CONTROLLER (T _____ C) |
| 42 | — | — | TEMPERATURE RECORDER (TR) |
| 43 | — | — | TEMPERATURE WELL (TW) |
| 44 | 1 | 4 | GAUG - MATL W |
| 45 | — | — | GAUGE GLASS (LG) |
| 46 | 2 | — | EXTERNAL LEVEL _____ |
| 47 | — | — | INTERNAL LEVEL _____ |
| 48 | — | — | LEVEL ALARM (LA) _____ |
| 49 | — | — | — |
| 50 | — | — | — |

NOTES LIG :- GR = 0 95@ operating temp.

HOLDS




| REV | ISSUE DATE | DESCRIPTION | PROJECT MANAGER | ENGR MANAGER | APPR | APPR |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | 4/14/89 | FOR TANK W | | | | |

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE LOCATION ZEELAND, ND

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-914 DWG NO -

LUMMUS

THE LUMMUS COMPANY
Bloomfield

| Always refer to this number | | | | |
|---|---|---|---|---|
| | Div. | Job | PO/Req. | Sup. |

**DATA SHEET-** LIQUID RING VACUUM PUMP

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| APPLICABLE TO ○ PROPOSAL ○ PURCHASE ○ AS BUILT | | | ITEM NO. GB 901 A/S | | | | |
| FOR AMOCO/DOE - JET FUEL PROJECT | | | UNIT | | | | |
| SITE | | | DRIVER | | | | |
| SERVICE VACUUM PUMP FOR 900 AREA | | | NO. REQUIRED | | | | |
| MANUFACTURER | | MODEL | SERIAL NO. | | | | |
| NOTE ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ☐ BY MANUFACTURER | | | | | | | |
| | | | | | | | |
| **OPERATING CONDITIONS** | | | | | | | |
| (ALL DATA ON PER UNIT BASIS) | | | OTHER CONDITIONS | | | | |
| | NORMAL | RATED | A | B | C | RUN-IN | |
| ○ GAS HANDLED (Also See Page 2 of 5) | | AIR | | | | | |
| ○ MMSCFD/SCFM (14.7 psia & 60°F dry) | | | | | | | |
| ○ WEIGHT FLOW (lb/min) - (Wet) - (Dry) | | 3.5 | | | | | |
| INLET CONDITIONS: | | | | | | | |
| ○ PRESSURE (psia) * | | 1.9 | | | | | |
| ○ TEMPERATURE (°F) | | 265 | | | | | |
| ○ RELATIVE HUMIDITY (%) | | | | | | | |
| ○ MOLECULAR WEIGHT (M) | | 29 | | | | | |
| ☐ ~~$n_s$ (Path Exponent, PTC-10)~~ $C_P/C_V$ | | 1.39 | | | | | |
| ☐ COMPRESSIBILITY ($Z_1$) OR (Zavg) | | 1.0 | | | | | |
| ☐ INLET VOLUME, (cfm-WET)* | | 494 | | | | | |
| DISCHARGE CONDITIONS: | | | | | | | |
| ○ PRESSURE (psia) * | | 22.1 | | | | | |
| ☐ TEMPERATURE (°F) | | | | | | | |
| ☐ $n_s$ (Path Exponent, PTC-10) | | | | | | | |
| ☐ COMPRESSIBILITY ($Z_2$) OR (Zavg) | | 1.0 | | | | | |
| | | | | | | | |
| ☐ bhp REQUIRED (All Losses Incl.) | | | | | | | |
| ☐ SPEED (rpm) | | | | | | | |
| ☐ PRESSURE RATIO (R) | | | | | | | |
| ☐ VOLUMETRIC EFFICIENCY (%) | | | | | | | |
| ☐ SILENCER ΔP (psi) INLET/DISCHARGE | / | / | / | / | / | / | |
| ☐ PERFORMANCE CURVE NO. | | | | | | | |
| PROCESS CONTROL: | | | | | | | |
| METHOD ○ BYPASS FROM TO ○ BYPASS ○ MANUAL ○ AUTO | | | | | | | |
| ○ SPEED VARIATION FROM TO | | | | | | | |
| ○ OTHER | | | | | | | |
| SIGNAL ○ SOURCE | | | | | | | |
| ○ TYPE | | | | | | | |
| ○ RANGE FOR PNEUMATIC CONTROL rpm AT psig AND rpm AT psig | | | | | | | |
| OTHER | | | | | | | |

AT CUSTOMER CONNECTIONS TO SILENCERS

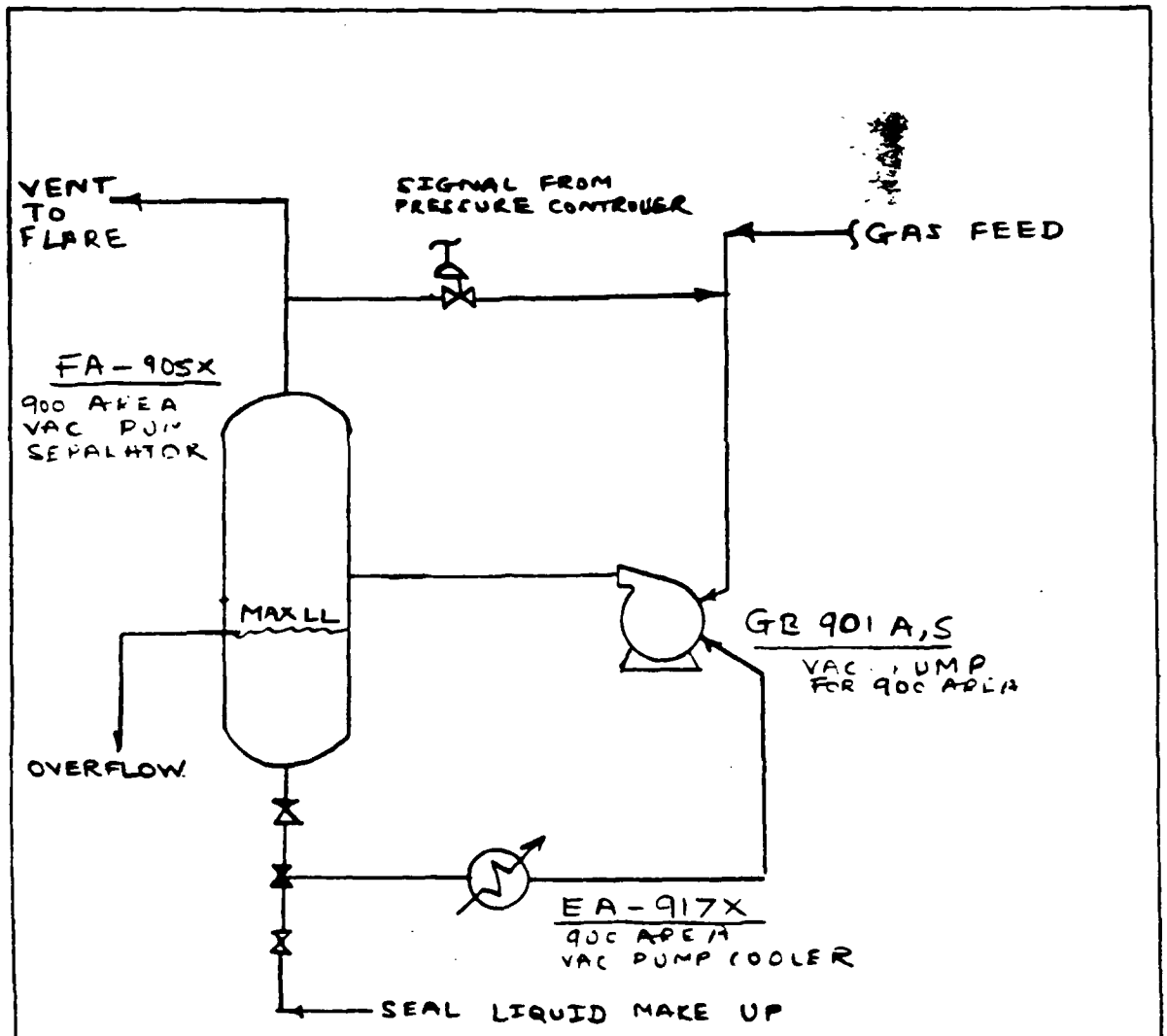
| Prepared: | Approved: | Date: 4/14/89 | Rev. △ | Rev. △ | Rev. △ |
|---|---|---|---|---|---|

A109 04 07R1-TP2 5.1/1 REV 4

PA-901

**DESIGN COMPUTATIONS FOR** VACUUM PACKAGE FOR 900 AREA

**JOB** _____ **ACCT.** 05571




A2.601

| REV | DATE | MADE | CHKD. | APPR. | Record | REV. | ISSUE | DWG. NO. |
|---|---|---|---|---|---|---|---|---|
| D | 4/14/89 | | | | | | | |

THE LUMMUS COMPANY
Bloomfield N. J.

A108 03 0774-1 REV. 1

# 6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

## 6.4 Offsites - AREA 400

# *OSBL ESTIMATE*

| | | |
|---|---|---|
| **PIPING** | | |
| 600 TONS X 1.1 FOR FITTINGS & FLANGES X $200/TON | | $1,320,000 |
| 2000 GALV. @ $25/FT | | $50,000 |
| LABOR @ .6 HRS/FT. X $55/HR (80000 FT) | | $2,640,000 |
| TRACING 16200 LF @ $20/FT | | $324,000 |
| **INSULATION** | | |
| FROM BACK UP | | $420,000 |
| **PIPERACK** | | |
| 3000LF @ $300/FT | | $900,000 |
| CONCRETE 1500 Y3 X $350/ | | $525,000 |
| TOTAL INTERCONNECTIONS | | $6,179,000 |
| EQUIPMENT | | $1,846,000 |
| INSTALLATION MATERIALS FOR EQUIPMENT @ 25% | | $461,500 |
| LABOR FOR EQUIPMENT & MATERIALS | | $461,500 |
| | S/T | $8,948,000 |
| ENGINEERING @ 10 % | | $900,000 |
| | S/T | $9,848,000 |
| CONTINGENCY @ 30% | | $2,954,400 |
| | TOTAL | $12,802,400 |

(1)

PIPE ABOVE GROUND

| | | | |
|---|---|---|---|
| 1 1/2 | 35000 LF | 3.6 #/FT | 126,000 #'S |
| 2 | 15,000 | 5.0 | 55,000 |
| 3 | 15,000 | 7.5 | 112,500 |
| 4 | 7000 | 11.0 | 77,000 |
| 8 | 1000 | 28.0 | 28,000 |
| 20 | 2000 | 78.0 | 156,000 |
| 30 | 2000 | 118.0 | 236,000 |

PIPE BELOW GROUND

| | | | |
|---|---|---|---|
| 6 | 1700 | 19 | 32,300 |
| 10 | 2000 | 40 | 80,000 |
| 15 | 1500 | 50 | 75,000 |
| 26 | 1500 | 153 | 229,500 |

WEIGHT TOTAL 1,207,300 PIPE $ ---/

| | | | |
|---|---|---|---|
| INSULATION | 1 1/2" 17,000 FT | $ 10/FT | $ 170,000 |
| | 2" 6000 | 12 | 72,000 |
| | 3" 8000 | 13 | 104,000 |
| | 4" 4000 | 14 | 56,000 |
| | 8" 1000 | 18 | 18,000 |
| | | | $ 420,000 |

AMOCO/DOE

5571
3/13/89
E.S.

OFFSITES SUMMARY — AREA 600 — TASK 4 DESIGN

FB ITEMS ATTACHED
GA ITEMS ATTACHED

NEW RACK 800' 10 FT WIDE DOUBLE TIER
2200' 10 FT WIDE DOUBLE TIER

PIPING

| | A2A - 150# C.S. | INSUL. | HDX .50# GALV. |
|---|---|---|---|
| 1 1/2" | 35,000 FT | [illegible] | 2" - 1000 FT |
| 2" | 11,000 FT | 6000 FT | 3" - 1000 FT |
| 3" | 15,000 FT | 8000 FT | |
| 4" | 7,000 FT | 4000 FT | |
| 8" | 1000 FT | 1000 FT | |
| 20" | 2000 FT (BURIED 9') | | |
| 30" | 2000 FT (STM TRACED) | 2000 FT | |

SEWERS

| | | | ELECTRICAL TRAYS | |
|---|---|---|---|---|
| 26" | T4S - BURIED 9' | 1700 FT | 2" | 7000 FT |
| 15" | T5S - BURIED 9' | 1500 FT | 2" | 2600 FT |
| 6" | T6S - BURIED 9' | 1500 FT | 3" | 4300 FT |
| 10" | T5N - BURIED 9' | 2000 FT | 4" | 2300 FT |
| | | | | [illegible] |

400 AREA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB- 401 JP-8 PRODUCT | 1 | | | | | | |
| 2 | 85' ID 40' TT TK SKIRT HT | | | | | | | |
| 3 | m☐ mm☐ | | | | | | | |
| 4 | MAT C.S. CLAD☐ LINING☐ CA 1/8 / mm | | | 8 | | | | 304,000 |
| 5 | DES PRESS +5" -2" WG PSIG DES TEMP 150 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 38000 BARRELS / GALLONS / M³ | | | | | | | |
| 8 | INTERNALS | | | | | | | |
| 9 | TYPE: CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 10 | INSUL☐ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT TONS | | | | | | | |
| 11 | FB- 402 STABILIZED NAPHTHA | 1 | | | | | | |
| 12 | 45' ID 40' TT TK SKIRT HT | | | | | | | |
| 13 | m☐ mm☐ | | | 10 | | | | 120,000 |
| 14 | MAT C.S. CLAD☐ LINING☐ CA 1/8 / mm | | | | | | | |
| 15 | DES PRESS +5"-2" WG PSIG DES TEMP 150 °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 12000 BARRELS / GALLONS / M³ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | TYPE CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 20 | INSUL☐ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT TONS | | | | | | | |
| 21 | FB- 403 FUEL OIL | | | | | | | |
| 22 | 95' ID 48' TT TK SKIRT HT | 1 | | | | | | |
| 23 | m☐ mm☐ | | | | | | | |
| 24 | MAT C.S. CLAD☐ LINING☐ CA 1/8 / mm | | | 8 | | | | 472,000 |
| 25 | DES PRESS +5"-2" WG PSIG DES TEMP 150 °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 59,000 BARRELS / GALLONS / M³ | | | | | | | |
| 28 | INTERNALS HEATING COIL | | | | | | | |
| 29 | TYPE: CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 30 | INSUL☒ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT. TONS | | | | | | | |
| | TOTAL THIS PAGE | 3 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT ALYOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | WAGE RATE | LOC. M.H. | LAB. COST

BY MHC. ES | DATE 3/89 | REV.

JOB EST NO. 5571 | ACCT FB

F-198

400 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB 404 LT. ENDS. | 1 | | | | | | |
| 2 | 20' ID 18' TT TK SKIRT HT | | | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C S CLAD ☐ LINING ☐ CA 1/8 mm | | | | | | | |
| 5 | DES PRESS +5" -2" WG PSIG DES TEMP 150 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | 30 | | | | 30 000 |
| 7 | CAPACITY: 1000 BARRELS GALLONS M³ | | | | | | | |
| 8 | INTERNALS | | | | | | | |
| 9 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 10 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT TONS | | | | | | | |
| 11 | FB 405 BENZENE PRODUCT | 1 | | | | | | |
| 12 | 32' ID 32' TT TK SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT C.S. CLAD ☐ LINING ☐ CA 1/8 mm | | | 20 | | | | 90 000 |
| 15 | DES PRESS +5" -2" WG PSIG DES TEMP 120 °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 4500 BARRELS GALLONS M³ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | TYPE: CR ☒ FR ☒ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 20 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT TONS | | | | | | | |
| 21 | FB 406 TOLUENE PRODUCT | 1 | | | | | | |
| 22 | 22' ID 24' TT TK SKIRT HT | | | 25 | | | | 40 000 |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT C S CLAD ☐ LINING ☐ CA 1/8 mm | | | | | | | |
| 25 | DES PRESS +5 -2 WG PSIG DES TEMP 120 °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 1600 BARRELS GALLONS M³ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 30 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT TONS | | | | | | | |
| | TOTAL THIS PAGE | 3 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY MAE. ES
DATE 3/89
REV.

JOB EST NO. 5571 ACCT FB

A123-1109-2 REV. 1

F-199

400 AREA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB- 407 XYLENE PRODUCT | 1 | | | | | | |
| 2 | 12' ID 12' TT TK SKIRT HT | | | | | | | |
| 3 | m ☐ mm ☐ | | | | | | | |
| 4 | MAT C S CLAD ☐ LINING ☐ CA 1/8 \| mm | | | 60 | | | | 12000 |
| 5 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 200 BARRELS \| GALLONS \| M³ | | | | | | | |
| 8 | INTERNALS | | | | | | | |
| 9 | TYPE CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 10 | INSUL ☐ API ☒ BULLET ☒ FAB-SHOP ☐ FIELD ☐ ERECT. WT TONS | | | | | | | |
| 11 | FB- 408 GASOLINE BLEND STORAGE | 1 | | | | | | |
| 12 | 17' ID 18' TT TK SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT C S CLAD ☐ LINING ☐ CA 1/8 \| mm | | | 40 | | | | 25000 |
| 15 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 630 BARRELS \| GALLONS \| M³ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | TYPE CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 20 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT TONS | | | | | | | |
| 21 | FB- 409 GASOLINE | 1 | | | | | | |
| 22 | 48' ID 40' TT TK SKIRT HT | | | | | | | |
| 23 | m ☐ mm ☐ | | | 10- | | | | 130000 |
| 24 | MAT C.S. CLAD ☐ LINING ☐ CA 1/8 \| mm | | | | | | | |
| 25 | DES PRESS ATMOS PSIG DES TEMP 120 °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 13000 BARRELS \| GALLONS \| M³ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 30 | INSUL ☐ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT TONS | | | | | | | |
| | TOTAL THIS PAGE | 3 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H.
WAGE RATE | LAB. COST

BY MAE-LS
DATE 3/89
REV.

JOB EST NO. 5571
ACCT FB

F-200

400 AREA

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB- 804 TAR PRODUCT | 1 | | | | | | |
| 2 | 30' ID 32' TT TK SKIRT HT | | | | | | | |
| 3 | m ☐ mm ☐ | | | 20 | | | | 36 000 |
| 4 | MAT C.S. CLAD ☐ LINING ☐ CA V4" / mm | | | | | | | |
| 5 | DES PRESS +5" - 2" WG PSIG DES TEMP 160 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 2800 BARRELS / GALLONS / M³ | | | | | | | |
| 8 | INTERNALS HEATING COIL | | | | | | | |
| 9 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 10 | INSUL ☒ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT WT | | TONS | | | | | |
| 11 | FB- 805 PHENOL PRODUCT | 1 | | | | | | |
| 12 | 32' ID 32' TT TK SKIRT HT | | | | | | | |
| 13 | m ☐ mm ☐ | | | | | | | |
| 14 | MAT C.S. CLAD ☐ LINING ☐ CA 1/8" / mm | | | | | | | |
| 15 | DES PRESS +5" - 2" WG PSIG DES TEMP 160 °F | | | 20- | | | | 82 000 |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 4600 BARRELS / GALLONS / M³ | | | | | | | |
| 18 | INTERNALS HEATING COIL | | | | | | | |
| 19 | TYPE: CR ☒ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☒ | | | | | | | |
| 20 | INSUL ☒ API ☒ BULLET ☐ FAB-SHOP ☐ FIELD ☒ ERECT. WT | | TONS | | | | | |
| 21 | FB- | | | | | | | |
| 22 | ID TT TK SKIRT HT | | | | | | | |
| 23 | m ☐ mm ☐ | | | | | | | |
| 24 | MAT CLAD ☐ LINING ☐ CA / mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: BARRELS / GALLONS / M³ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE: CR ☐ FR ☐ DR ☐ SPHERE ☐ OTHERS ☐ HORIZ ☐ VERT ☐ | | | | | | | |
| 30 | INSUL ☐ API ☐ BULLET ☐ FAB-SHOP ☐ FIELD ☐ ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | 2 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| CLIENT | AMOCO / DOE - GREAT PLAINS GASIF. PLANT | PROD. FACT | | LOC. M.H. | |
| LOCATION | BEULAH, NORTH DAKOTA | WAGE RATE | | LAB. COST | |
| PROJECT | JET FUEL FROM COAL DERIVED LIQUIDS | | | | |

BY M.E.S. DATE 3/89 REV.

JOB EST NO. 5571 ACCT FB

F-201

400 AREA

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB- 910 O-CRESOL PRODUCT | 1 | | | | | | |
| 2 | 22' ID 24' TT TK SKIRT HT | | | | | | | |
| 3 | m☐ mm☐ | | | | | | | |
| 4 | MAT CS CLAD☐ LINING☐ CA / mm | | | 25- | | | | 400 00 |
| 5 | DES PRESS +5"-2" WG DES TEMP 160 °F | | | | | | | |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY: 1600 BARRELS/ GALLONS/ M³ | | | | | | | |
| 8 | INTERNALS HEATING COIL | | | | | | | |
| 9 | TYPE: CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 10 | INSUL☒ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT. | | TONS | | | | | |
| 11 | FB- 912 M/P CRESOL PRODUCT | 1 | | | | | | |
| 12 | 25' ID 24' TT TK SKIRT HT | | | | | | | |
| 13 | m☐ mm☐ | | | | | | | |
| 14 | MAT C.S. CLAD☐ LINING☐ CA 1/8 / mm | | | 25+ | | | | 33 000 |
| 15 | DES PRESS +5"-2" WG DES TEMP 160 °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY: 2100 BARRELS/ GALLONS/ M³ | | | | | | | |
| 18 | INTERNALS HEATING COIL | | | | | | | |
| 19 | TYPE: CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 20 | INSUL☒ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT. | | TONS | | | | | |
| 21 | FB- 913 2,3 / 2,4 XYLENOL PRODUCT | 1 | | | | | | |
| 22 | 14' ID 16' TT TK SKIRT HT | | | 50- | | | | 22 000 |
| 23 | m☐ mm☐ | | | | | | | |
| 24 | MAT C.S. CLAD☐ LINING☐ CA 1/8" / mm | | | | | | | |
| 25 | DES PRESS +5"-2" WG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY: 440 BARRELS/ GALLONS/ M³ | | | | | | | |
| 28 | INTERNALS HEATING COIL | | | | | | | |
| 29 | TYPE: CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 30 | INSUL☒ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT. | | TONS | | | | | |
| | TOTAL THIS PAGE | 3 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO / DOE - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY ~~MAE~~ CJ
DATE 3/85
REV.

JOB EST NO. 5571
ACCT FB

F-202

400 AREA

**LUMMUS** — **ESTIMATE SHEET** — **THE LUMMUS COMPANY** Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | FB. 914 MIXED XYLENOL PRODUCT | 1 | | | | | | |
| 2 | 18' ID 19' TT TK SKIRT HT | | | | | | | |
| 3 | m☐ mm☐ | | | | | | | |
| 4 | MAT C-S. CLAD☐ LINING☐ CA 1/8 mm | | | | | | | |
| 5 | DES PRESS 5" - 2" WG ~~PSIG~~ DES TEMP 160 °F | | | 35- | | | | 30000 |
| 6 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 7 | CAPACITY 820 BARRELS/ GALLONS/ M³ | | | | | | | |
| 8 | INTERNALS HEATING COIL | | | | | | | |
| 9 | TYPE CR☒ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☒ | | | | | | | |
| 10 | INSUL☒ API☒ BULLET☐ FAB-SHOP☐ FIELD☒ ERECT. WT TONS | | | | | | | |
| 11 | FB. | | | | | | | |
| 12 | ID TT TK SKIRT HT | | | | | | | |
| 13 | m☐ mm☐ | | | | | | | |
| 14 | MAT CLAD☐ LINING☐ CA mm | | | | | | | |
| 15 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 16 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 17 | CAPACITY BARRELS/ GALLONS/ M³ | | | | | | | |
| 18 | INTERNALS | | | | | | | |
| 19 | TYPE CR☐ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☐ | | | | | | | |
| 20 | INSUL☐ API☐ BULLET☐ FAB-SHOP☐ FIELD☐ ERECT. WT TONS | | | | | | | |
| 21 | FB. | | | | | | | |
| 22 | ID TT TK SKIRT HT | | | | | | | |
| 23 | m☐ mm☐ | | | | | | | |
| 24 | MAT CLAD☐ LINING☐ CA mm | | | | | | | |
| 25 | DES PRESS PSIG DES TEMP °F | | | | | | | |
| 26 | DES PRESS kg/cm² DES TEMP °C | | | | | | | |
| 27 | CAPACITY BARRELS/ GALLONS/ M³ | | | | | | | |
| 28 | INTERNALS | | | | | | | |
| 29 | TYPE CR☐ FR☐ DR☐ SPHERE☐ OTHERS☐ HORIZ☐ VERT☐ | | | | | | | |
| 30 | INSUL☐ API☐ BULLET☐ FAB-SHOP☐ FIELD☐ ERECT. WT TONS | | | | | | | |
| | TOTAL THIS PAGE | 1 | | | | | | |
| | TOTAL ACCOUNT | 16 | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT | PROD. FACT | | LOC. M.H. | | BY [illegible]-ES |
| LOCATION BEULAH, NORTH DAKOTA | | | | | DATE 3/85 |
| PROJECT JET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE | | LAB. COST | | REV |

JOB EST NO. 5571 ACCT FB

F-203

400 AREA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | | | | | | | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GA 401/S TAR/TAR OIL FEED | | | | | | | 2 | | | | | | |
| 2 | GPM 110 | SUCT | PSIG | DISCH | PSI | TEMP 160 °F | | | | | 25000 | | | |
| 3 | $m^3/h$ | SUCT | kPa kg/cm² | DISCH | kPa kg/cm² | TEMP °C | | | | | | | | |
| 4 | SP GR 1.0 | ΔP | FT | 50 PSI | | STGS | | | | | | | | |
| 5 | | ΔP | m | kPa kg/cm² | | RPM | | | | | | | | |
| 6 | MAT CASE CS/SS | IMPELLER | | | | 10 H.P. | | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ | | | | | kW | | | | | | | | |
| 8 | TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | | | | | | | |
| 10 | INSUL ☐ | ERECT. WT. PUMP & DRIVER | | | | | | | TONS | | | | | |
| 11 | GA 402/S CRUDE PHENOL FEED | | | | | | | 2 | | | | | | |
| 12 | GPM 30 | SUCT | PSIG | DISCH | PSI | TEMP 120 °F | | | | | | | | |
| 13 | $m^3/h$ | SUCT | kPa kg/cm² | DISCH | kPa kg/cm² | TEMP °C | | | | | 15000 | | | |
| 14 | SP GR | ΔP | FT | 50 PSI | | STGS | | | | | | | | |
| 15 | | ΔP | m | kPa kg/cm² | | RPM | | | | | | | | |
| 16 | MAT CASE CS | IMPELLER 12 CY | | | | 2½ H.P. | | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ | | | | | kW | | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | | | | | | | |
| 20 | INSUL ☒ | ERECT. WT. PUMP & DRIVER | | | | | | | TONS | | | | | |
| 21 | GA 403 FUEL OIL TRANSFER | | | | | | | 2 | | | | | | |
| 22 | GPM 600 | SUCT | PSIG | DISCH | PSI | TEMP 120 °F | | | | | | | | |
| 23 | $m^3/h$ | SUCT | kPa kg/cm² | DISCH | kPa kg/cm² | TEMP °C | | | | | 25000 | | | |
| 24 | SP GR .85 | ΔP | FT | 50 PSI | | STGS | | | | | | | | |
| 25 | | ΔP | m | kPa kg/cm² | | RPM | | | | | | | | |
| 26 | MAT CASE CS | IMPELLER 12 CY | | | | 30 H.P. | | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ | | | | | kW | | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | | | | | | | |
| 30 | INSUL ☒ | ERECT. WT. PUMP & DRIVER | | | | | | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | 6 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY MFC ES | JOB EST NO. 5571 | ACCT
WAGE RATE | LAB. COST | DATE 3/85 | REV. | GA

A122 0482-10 REV. 3

F-204

400 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 404/S STABIL. NAPHTHA TRANSFER | 2 | | | | | | |
| 2 | GPM 400 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 20 000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12 CY 20 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 405/S CRUDE NAPHTHA FEED | 2 | | | | | | |
| 12 | GPM 25 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 15000 | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR 0.71 ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE IMPELLER 1.5 HP | | | | | | | |
| 17 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 406/S GASOLINE BLENDING STOCK TRANS. | 2 | | | | | | |
| 22 | GPM 75 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 15000 | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR 0.89 ΔP FT 50 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER 12 CY 5 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | 6 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD FACT | LOC. M.H. | BY HEL EJ | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 3/89 | REV.

A122 0482 10 REV. 3

F-105

400 AREA

LUMMUS

# ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 407/S BENZENE TRANSFER | 2 | | | | | | |
| 2 | GPM 200 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 15000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR 0.89 ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12 CY 10 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 408/S TOLUENE TRANSFER | 2 | | | | | | |
| 12 | GPM 150 SUCT PSIG DISCH PSI TEMP °F | | | | 15000 | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR .87 ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER 12 CY 7½ HP | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH SEAL ☒ | | | | | | | |
| 20 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 409/S XYLENE TRANSFER | 2 | | | | | | |
| 22 | GPM 25 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 15000 | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR .88 ΔP FT 50 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER 12 CY 1.5 HP | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH SEAL ☒ | | | | | | | |
| 30 | INSUL ☐ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | | | | | | | |
| | TOTAL ACCOUNT | 6 | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY MEL ET
DATE 3/85
REV.

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

F-310

400 AREA

LUMMUS — ESTIMATE SHEET — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 410/S JP-8 TRANSFER | 2 | | | | | | |
| 2 | GPM 1000 SUCT PSIG DISCH PSI TEMP 100 °F | | | | 40000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR .82 ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12CR 50 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 411/S GASOLINE TRANSFER | 2 | | | | | | |
| 12 | GPM 400 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 20000 | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR 0.74 ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER 12CR 20 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☒ | | | | | | | |
| 20 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA | 2 | | | | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE IMPELLER H.P. | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | 6 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | BY HCL ES | JOB EST NO. 5571 | ACCT GA
WAGE RATE | LAB. COST | DATE 3/85 | REV.

A122 0482-10 REV. 3

F-107

400 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 413/S 300# LT ENDS TRANSFER | 2 | | | | | | |
| 2 | GPM 100 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 15000 | | | |
| 3 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP.GR 0.98 ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12 CV 5 H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH. SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 414/S TAR PRODUCT TRANSFER | 2 | | | | | | |
| 12 | GPM 200 SUCT PSIG DISCH PSI TEMP 160 °F | | | | 20000 | | | |
| 13 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP.GR 1.08 ΔP FT PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER 12 CV 15 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☒ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH. SEAL ☐ | | | | | | | |
| 20 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 415/S PHENOL PRODUCT TRANS. | 2 | | | | | | |
| 22 | GPM 200 SUCT PSIG DISCH PSI TEMP 160 °F | | | | 15000 | | | |
| 23 | m³/h SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP.GR 1.08 ΔP FT 50 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER 12 CV 10 H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH. SEAL ☒ | | | | | | | |
| 30 | INSUL ☒ ERECT. WT. PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | 6 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY MHC CS | JOB EST NO. 5571 | DATE 3/89 | REV. | ACCT GA

A122 0482-10 REV. 3

F-108

400 AREA

# LUMMUS — ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 416/S O-CRESOL TRANS. | 2 | | | | | | |
| 2 | GPM 150 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 15000 | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR 0.98 ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12 CR 7½ H.P. | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | |
| 10 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA 417/S M/P CRESOL TRANS. | 2 | | | | | | |
| 12 | GPM 200 SUCT PSIG DISCH PSI TEMP 120 °F | | | | 15000 | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR 1.035 ΔP FT 50 PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE CS IMPELLER 12 CR 10 H.P. | | | | | | | |
| 17 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH SEAL ☒ | | | | | | | |
| 20 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA 418/S 2,3/2,4 CRESOL TRANSFER | 2 | | | 15000 | | | |
| 22 | GPM 50 SUCT PSIG DISCH PSI TEMP 120 °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR 0.97 ΔP FT 50 PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE CS IMPELLER 12 CR 2½ H.P. | | | | | | | |
| 27 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH SEAL ☒ | | | | | | | |
| 30 | INSUL ☒ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | 6 | | | | | | |
| | TOTAL ACCOUNT | | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT
WAGE RATE
LOC. M.H.
LAB. COST

BY MEL ES
DATE 3/81
REV.

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

F-204

400 AREA

**LUMMUS** — **ESTIMATE SHEET** — THE LUMMUS COMPANY, Bloomfield

| | DESCRIPTION | QUANTITY REQ | QUANTITY EA | UNIT COST | MATERIAL COST | STD LABOR MH UNIT | STD LABOR MH TOTAL | SUBCONTRACT COST |
|---|---|---|---|---|---|---|---|---|
| 1 | GA 419/5 MIXED XYLENOL TRANS. | 2 | | | 15000 | | | |
| 2 | GPM 100 SUCT PSIG DISCH PSI TEMP 120 °F | | | | | | | |
| 3 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 4 | SP GR 0.91 ΔP FT 50 PSI STGS | | | | | | | |
| 5 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 6 | MAT CASE CS IMPELLER 12 cr 5 HP | | | | | | | |
| 7 | DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 8 | TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 9 | MECH SEAL ☒ | | | | | | | |
| 10 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 11 | GA | | | | | | | |
| 12 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 13 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 14 | SP GR ΔP FT PSI STGS | | | | | | | |
| 15 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 16 | MAT CASE IMPELLER HP | | | | | | | |
| 17 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 18 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 19 | MECH SEAL ☐ | | | | | | | |
| 20 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| 21 | GA | | | | | | | |
| 22 | GPM SUCT PSIG DISCH PSI TEMP °F | | | | | | | |
| 23 | $m^3/h$ SUCT kPa kg/cm² DISCH kPa kg/cm² TEMP °C | | | | | | | |
| 24 | SP GR ΔP FT PSI STGS | | | | | | | |
| 25 | ΔP m kPa kg/cm² RPM | | | | | | | |
| 26 | MAT CASE IMPELLER HP | | | | | | | |
| 27 | DRIVE EM – ☐ TURB ☐ DIESEL ☐ OTHER ☐ kW | | | | | | | |
| 28 | TYPE CENT – ☐ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐ | | | | | | | |
| 29 | MECH SEAL ☐ | | | | | | | |
| 30 | INSUL ☐ ERECT WT PUMP & DRIVER | | TONS | | | | | |
| | TOTAL THIS PAGE | 2 | | | | | | |
| | TOTAL ACCOUNT | 38 | | | | | | |

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS

PROD. FACT | LOC. M.H. | WAGE RATE | LAB. COST

BY [illegible] ES
DATE 3/8/5
REV.

JOB EST NO. 5571
ACCT GA

A122 0482-10 REV. 3

F-510

APPENDIX G

Letter from D. P. Daley to J. G. Masin, March 3, 1989,
"GPGP By-product Marketing Assessment"

**Burns and Roe Services Corporation**
P.O. Box 18288, Pittsburgh, PA 15236 • 412-892-4701

March 3, 1989
DPD-89-154

Mr. J. G. Masin
Amoco Oil Company
Research and Development Department
P.O. Box 400
Naperville, Illinois 60566

Subject: Contract No. DE-AC22-87PC79338
Subtask 3.03
GPGP By-Product Marketing Assessment

Dear Mr. Masin:

In response to your request for recent market information on the GPGP by-products, attached please find a Market Assessment performed by Stanford International for Fluor. This assessment was presented in Fluor's January 1989 report to the U.S. DOE entitled "Great Plains Coal Gasification Plant - By-Products Development Program Summary Report".

If you have any questions, please contact S.N. Rao at (412) 892-4716 or R.J. Rossi at (412) 892-4845.

Very truly yours,

Donald P. Daley

Donald P. Daley
Project Director

RR/jm

Attachment

cc: R. Carabetta
G. McGurl w/attachment
J. Parise (2)
G. Reule
G. Stiegel w/attachment
P. LaRosa w/attachment
S.N. Rao w/attachment
R. Rossi w/attachment
W. Harrison (USAF) w/attachment
A. Kuhn (DGC) w/attachment

## 2.2 Task #2 - Market Assessment

### 2.2.1 Objective

The objective of this task was to obtain from an independent source a comprehensive market analysis to help determine the most promising by-products for development and marketing and to prioritize the development and marketing among the by-products. The marketing analysis was executed by Stanford International (SI) of Menlo Park, California (formerly called Stanford Research Institute).

### 2.2.2 Scope

The scope of the study was as follows:

1. Assessment of markets
2. Exploration of pricing criteria for products
3. Matching products with markets.

Each of these items is discussed below.

The market assessment was based on consideration of the following market considerations:

- Supply and demand evaluation of domestic and where applicable foreign markets.
- An analysis of the production capacity by domestic and foreign producers.
- Evaluation of imports and exports, trade limitations and transportation issues.
- Survey of announced and potential manufacturing expansions.
- Projections of the impact of new technologies, new products, and existing commodity replacements.

For all of the above considerations historical and forecast information was used. SI is continuously updating a series of books for various chemicals and commercial gas. Input was received from the proprietary background information

Rather than relying on historical data for price projections, the scope of the project was aimed at exploring pricing criteria for the various products and then projecting future pricing and trends based on these criteria. The basic presumption was that prices are market driven; that is, the price of a product is solely a function of basic market elements and is not affected by political pressures, foreign cartels, trade sanctions or other undeterminate events.

The potential by-products had to be evaluated in view of existing, competitive products, therefore, the scope of the task included matching the volume and quality of the potential by-products with those currently marketed. DGC provided SI with anticipated volumes, composition and quality of the potential products.

### 2.2.3 Technical Approach

SI's technical approach to execution of the task was based on:

- Contacting suppliers and product users
- Using published surveys and trade journals
- Using SI's own nonproprietary data base

Primary information was obtained by contacting individual suppliers and users of the respective products under evaluation. Nonproprietary and proprietary information thus collected was evaluated and compared. The requested information focused on the three main elements of the work scope, namely: assessing the market, exploring pricing and required product quality. Also, inquiries were made about projected expansion or termination of current production. Product users were also queried whether or not a coal derived product would be acceptable for their raw material purchases.

Published literature was another source of information. Because the depth of the study was limited, information on foreign markets and price trends was mostly obtained from available publications.

In executing the project, SI also relied on its applicable proprietary data base. SI's data base information complemented and augumented the above mentioned information sources.

### 2.2.4 Task Description

DGC defined the following product slate for evaluation and provided the potential quantities that could be produced:

| | Annual Production, MM Lbs/Year |
|---|---|
| Phenol | 37 |
| Ortho cresol | 10 |
| Meta-para cresol mix | 26.4 |
| m-Ethyl phenol<br>2,3-Xylenol<br>p-Ethyl phenol | 7.6 |
| 3,4-Xylenols | 1.7 |
| 3,5-Xylenols | 3.4 |
| 2,4-, 2,5-Xylenol | 6.5 |
| Creosote | 27 |
| Aromatic naphtha, millions of U.S. gallons/yr | 10 |
| Carbon dioxide, million standard cubic feet/day | 180 |
| Argon, thousands of short tons/yr | 34.5 |
| Krypton, Xenon, millions of liters/yr | 2.6 |

Accordingly, SI evaluated each commodity as defined by the objective and scope of the project.

2.2.5 Results and Conclusions

The target markets defined in this section are domestic ones for phenol, aromatics, carbon dioxide and argon. All others include an export component.

2.2.5.1 Phenol

| | |
|---|---|
| Projected Production: | 37 MM lb/yr |
| Percent of U.S. Capacity (1987): | 1.1 |
| Markets Accessible to DGC (1992): | 300 MM lb/yr |

SI's assessment projects that provided DGC markets specification grade phenol (with no impurities that are characteristics of coal derived phenols) a good market potential exists in the 1990-1995 timeframe. Because no demand decrease is forecast and because synthetic phenol will require a premium price due to firm benzene and propylene prices, one can expect a firm netback value of 45-50 c/lb for phenol. However, because of the cyclical nature of the chemical market, the opportunities should be exploited in the near future to establish a position.

2.2.5.2 Cresols

| | |
|---|---|
| Projected Production | |
| Ortho Cresol | 10 MM lb/yr |
| Meta-Para Cresol Mix | 26.4 MM lb/yr |
| Percent of U.S. Capacity (1987) | |
| Ortho Cresol | 40 |
| Meta-Para Cresol Mix | 91 |
| Markets Accessible to DGC (1992) | |
| Ortho Cresol | 80 MM lbs/yr (including exports) |
| Meta-Para Cresol Mix | 50 MM lbs/yr (including exports) |

As the above figures show, DGC's cresol production would be a dominant share of the U.S. market. In the markets accessible to DGC certain foreign markets are included and the possibility of export must be followed up to confirm market potential abroad. Overall, the cresol market is difficult to penetrate. Demand is in decline and users are looking for substitute chemicals because the toxicity of cresols has been called into question by the USEPA and is presently being investigated. Cresol prices are very much subject to wide cycling, and the entry of a large volume of cresols would certainly suppress the price.

However, a number of cresol producers may close plants and abandon the market. Therefore, for specific use a small segment of the domestic market for quality products may open.

2.2.5.3 Xylenols

| | |
|---|---|
| Projected Production | |
| m-Ethyl phenol<br>2,3-Xylenol<br>p-Ethyl phenol | 7.6 MM lb/yr |
| 3,4-Xylenols | 1.7 MM lbs/yr |
| 3,5-Xylenols | 3.4 MM lbs/yr |
| 2,4-, 2,5-Xylenols | 6.5 MM lbs/yr |
| Present U.S. Capacity (1987) | |
| m-Ethyl phenol<br>2,3-Xylenol<br>p-Ethyl phenol | 20.5 |
| 3,4-Xylenols<br>3,5-Xylenols<br>2,4-, 2,5-Xylenols | 10.5 |
| Markets Accessible to DGC (1992) | |
| m-Ethyl phenol<br>2,3-Xylenol<br>p-Ethyl phenol | 10 MM lb/yr |
| 3,4-Xylenols<br>3,5-Xylenols<br>2,4-, 2,5-Xylenols | 50 MM lb/yr |

The market for Xylenols, like Cresols, is on the decline. The largest volume demand of Xylenol is the 2,6 Xylenol which is largely produced synthetically and consumed by the producers. Unfortunately, DGC's Xylenol stream has practically no 2,6 Xylenol. On the other hand 2,4 Xylenol are used in the production of antioxidants, 3,5 Xylenols for fungicides, since Xylenols must be tailored to specific applications it will be very difficult to move all the Great Plans volumes of Xylenols within the USA.

2.2.5.4 Creosote

| | |
|---|---|
| Projected Production: | 27 MM lbs/yr |
| Percent of U.S. Capacity (1987) | 39 |
| Markets Accessible to DGC (1992) | 60 MM lbs/yr |

Creosote demand is steadily declining because of its high toxicity, extensive regulatory obligations and shrinking end use. No new technical applications are expected.

2.2.5.5 Aromatics

| | |
|---|---|
| Projected Production | 10 MM gallon/yr |
| Percent of US Capacity (1987) | 7.1 |
| Markets Accessible to DGC (199-) | 3,000 MM gallon/yr |

The Rectisol naphtha contains a large percentage of aromatics: benzene, toluene, and xylenes (BTX) (See Section 2.3). As such, it is a valuable raw material; however, this stream is relatively low in volume: about 650 barrels per day (10 MM gallon/yr). In view of a strong demand for these aromatics, the market potential for this stream is favorable. Because of the poor economics involved in processing such small quantities, the mixture should be shipped to a refiner and processed there with pyrolysis gasoline to extract the benzene, toluene and xylenes rather than separating the individual compounds at the plant site. However, because of objectionable odor and toxicity the high sulfur content and gumming tendency from the diolefins present, this stream must undergo catalytic hydrotreating and stabilization to make it suitable for shipping.

2.2.5.6 $CO_2$

| | |
|---|---|
| Projected Production | 180 MMSCFD |
| Percent of U.S. Capacity (1987) | Not applicable |
| Markets Accessible to DGC (1992) | >120 MMSCFD |

DGC currently produces 180-200 MMSCFD of low BTU (40-50 Btu/SCF) waste gas that is used as an auxiliary fuel in the boilers. This stream contains about 95-96 percent $CO_2$. SI evaluated the market potential of this gas stream for $CO_2$ flooding in enhanced oil recovery applications.

The survey confirmed the potential demand of $CO_2$ in the Williston basin in Western North Dakota and eastern Montana as well as in Canada. However, this demand is contingent on crude prices. Table 2-1 lists the crude price and the respective $CO_2$ price that justify the economics of enhanced oil recovery. To justify the economics of enhanced oil recovery, the $CO_2$ price should not exceed 20-30 percent of the crude price (dollars per barrel) assuming that 7,000 SCF of $CO_2$ is used to produce one incremental barrel of crude oil.

TABLE 2-1

$CO_2$ PRICE VS. CRUDE OIL PRICE

| Year | Carbon Dioxide[1] (dollars per thousand cubic feet) | Crude Oil[2] (dollars per barrel) |
|---|---|---|
| 1983 | 1.50 | 29.35 |
| 1984 | N/A | 28.87 |
| 1985 | N/A | 26.80 |
| 1986 (Jan) | 0.80-1.50 | 25.78 |
| 1986 (Mar) | 0.40-0.60 | 14.56 |
| 1987 | | 17.54 |

[1]Price for product delivered to Denver City, Texas.
[2]Crude oil first purchase price in Texas.

Sources: Petroleum Marketing Monthly, Energy Information Administration (crude oil prices); SI estimates (carbon dioxide prices).

The assessment also reaffirmed that the $CO_2$ delivery must be via a pipeline. The construction of a pipeline, however, may pose difficulties both financially and with respect to permitting.

2.2.5.7 Argon

| | |
|---|---|
| Projected Production | 34,500 short tons/year |
| Percent of US Capacity (1987) | 7 |
| Markets Accessible to DGC (1992) | 200,000 short tons/year |

The demand for Argon has grown appreciably in the last 15-20 years and is expected to level off in the near term. The Argon market is dominated by a few major producers; Air Products, Air Liquide and Union Carbide. With appropriate market strategy DGC has good potential to penetrate and capture a fair share of the North, Southern/North Central market of the United State.

2.2.5.8 Krypton, Xenon

| | |
|---|---|
| Projected Production | 2.6 MM liters/year |
| Percent of US Capacity (1987) | 54 |
| Markets Accessible to DGC (1992) | small |

There is only limited market for these two rare gases. The projected market for Krypton is in decline while Xenon projections show an upward trend. Thus, market potential for Krypton is less than marginal, while for Xenon it is better than marginal.

2.2.6 Recommendations

SI's recommendations can be summarized as follows:

1. Current users of the chemical commodities that SI evaluat for DGC are geared to raw materials synthetically manufactured. These users will not relax specifications and will require products of equal quality than those derived from synthetics. Therefore, DGC must develop by-products upgrading processes, which assure high quality products.

2. Phenol, Argon and aromatics from naphtha are the products with the largest market potential. Therefore, primary efforts should be concentrated on developing these three commodities. Necessary purification processes should be pursued and a marketing strategy should be developed.

   The naphtha stream must be desulfurized and saturated via catalytic hydrogenation in order to make the material amenable to rail or truck transport. Secondly, a refiner for aromatics extraction should be located within reasonable distance to minimize transport costs.

3. $CO_2$ potential for enhanced oil recovery application is contingent on two essential factors: oil prices and pipeline availability. Because higher oil prices are not predicted for the near futures, $CO_2$ marketing for DGC must be considered only in the long term.

4. The marketing potential of Krypton and Xenon is marginal, and development of these two low volume commodities should not be abandoned but should receive low priority.

5. Cresols and xylenols required a firm, long term export commitment to justify their full development and marketing.

6. Creosote development should not be pursued, at least as a single product direct from tar oil.

[redacted]

APPENDIX H

LCI Report on Task 5:
Production Run Recommendation

## APPROACH TO TASK 5

### A. DEMONSTRATION RUN IN A CONVENTIONAL REFINERY

Experimental work by Amoco Research has shown that the upgrading of Tar Oil to JP-8 Aviation Turbine Fuel is possible under the following conditions:

- Staged deep hydrotreating
- 2000 psig reactor pressure
- Low space velocity (WHSV = 0.25 Overall)
- Catalyst with high denitrogenation activity

The flow system, recommended by Amoco Research (Figure 1), would be difficult to set up in U.S. refineries because the two existing expanded bed units are too large and a 10,000 Bbl test run would be contaminated by the inventory of the systems. An alternate approach, based on a modified two stage hydrocracker, should be able to provide an acceptable product. This alternate approach consists of five steps:

- Hot filtration of the Tar Oil to remove the 0.5% solids content. While most hydrocrackers have a feed filter, the amount contained in the Tar Oil is higher than petroleum vacuum gas oil and a prefiltration is advisable to ensure a smooth run.

- Operation of the hydrocracker in a recycle mode through the first stage of the hydrocracker only (which contains a denitrogenation catalyst) to remove the nitrogen, sulfur, and oxygen, and to saturate aromatics. This hydrotreating step is run with a 6/1 product/feed recycle to control heat effects and to ensure that the desired degree of hydrotreating is obtained.

- Fractionation of the hydrotreated products.

- Hydrocracking of the $550^{o}F+$ material using both stages of the hydrocracker with recycle to extinction.

- Clay treating of the jet fuel product produced.

Referring to Figure 2 and Table I, the filtration, hydrotreating and fractionation steps are as follows:

- 15,000 Bbl of Tar Oil are hot filtered and sent to storage.

- The hydrocracker is modified to permit by-passing of the second stage.

- The first stage of the hydrocracker is operated with a 6/1 recycle/feed ratio.

- The effluent is fractionated and sent to two product tanks:
  - 275/550°F Jet Fuel
  - 550°F+ Gas Oil
- The fuel gas and naphtha are sent to the refinery for further processing.
- Operation continues with recycle from the above tanks in the amounts indicated in Table I until all of the fresh Tar Oil feed is consumed.
- Operation then proceeds with feed only from the product tanks until the products in the two tanks reach the following quality goals:
  - 275/550°F Jet Fuel reaches the desired density and aromatics content.
  - 550°F+ gas oil nitrogen and oxygen content is reduced to less than 100 ppm/wt each.

Referring to Figure 3 and Table I, the hydrotreating and clay treating steps are accomplished as follows:

- The hydrocracker is returned to normal operation and charged with the hydrotreated 550°F+ gas oil. The hydrocracker operates with a 30% recycle.
- The first stage of the hydrocracker reduces the nitrogen content from less than 100 ppm/w to less than 10 ppm/w.
- The second stage of the hydrocracker converts about 70% of the fresh feed to jet fuel and naphtha per pass.
- The jet fuel fraction from the hydrocracker is combined with the jet fuel fraction from the hydrotreating step and clay treated. The feed rate to the clay treater is adjusted to obtain a 1 ft./min. superficial velocity.
- Antioxidant is added (UOP-U3444 at 2.8 PPM) and the product is sent to storage.

Assuming that the required product quality is obtained at a recycle ratio between 6/1 and 9/1 (fresh feed between 10-15% of total feed to reactor) and the desired run length for the demonstration run is about

10 days, we calculate that the hydrocracker capacity should be 6,000 - 10,000 BPSD. Allowing for turndown and allowing the test to range from 5 to 30 days, the acceptable range of hydrocracker capacity would be 3,000 - 30,000 BPSD.

With the above range in mind, Table II was prepared which lists refineries which have hydrocrackers with a capacity of 3,000 - 30,000 BPSD, and the capability of converting at least 50% of feed to lighter distillates. The refineries given in Table II should be able to meet the following conditions but this will have to be established by contract with the refineries:

1. Reactor total pressure of at least 2,000 psig.

2. Two stage hydrocracker with first stage containing desulfurization/denitrogenation catalyst.

3. First stage hydrogen addition potential of at least 500 SCF/Bbl available.

4. Ability to fractionate reactor effluent and recycle unconverted gas oil.

If it is decided to prepare 10,000 Bbl of Jet fuel from Tar Oil, then a letter should be drafted to the refineries given in Table II outlining the desired test, the requirements needed for the hydrotreating/hydrocracking step (given above), the material balance given in Table I, and requesting the refiner's interest in preparing the 10,000 Bbl of jet fuel.

## B. DEMONSTRATION RUN IN OTHER FACILITIES

In addition to the refineries listed in Table II, there are some other leads which should be investigated which could provide the proper processing conditions:

1. Syncrude Canada has high pressure hydrotreating facilities for Bitumen which could be used for processing coal tar liquids. Their address is as follows:

   Syncrude Canada Ltd.
   P. O. Bag 4023 MD 1000
   Fort McMurray AB, T9H 3H5
   Canada
   403-790-6111

2. Southern Services" Advanced Coal Liquefication Facilities have a small pilot plant (20 BPSD) which has high pressure reactors. Their address is as follows:

   Wilsonville Advanced Coal
   Liquefication Facility
   P. O. Drawer 329
   Wilsonville, Alabama 35106
   Contact: Bill Hollenack

3. Unocal had operated a Shale Oil upgrading facility in the past in Parachute Creek. No current address is available but Union Oil in Brea, California could be contacted at the following address:

   Unocal Science & Technology Division
   376 South Valencia Ave.
   Brea, California 92621
   714-528-7201
   Contact: C. P. Reeg
   V. P. of Chemical Research

4. Ashland Oil had operated the H-Coal project in Cattlesburg, Kentucky. This 600-1800 BPSD facility is now shut down. The contact is as follows:

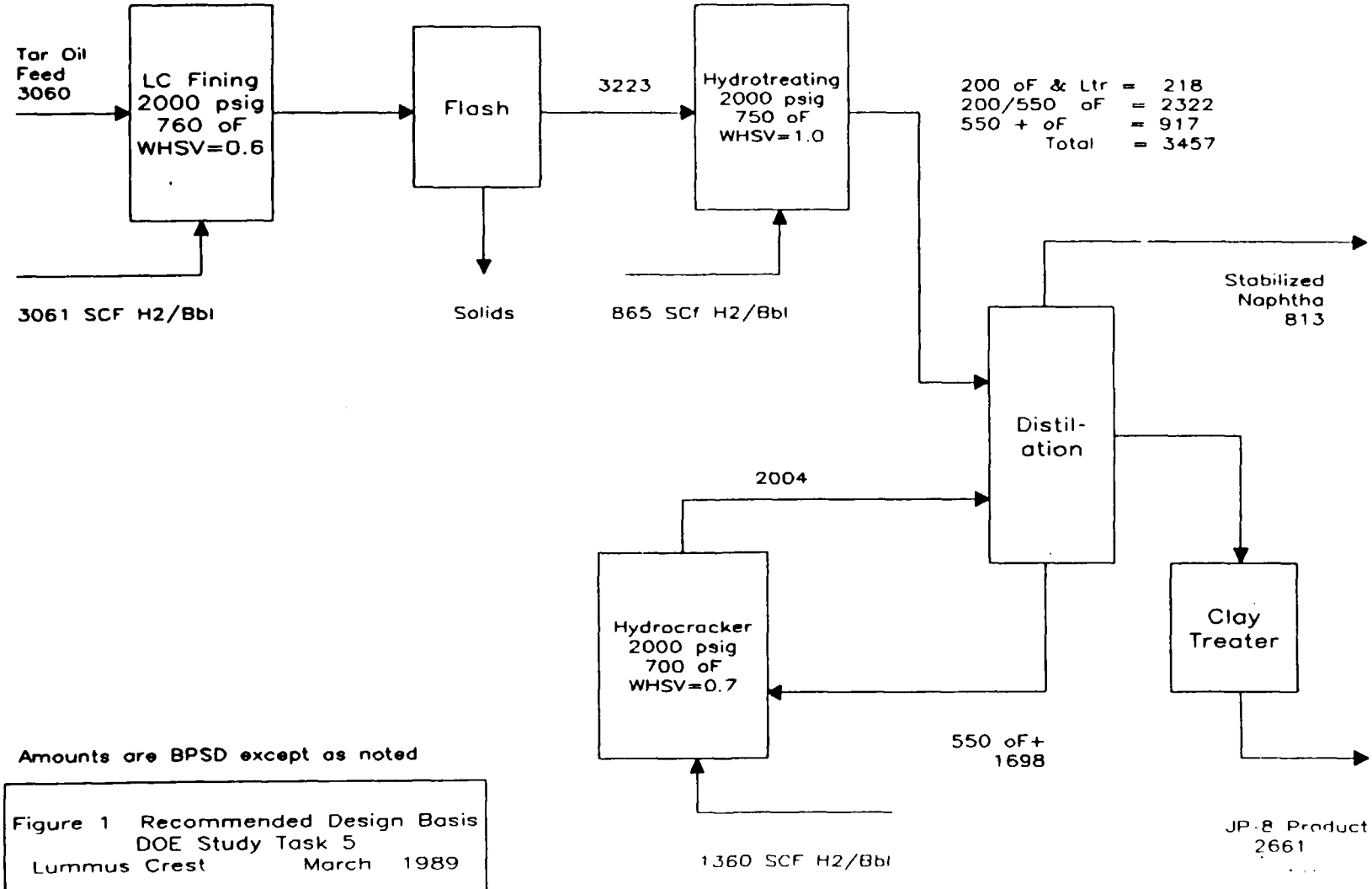
   Charles Hoertz
   President Ashland Synthetic Fuels
   2000 Ashland Drive
   Russel, Kentucky 41169
   606-329-3333

5. Gary Refining has processed Shale Oil in the past and may still have the equipment. Their address is as follows:

   Gary Refining Company
   115 Inverness Drive
   Englewood, Colorado 80112
   303-797-3800
   Contact: Victor Baraldi

6. SASOL in South Africa has hydrotreated Tar Oil in the past to produce distillate fuels.

# Figure 1 Recommended Process Design Basis




Amounts are BPSD except as noted

Figure 1 Recommended Design Basis
DOE Study Task 5
Lummus Crest March 1989

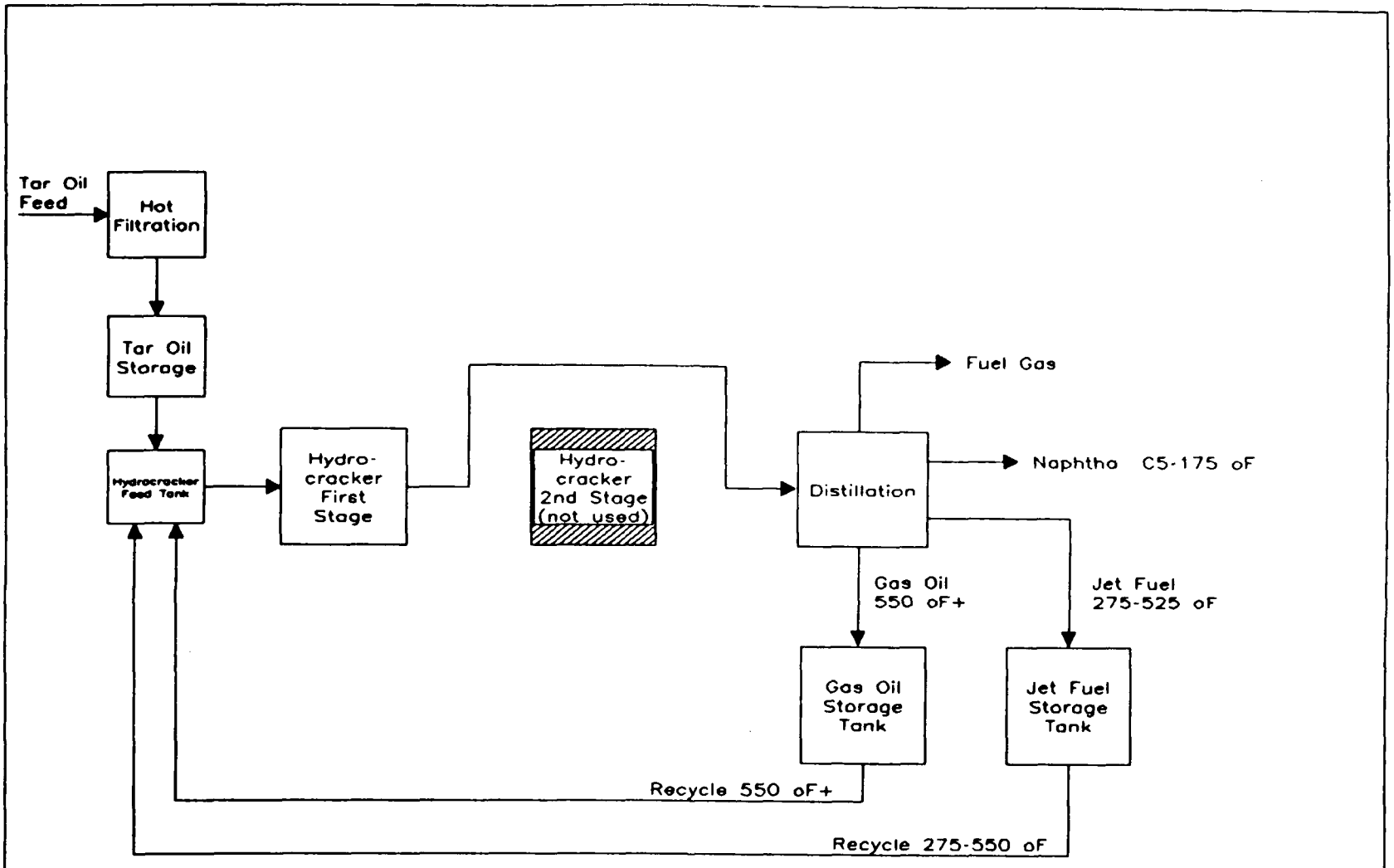



Figure 2 Hydrotreating Step
DOE Study Task 5
Lummus Crest March 1989

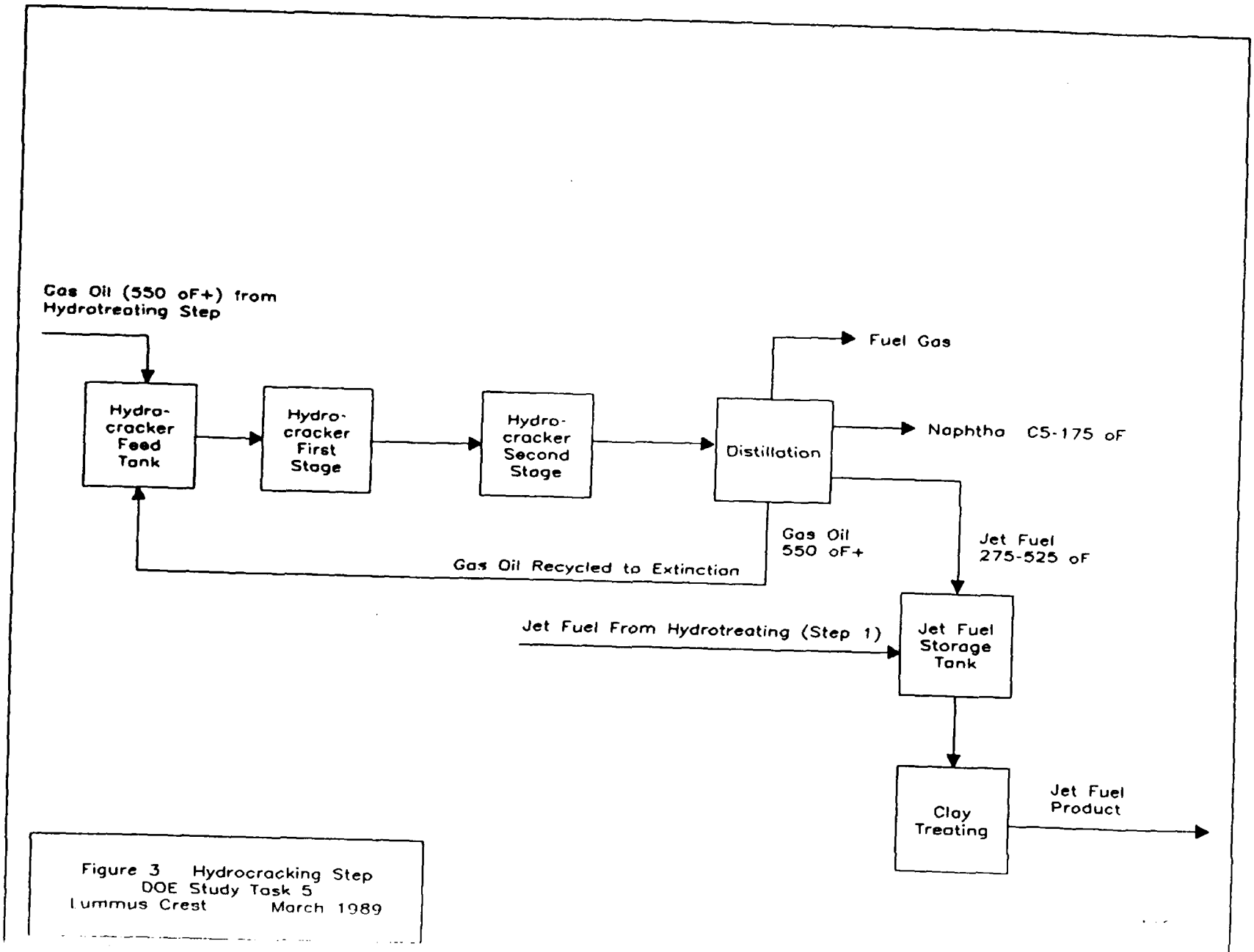



Figure 3 Hydrocracking Step
DOE Study Task 5
Lummus Crest March 1989

## Table I Estimated Material Balance For Proposed Refinery Test Run

### Step 1 Hot Filtration

Note: This step is not needed if the VGO Hydrocracker has a feed filter capable of handling 0.5% solids. It is run as a 15000 Bbl Batch and stored as feed for step 2

| Component | Wt% | Vol% | Grav | M# | Bbl | Wt% S | Wt% N | Wt% O | Wt% Solid |
|---|---|---|---|---|---|---|---|---|---|
| Feed 300/550 oF | 49.50 | 51.89 | 0.9807 | 2670.0 | 7784 | | | | 0.00 |
| Feed 550/1020 oF | 50.00 | 47.86 | 1.0840 | 2697.0 | 7179 | | | | 0.00 |
| Solids Loss | 0.50 | 0.25 | 2.0000 | 27.0 | 38 | | | | 100.00 |
| Total Feed | 100.00 | 100.00 | 1.0280 | 5393.9 | 15000 | 0.49 | 0.73 | 5.44 | 0.50 |

### Step 2 High Pressure Hydrotreating

This step uses the first stage of a two stage VGO Hydrocracker. This stage must have a NDW/NDS Catalyst,and is run initially with a 6/1 recycle ratio. Total pressure is at least 2000 Psig and the temperature is adjusted to 750 oF.

| Component | Wt% | Vol% | Grav | M#/SD | BPSD | Wt% S | Wt% N | Wt% O |
|---|---|---|---|---|---|---|---|---|
| Feed 300/550 oF | 8.03 | 7.41 | 0.9807 | 178.0 | 519 | 0.488 | 0.726 | 5.443 |
| Feed 550/1020 oF | 8.22 | 6.87 | 1.0840 | 182.4 | 481 | 0.488 | 0.726 | 5.443 |
| Recycle 275/525 oF | 41.26 | 44.49 | 0.8400 | 915.0 | 3114 | 0.000 | 0.000 | 0.000 |
| Recycle 525/1020 | 42.49 | 41.23 | 0.9335 | 942.4 | 2886 | 0.001 | 0.001 | 0.020 |
| Total Oil Feed | 100.00 | 100.00 | 0.9057 | 2217.8 | 7000 | 0.080 | 0.118 | 0.893 |
| Chemical H2(100%) | 0.90 | | | 20.0 | | | | |
| Total Feed | 100.90 | 100.00 | 0.9057 | 2237.8 | 7000 | 0.08 | 0.12 | 0.89 |
| **Total Reactor Products** | | | | | | | | |
| H2S | 0.08 | | | 1.9 | | | | |
| NH3 | 0.14 | | | 3.2 | | | | |
| H2O | 1.00 | | | 22.3 | | | | |
| C1/C4 | 1.00 | | | 22.2 | | | | |
| C5/275 oF | 2.50 | 3.14 | 0.7200 | 55.4 | 220 | | | |
| 275/525 oF | 48.33 | 52.11 | 0.8400 | 1071.9 | 3648 | 0.000 | 0.000 | 0.000 |
| 525/1020 oF | 47.84 | 46.42 | 0.9335 | 1060.9 | 3249 | 0.001 | 0.001 | 0.020 |
| Reactor Products | 100.90 | 101.67 | | 2237.8 | 7117 | 0.000 | 0.000 | 0.002 |
| **Net Products** | | | | | | | | |
| H2S | 0.52 | | | 1.9 | | | | |
| NH3 | 0.88 | | | 3.2 | | | | |
| H2O | 6.18 | | | 22.3 | | | | |
| C1/C4 | 6.15 | | | 22.2 | | | | |
| C5/275 oF | 15.38 | 22.01 | 0.7200 | 55.4 | 220 | 0.000 | 0.000 | 0.000 |
| 275/525 oF | 43.52 | 53.39 | 0.8400 | 156.9 | 534 | 0.000 | 0.000 | 0.000 |
| 525/1020 oF | 32.89 | 36.31 | 0.9335 | 118.6 | 363 | 0.001 | 0.001 | 0.020 |
| Net Products | 105.54 | 111.71 | | 380.4 | 1117 | 0.001 | 0.001 | 0.001 |

Table I Continued

Step 3 High Pressure Hydrocracking

This step uses both stages of a two stage VGO Hydrocracker.
The Hydrocracker converts 70 % of feed per pass. Total pressure is
at least 2000 Psig and the temperature is adjusted to 700 oF.

| Component | Wt% | Vol% | Grav | M#/SD | BPSD | Wt% S | Wt% N | Wt% O |
|---|---|---|---|---|---|---|---|---|
| Feed 550/1020 oF | 70.00 | 68.00 | 0.9335 | 118.6 | 363 | 0.001 | 0.001 | 0.020 |
| Recycle 525/1020 | 30.00 | 32.00 | 0.8500 | 50.8 | 171 | 0.000 | 0.000 | 0.000 |
| Total Oil Feed | 100.00 | 100.00 | 0.9068 | 169.4 | 534 | 0.001 | 0.001 | 0.014 |
| Chemical H2(100%) | 1.88 | | | 3.2 | | | | |
| Total Feed | 101.88 | | | 172.5 | | | | |
| Total Reactor Products | | | | | | | | |
| H2S | 0.00 | | | 0.0 | | | | |
| NH3 | 0.00 | | | 0.0 | | | | |
| H2O | 0.01 | | | 0.0 | | | | |
| C1/C4 | 7.00 | | | 11.9 | | | | |
| C5/275 oF | 17.50 | 20.77 | 0.7200 | 29.6 | 118 | 0.000 | 0.000 | 0.000 |
| 275/525 oF | 47.37 | 49.07 | 0.8250 | 80.2 | 278 | 0.000 | 0.000 | 0.000 |
| 525/1020 oF | 30.00 | 30.16 | 0.8500 | 50.8 | 171 | 0.000 | 0.000 | 0.000 |
| Reactor Products | 101.88 | 100.00 | 0.8107 | 172.5 | 567 | 0.000 | 0.000 | 0.000 |

Total Products from Both Hydrotreating Steps

| Component | Wt% | Vol% | Grav | M#/SD | BPSD | Wt% S | Wt% N | Wt% O |
|---|---|---|---|---|---|---|---|---|
| C5/275 oF | 26.41 | 29.38 | 0.7200 | 85.1 | 338 | 0.000 | 0.000 | 0.000 |
| 275/525 oF | 73.59 | 70.62 | 0.8349 | 237.1 | 812 | 0.000 | 0.000 | 0.000 |
| Total | 100.00 | 100.00 | | 322.2 | 1150 | 0.000 | 0.000 | 0.000 |

TABLE II

LIST OF REFINERIES WITH HYDROCRACKING CAPACITY

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Tesoro Petroleum<br>Kenai Refinery<br>Box 3691<br>Kenai, AK 99611 | Jose Verdin<br>907-776-8191 | 9,000 | Residue |
| Atlantic Richfield<br>Watson Refinery<br>Box 6210<br>Carson, CA 91749 | A. W. Johnson<br>213-548-8000 | 22,000 | Dist. |
| Chevron U.S.A.<br>Richmond Refinery<br>Box 1272<br>Richmond, CA 94802 | J. P. Krider<br>415-620-3000 | 30,000 | Residue |
| Mobil Oil<br>Torrance Refinery<br>3700 West 190th St.<br>Torrance, CA 90509-2929 | L. K. Williams<br>213-328-2550 | 21,700 | Dist. |
| Mobil Oil<br>Beaumont Refinery<br>Box 3311<br>Beaumont, TX 77704 | J. A. Jones<br>409-883-9411 | 32,000 | Dist. |
| Texaco<br>Port Arthur Refinery<br>Box 712<br>Port Arthur, TX 77640 | R. E. Anderson<br>713-982-5711 | 15,000 | Dist. |
| Texaco<br>Bakersfield Refinery<br>Box 1476<br>Bakersfield, CA 93302 | D. R. Hall<br>805-326-4200 | 14,300 | Dist. |
| Texaco<br>Los Angeles Refinery<br>Box 817<br>Wilmington, CA 90748 | R. E. Morris<br>213-835-8261 | 20,000 | Dist. |
| Tosco<br>Avon Refinery<br>Martinez, CA 94553 | J. M. Cleary<br>415-228-1220 | 23,000 | Dist. |

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Unocal<br>1660 West Anaheim St.<br>Box 758<br>Wilmington, CA 90744 | A. V. Mandlekar<br>213-513-7600 | 22,000 | Residue |
| Texaco<br>Delaware City Refinery<br>Delaware City, DE 19706 | R. C. Mifflin<br>302-834-6000 | 19,000 | |
| Hawaiian Independent<br>733 Bishop St.<br>Suite 3000, Box 3379<br>Honolulu, HI 96813 | Everett Lewis<br>808-547-3222 | 16,000 | Residue |
| Clark Oil, Blue Island<br>Division of APEX Oil<br>8182 Maryland Ave.<br>St. Louis, MO 63105 | S. A. Goldstein<br>314-889-9600 | 9,500 | Dist. |
| Marathon<br>Robinson Refinery<br>Robinson, IL 62454 | K. N. Warren<br>618-544-2121 | 23,000 | Dist. |
| Kerr-McGee<br>Wynnewood Refinery<br>Box 305<br>Wynnewood, OK 73098 | John L. Ray<br>405-665-4311 | 5,000 | Dist. |
| Total<br>Arkansas City Refinery<br>1400 South M St.<br>Arkansas City, KS 76005 | Jack Hazen<br>316-442-5100 | 3,200 | Dist. |
| Exxon<br>Baton Rouge Refinery<br>Box 551<br>Baton Rouge, LA 70821-0551 | D. H. Daigle<br>504-359-7711 | 24,000 | Dist. |
| Exxon<br>Billings Refinery<br>Box 1163<br>Billings, MT 59103-1163 | J. A. MacFarlane<br>406-657-5380 | 4,900 | Dist. |
| Exxon<br>Benica Refinery<br>3400 East 2nd St.<br>Benica, CA 94510-1097 | D. L. Wiggins<br>707-745-7011 | 29,500 | Dist. |

| Refinery Name & Address | Contact & Phone | Capacity BPSD | Feed |
|---|---|---|---|
| Sohio<br>1150 South Metcalf St.<br>Lima, OH 45804 | P. Oves<br>419-226-2300 | 23,000 | Dist. |
| Sohio<br>Toledo Refinery<br>Box 696<br>Toledo, OH 43964 | J. T. Jacobson<br>419-698-6408 | 35,000 | Dist. |
| Sohio<br>Marcus Hook Refinery<br>Box 428<br>Marcus Hook, PA 19061 | J. M. Gibson<br>215-499-7000 | 21,000 | |

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