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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DECEMBER 1989

FINAL REPORT FOR THE PERIOD MARCH 1989-DECEMBER 1989

AERO PROPULSION AND POWER LABORATORY
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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for Public Release; Distribution is Unlimited
4. PERFORMING ORGANIZATION REPORT NUMBER(S) N/A	5. MONITORING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-87-2042, Vol XII
6a. NAME OF PERFORMING ORGANIZATION Amoco Oil Company 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Wright Research and Development Center Aero Propulsion and Power Laboratory (WRDC/POSF)
6c. ADDRESS (City, State, and ZIP Code) P. O. Box 3011 Naperville, IL 60566	7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson Air Force Base, OH 45433-6563
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER FY1455-86-N0655
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO: 63216F; PROJECT NO: 2480; TASK NO: 16; WORK UNIT ACCESSION NO: 01

11. TITLE (Include Security Classification)
Production of Jet Fuels from Coal-Derived Liquids -- Vol XII--Preliminary Process Design and Cost Estimate and Production Run Recommendation

12. PERSONAL AUTHOR(S)
M. W. Furlong, J. D. Fox, J. G. Masin

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 3/89 TO 12/89	December 1989	380

16. SUPPLEMENTARY NOTATION
None

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Turbine Fuel, JP-4, JP-8, High Density Fuel, Great Plains Gasification Plant, Tar Oil, Economics, Design. (EG)
21	21	07	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

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.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL William E. Harrison, III	22b. TELEPHONE (Include Area Code): 513/255-6601 22c. OFFICE SYMBOL: WRDC/POSF

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

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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.

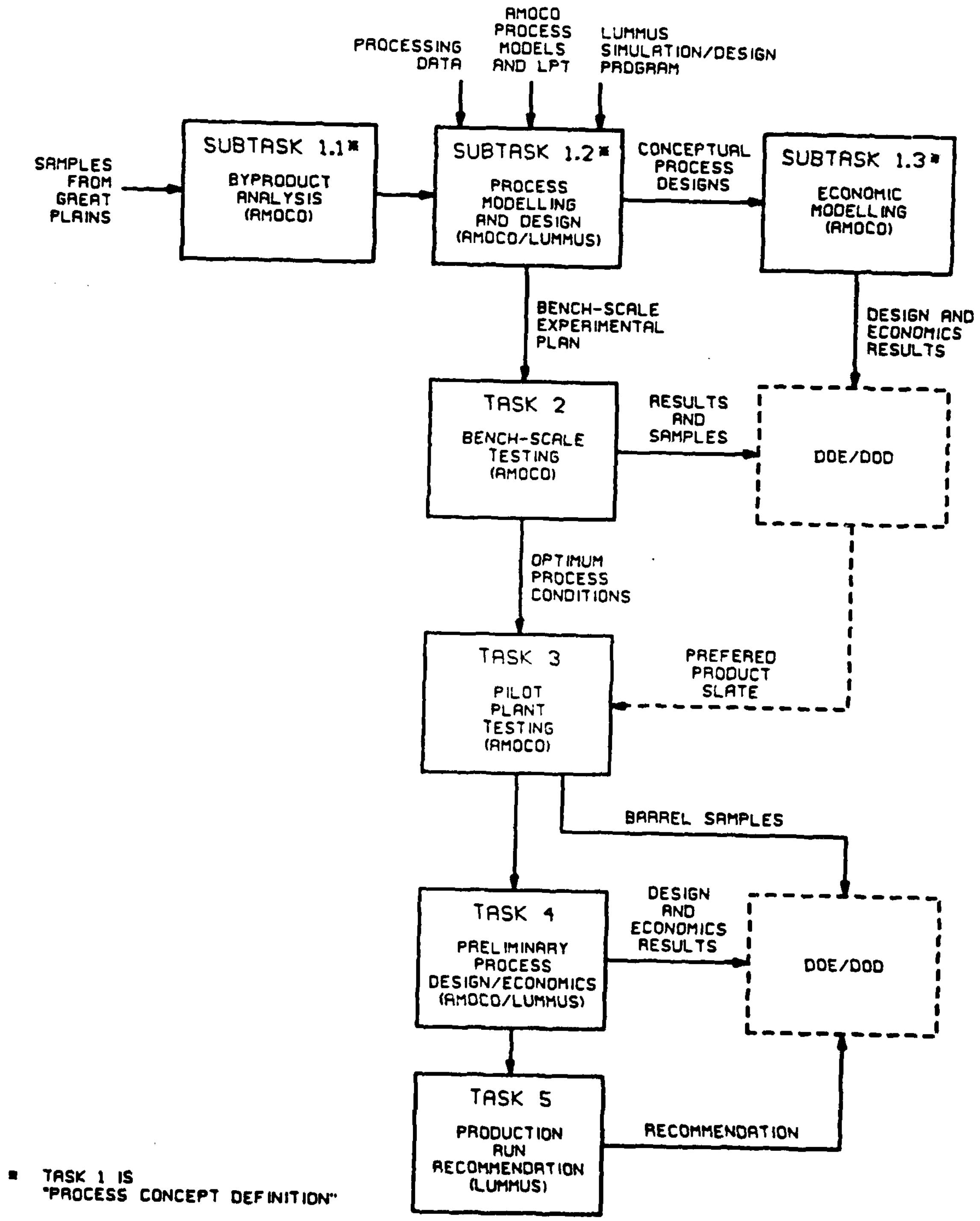

FIGURE 1
PRODUCTION OF JET FUEL FROM COAL DERIVED LIQUIDS: AMOCO/LUMMUS ACTIVITIES

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.

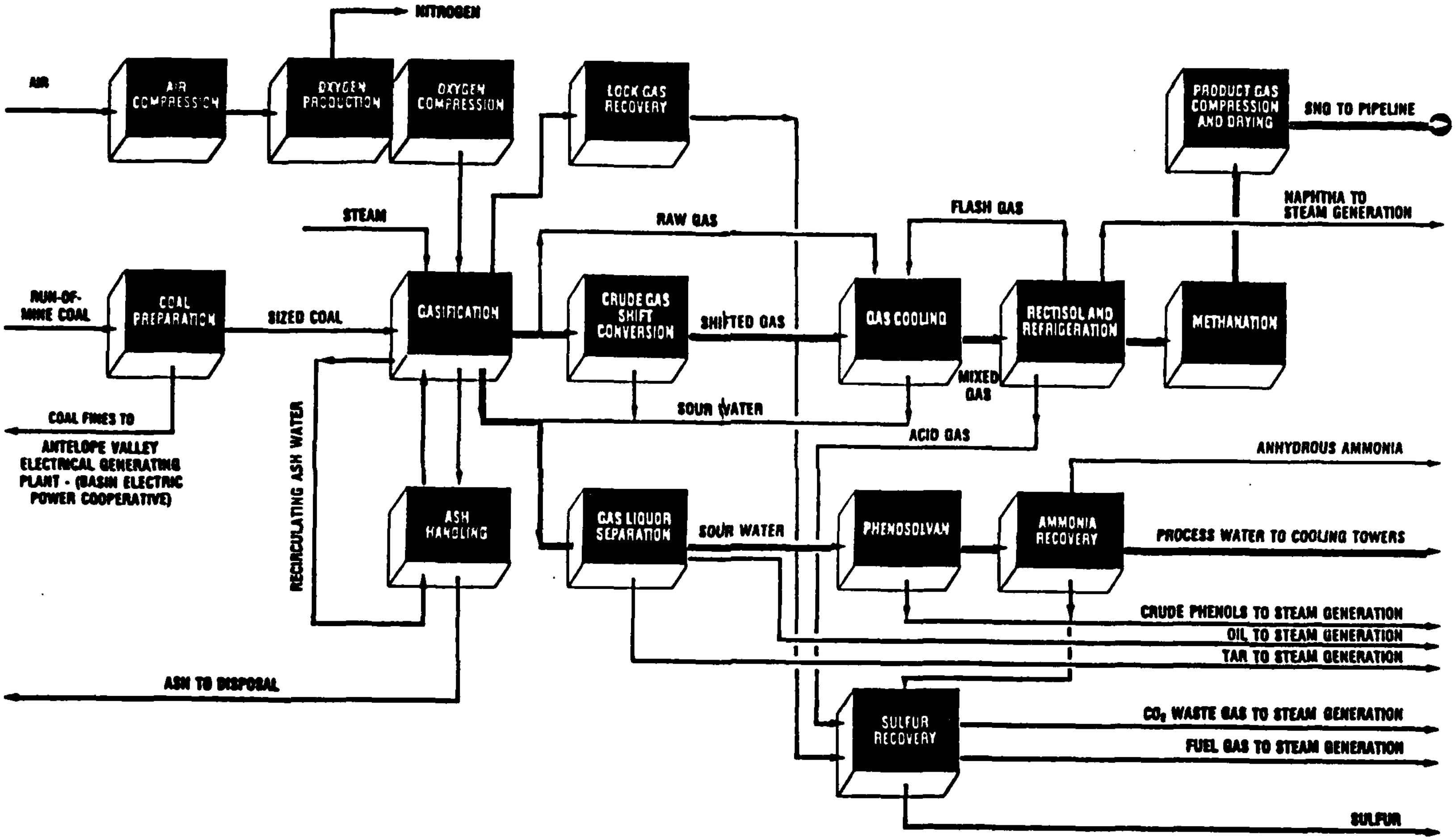

FIGURE 2. GREAT PLAINS GASIFICATION PROCESS BLOCK FLOW DIAGRAM

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.

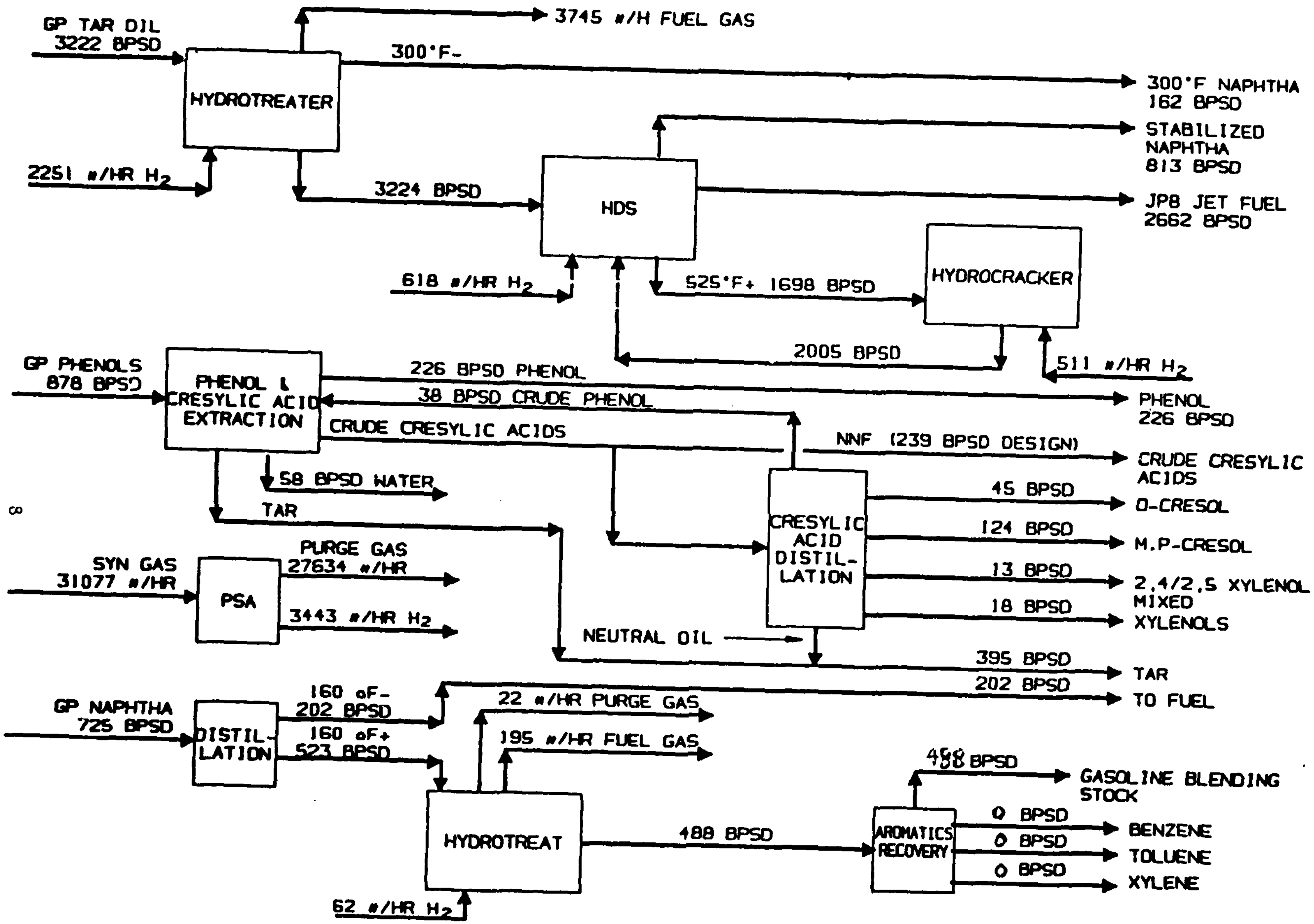

FIGURE 3: PROFITABLE JP-8 DESIGN

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

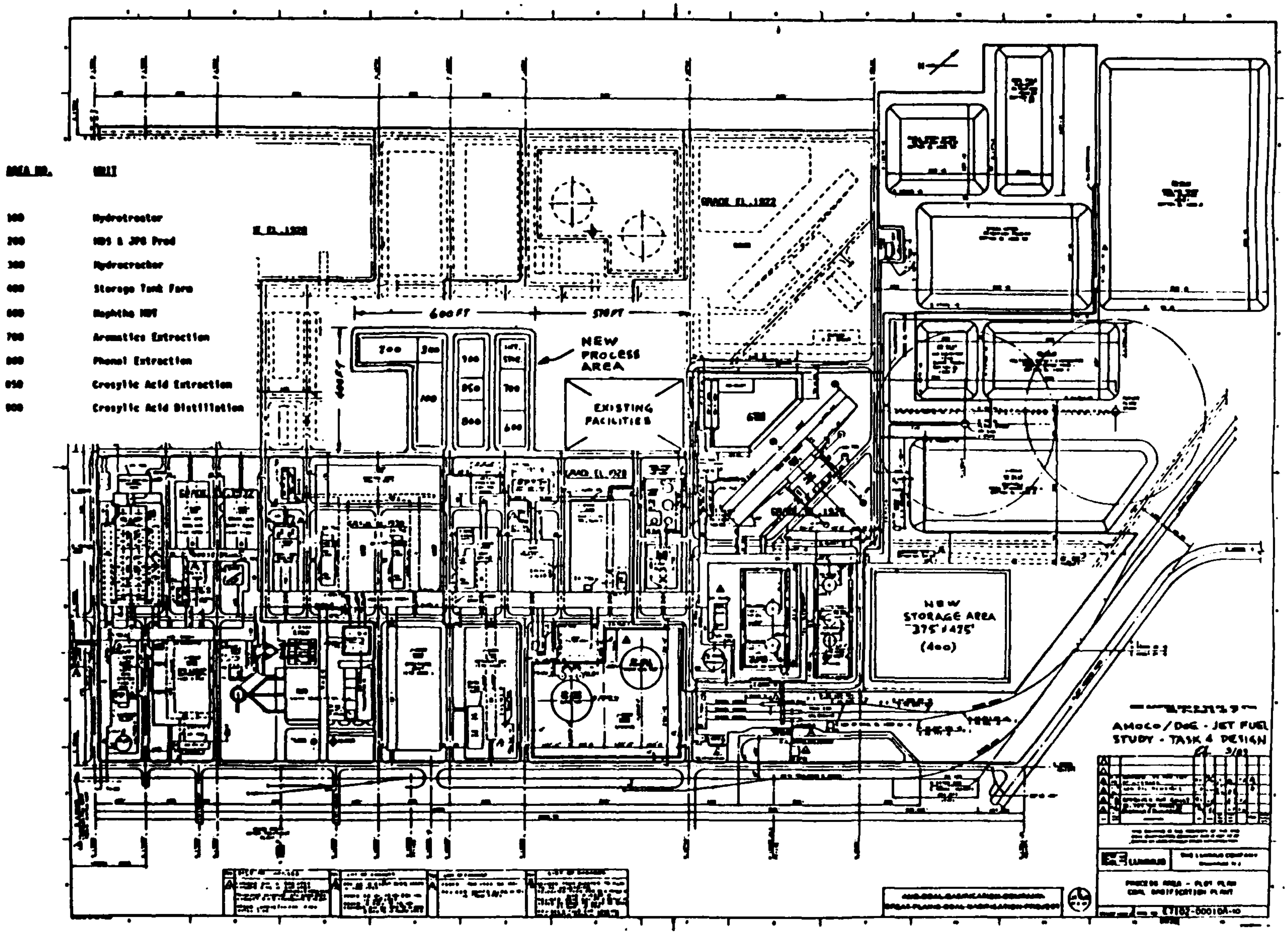

FIGURE 4: PLOT PLAN TIE-IN

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.

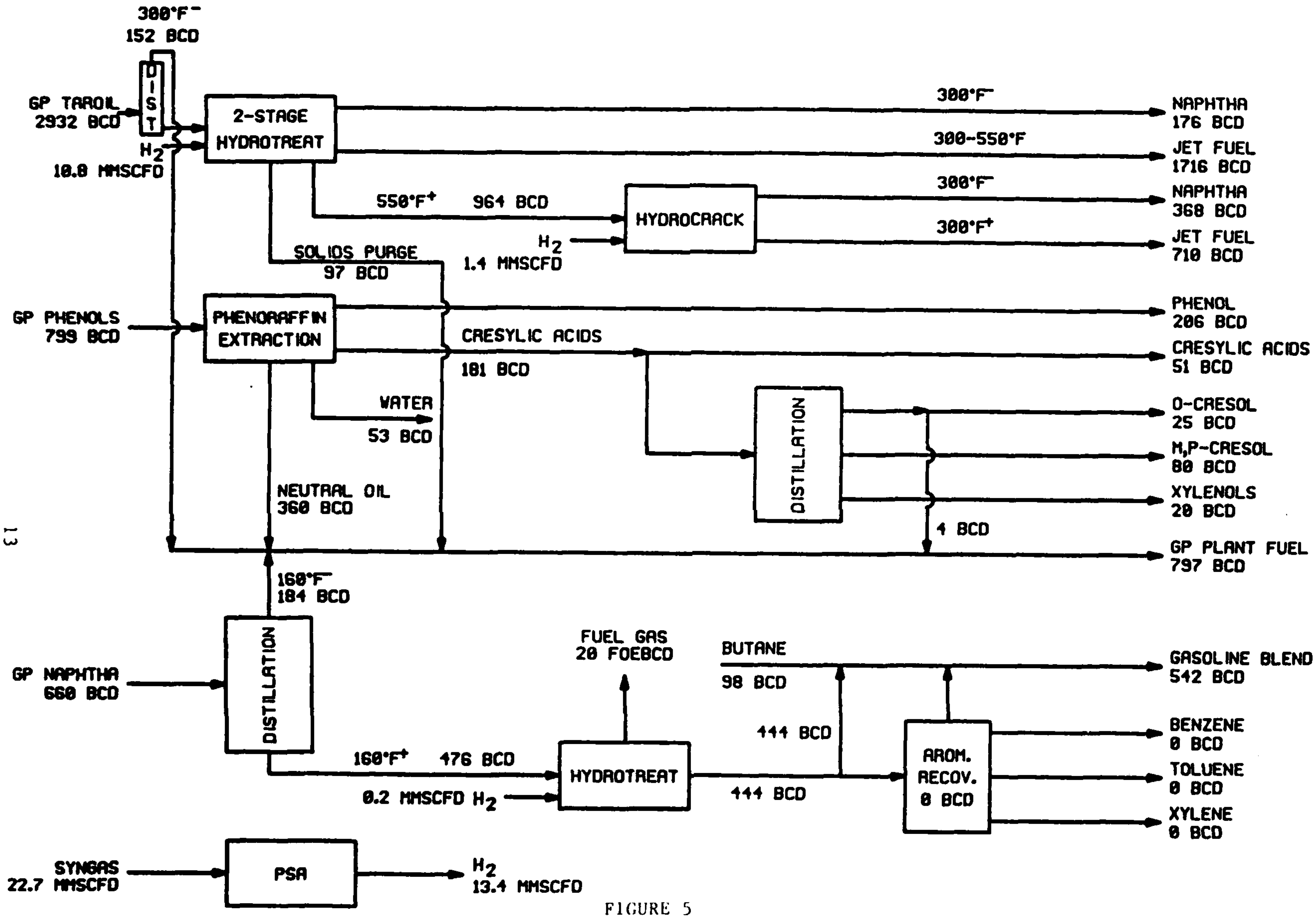

FIGURE 5

GREAT PLAINS CASE 4
BLOCK FLOW DIAGRAM
PROFITABLE JP-8

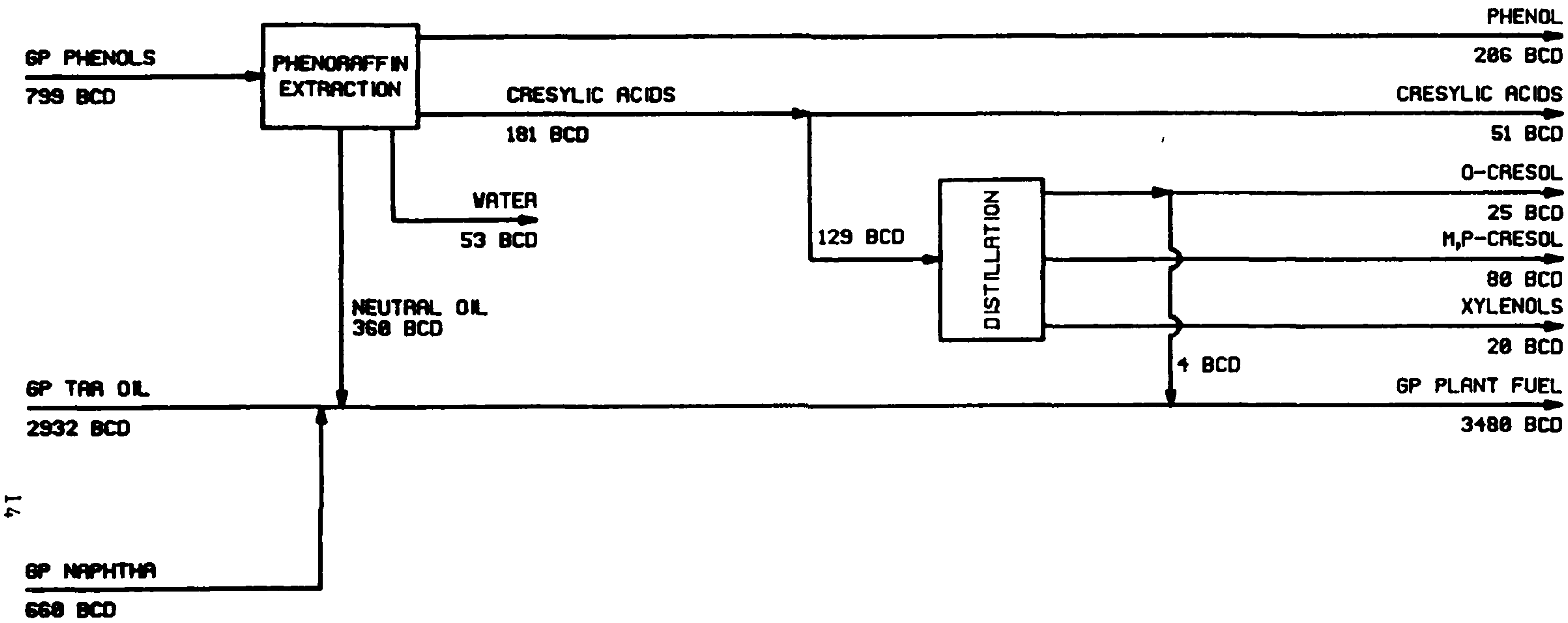

FIGURE 6
GREAT PLAINS CASE 7
BLOCK FLOW DIAGRAM
MAXIMUM PROFIT

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 Task 1	Max Profit Task 2	Profit JP-8 Task 1	Profit JP-8 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	Task 4 With ARU	Task 4 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. <u>Economics Summary</u>

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. <u>Economic Sensitivities</u>

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.

<u>Replacement Fuel Costs</u>--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

Economics	Max Profit Task 1	Max Profit Task 4	Profit JP-8 Task 1	Profit JP-8 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

Cash Flow, $M/CD	Max Profit Task 1	Max Profit Task 4	Profit JP-8 Task 1	Profit JP-8 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.

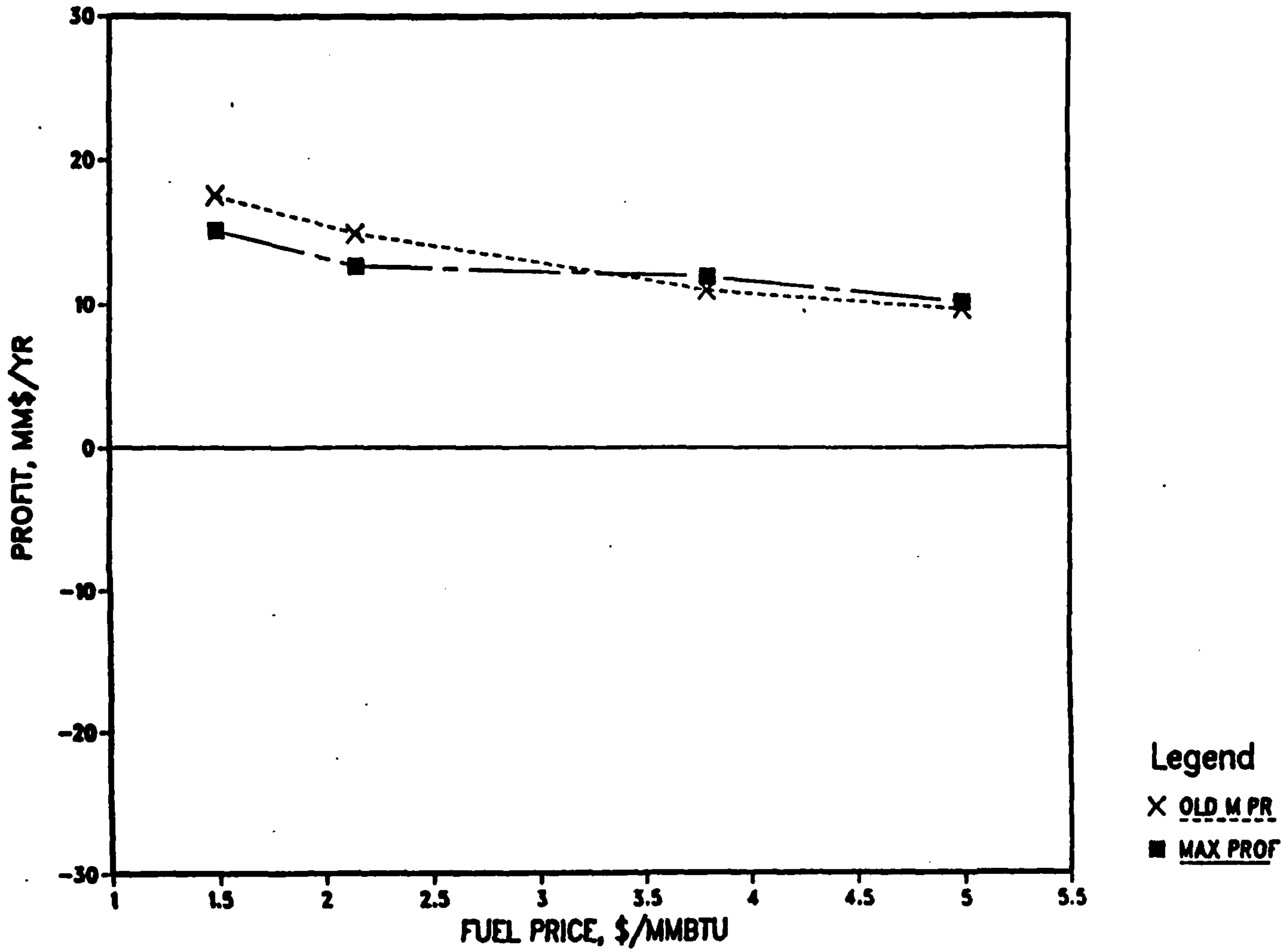

FIGURE 7
MAXIMUM PROFIT CASE
EFFECT OF FUEL PRICE

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

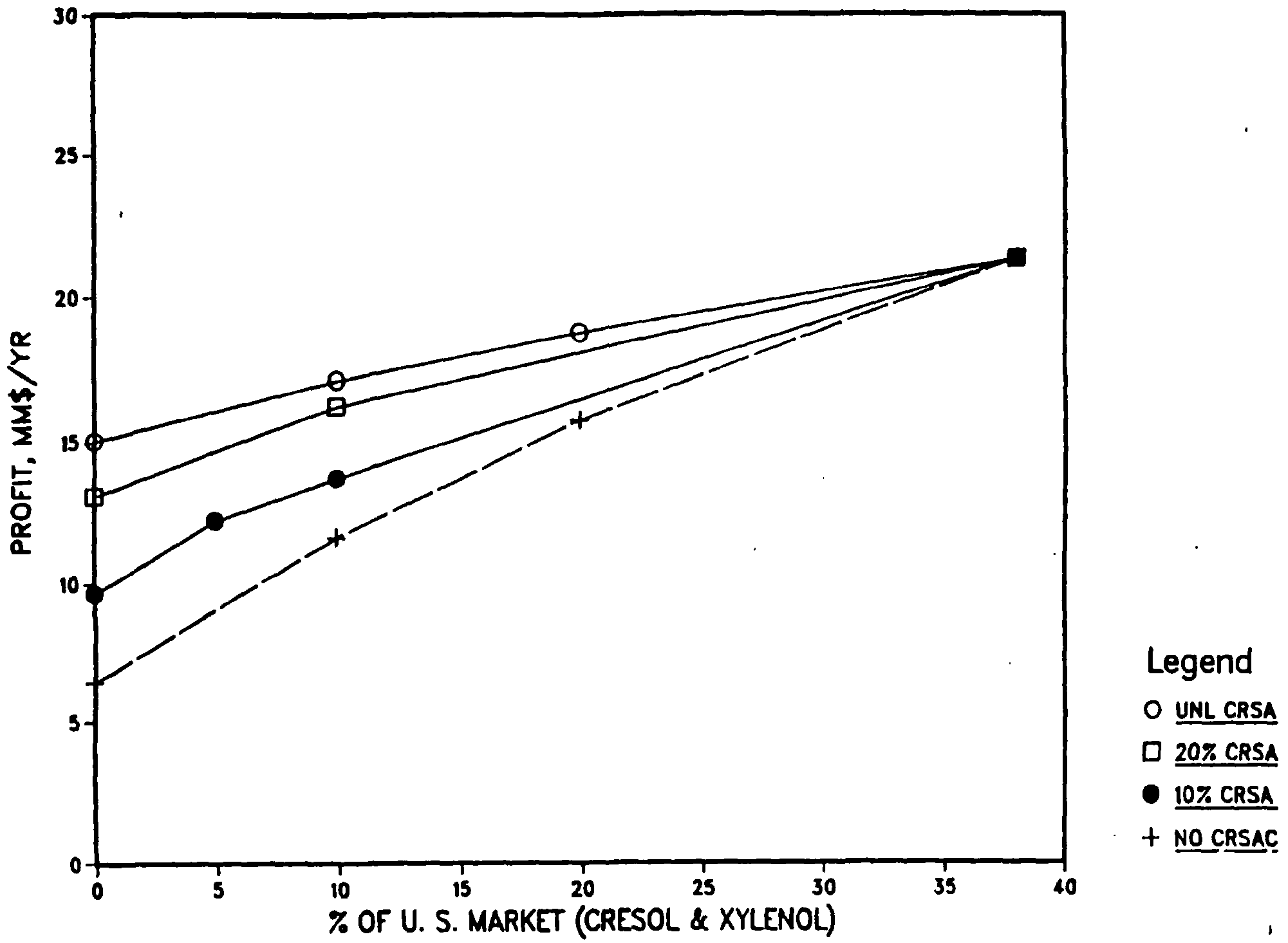

FIGURE 8
MAXIMUM PROFIT CASE
EFFECT OF CHEMICALS SALE

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

TABLE II

(Continued)

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

TABLE II

(Concluded)

Refinery Name & Address	Contact & Phone	Capacity BPSD	Feed
Sohio 1150 South Metcalf St. Lima, OH 45804	P. Oves 419-226-2300	23,000	Dist.
Sohio Toledo Refinery Box 696 Toledo, OH 43964	J. T. Jacobson 419-698-6408	35,000	Dist.
Sohio Marcus Hook Refinery Box 428 Marcus Hook, PA 19061	J. M. Gibson 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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1. Smith, E. B., "Jet Fuels from Coal; Third Quarterly Report," U.S. Department of Energy Research Contract No. DE-FC21-86MC11076, May 1987.

2. Sinor, J. E., "Production of Jet Fuel from Coal-Derived Liquids, Vol 1, Market Assessment for Liquid By-Products from the Great Plains Gasification Plant," AFWAL-TR-87-2042, August 1987.

3. Fleming, B. A., et al., "Production of Jet Fuels From Coal-Derived Liquids, Vol VI, Preliminary Analysis of Upgrading Alternatives for the Great Plains Liquid By-Product Streams," AFWAL-TR-87-2042, September 1988.

4. Furlong, M. W., et al., "Production of Jet Fuels from Coal-Derived Liquids, Vol IX, Results of Bench-Scale and Pilot Plant Testing," AFWAL-TR-87-2042, Vol IX, June 1989.

5. U.S. Department of Energy, Contract No. DE-RP-22-86PC90015, "Production of Jet Fuel from Coal-Derived Liquids," Effective May 1, 1987.

6. Gary, J. H., and G. E. Handwerk, "Petroleum Refining Technology and Economics," Marcel Dekker, Inc., 1984, page 140.

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°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°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°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^oF, 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^{o}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	

CS5571-1.txt

1.3 Overall Utility Balance

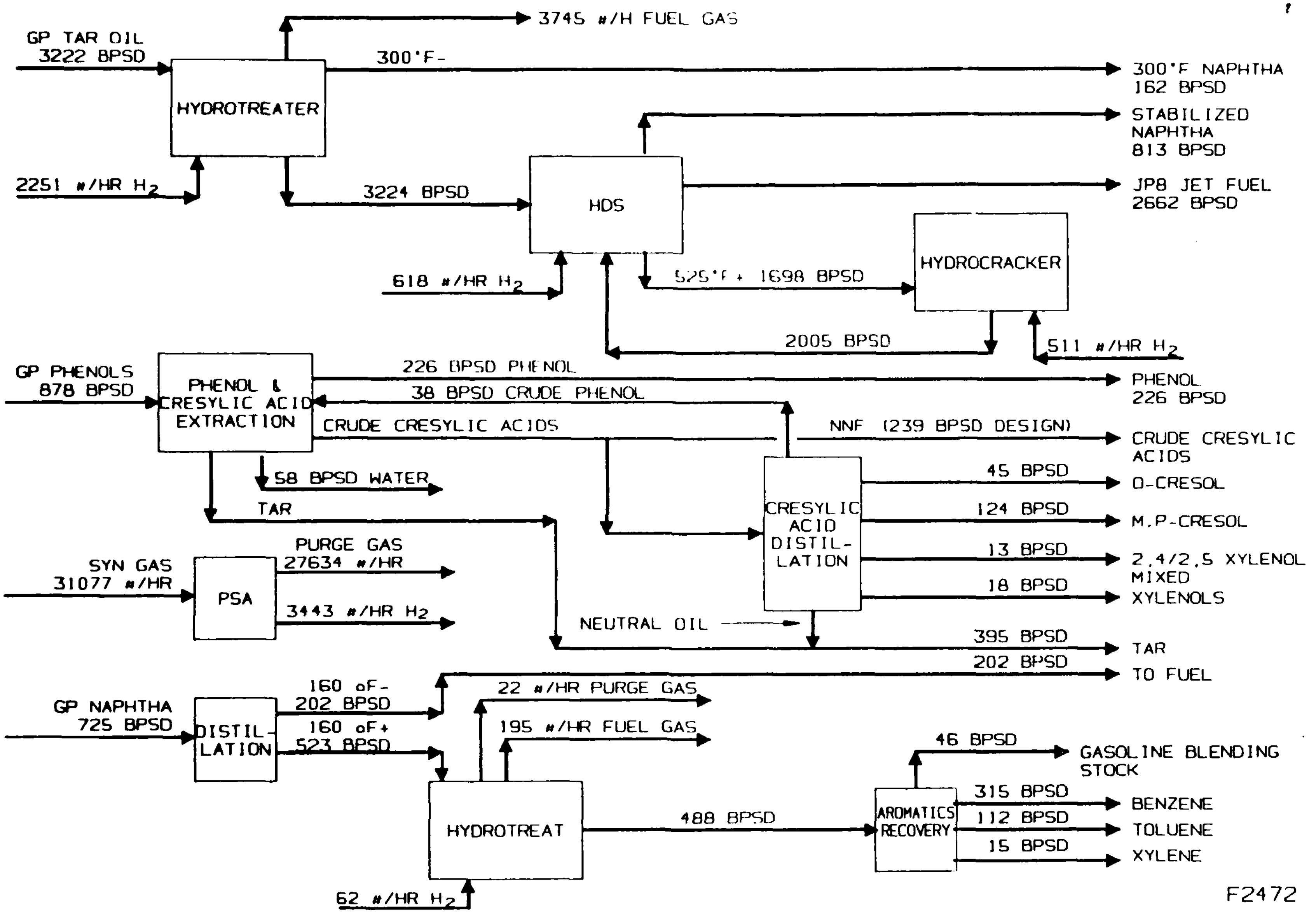
The overall utility consumption of the complex is as follows:

#6 Fuel Oil	4290 BPSD
SNG Equipment of Syn Gas & Purge Gas	4.13 MMSCFD
Power	7950 kW
Cooling Water	8860 GPM (30°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

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°F- components which are sent back to the SNG plant to be used as fuel.

- The 300°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°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 $80^{\circ}F$.

- 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.

<u>Table 2.1.2 HDS Reactor Operation</u>

Reactor Type	Fixed Bed
Number of Reactors	1
Number of Beds/Reactor	2
Catalyst per Bed	Bed 1 1/3
	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%
H_2		63.19
CO		18.61
CO_2		1.48
CH_4		16.21
C_2H_6		0.31
COS, H_2S, CS_2		< 0.01
N_2 + Ar		0.19
H_2O		< 0.01

Purge Gas

Pressure	5 psig
Temperature	100 °F
Composition	Mol %
H_2	19.32
CO	40.76
CO_2	3.24
CH_4	35.51
C_2H_6	0.69
N_2+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^{o}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.

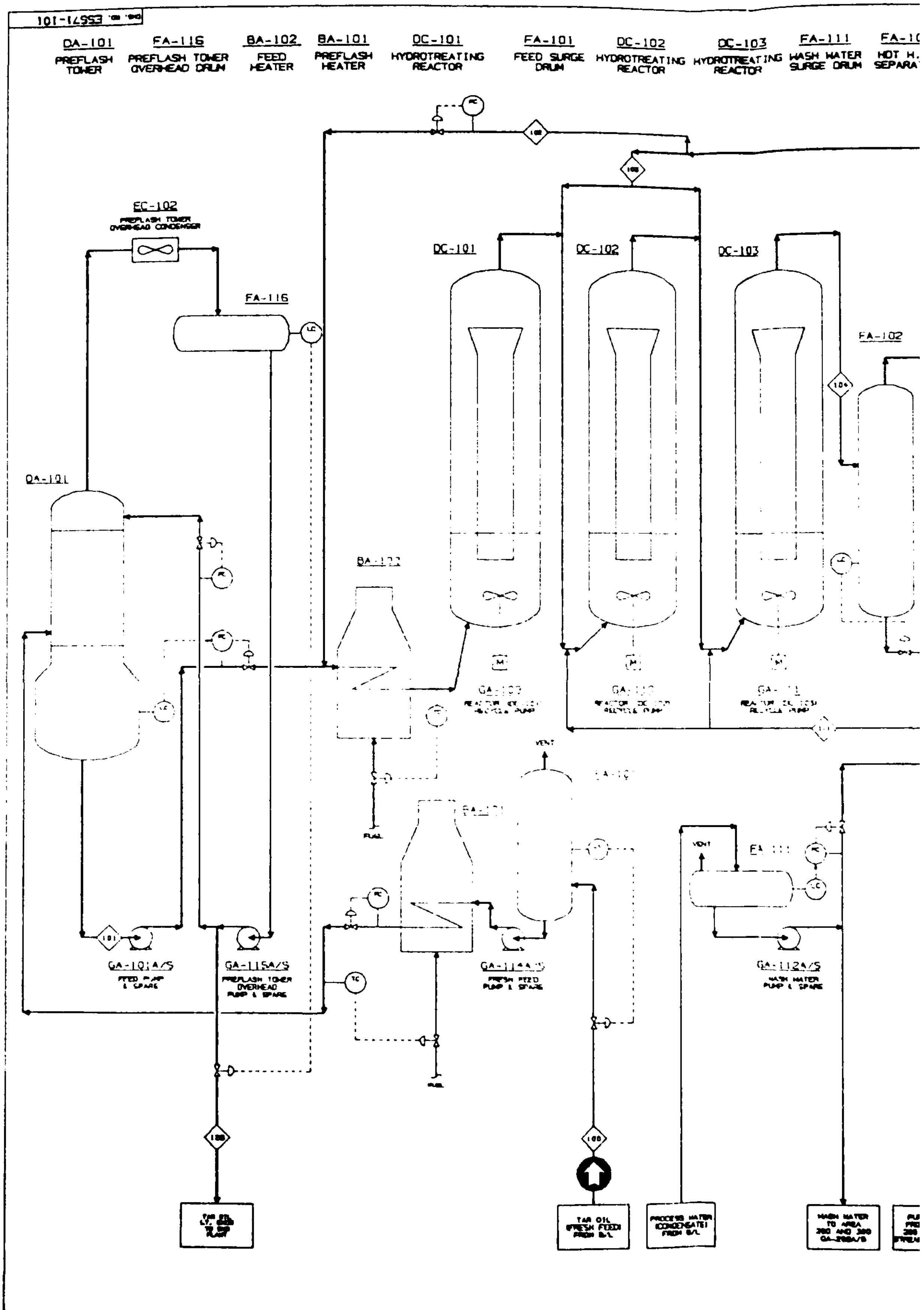
Table 2.1.4 HCR Operating Conditions

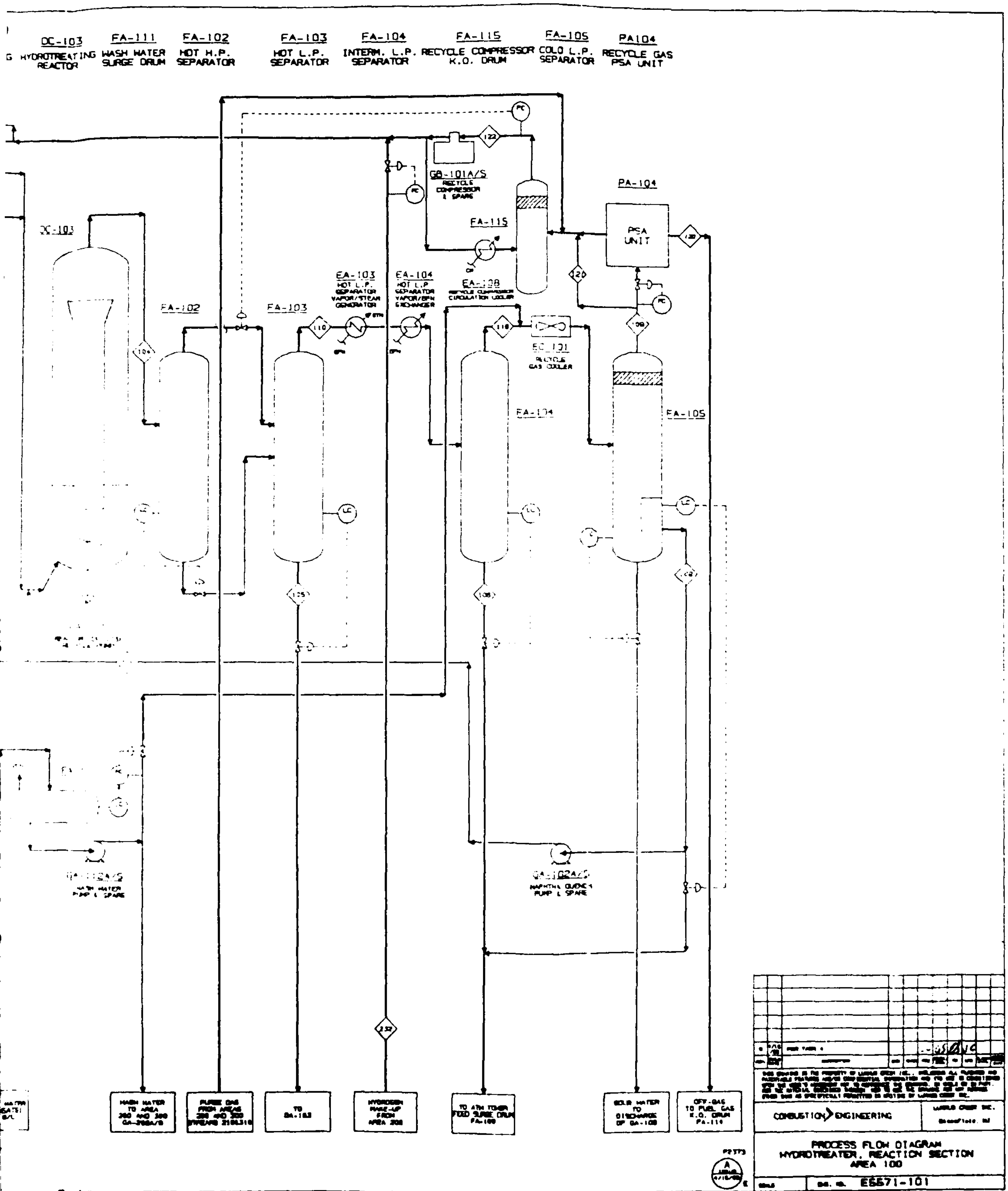
Reactor Type	Fixed Bed
Number of Reactors	1
Number of Beds/Reactor	5
Catalyst per Bed	10% Bed 1 22.5 % Beds 2-5
WHSV, HR^{-1}	0.7
Hydrogen Chemical Consumption	SCF/BBl 1123
Reactor Pressure (outlet)	1700 psia
H_2 Partial Pressure (outlet)	1441 psia
Hydrogen Recycle Rate SCF/BBl	6973 (excluding quench)
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)


DWG. NO. E5571-101
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
DC-101
DC-102
DC-103
FA-102
DA-101
GA-101A/S
FEED PUMP & SPARE
GA-115A/S
PREFLASH TOWER OVERHEAD PUMP & SPARE
GA-112A/S
WASH WATER PUMP & SPARE
VENT
FUEL
TAR OIL FRESH FEED FROM B/L
PROCESS WATER (CONDENSATE) FROM B/L
WASH WATER TO AREA 200 AND 300 GA-208A/S



B-12

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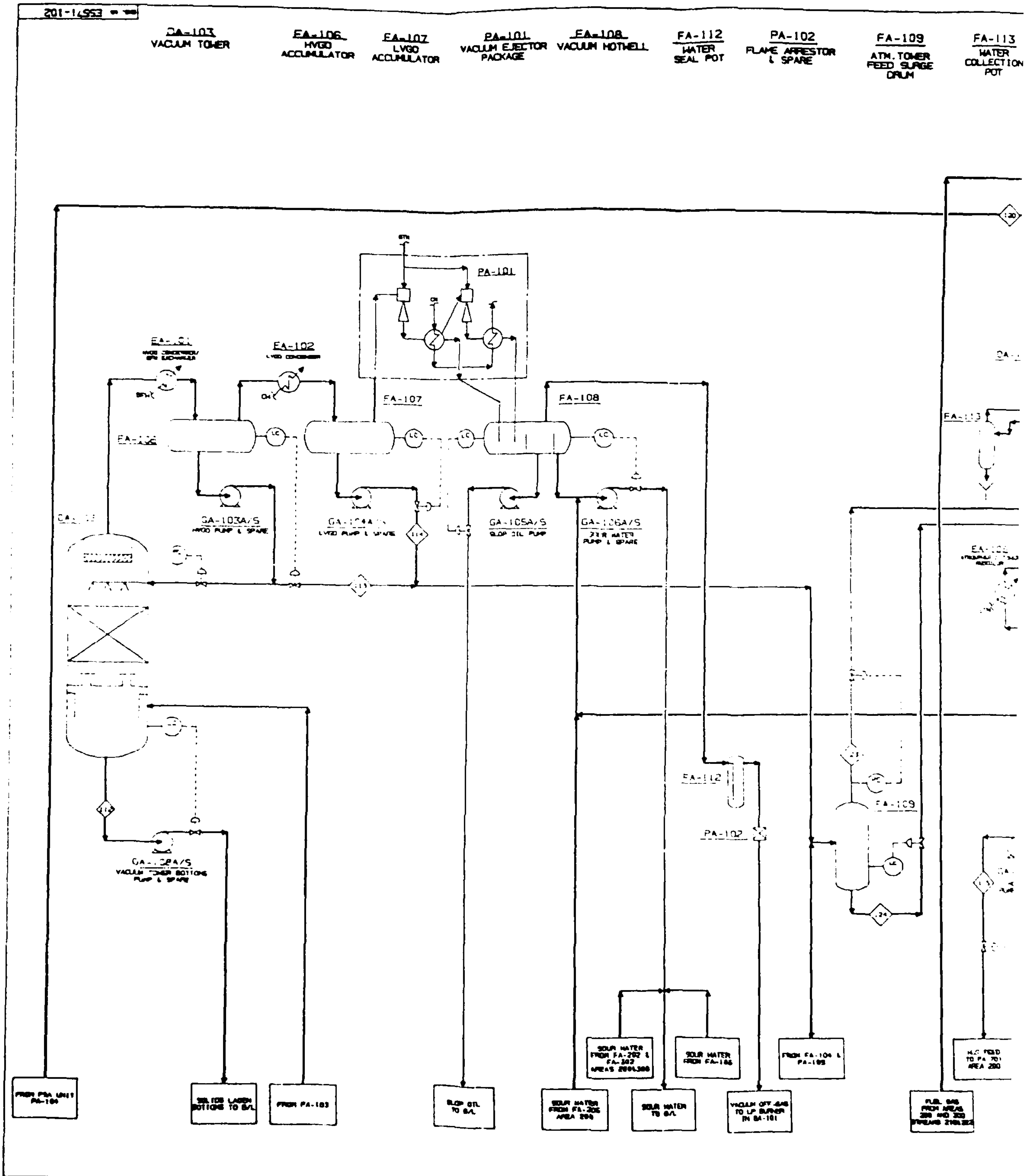
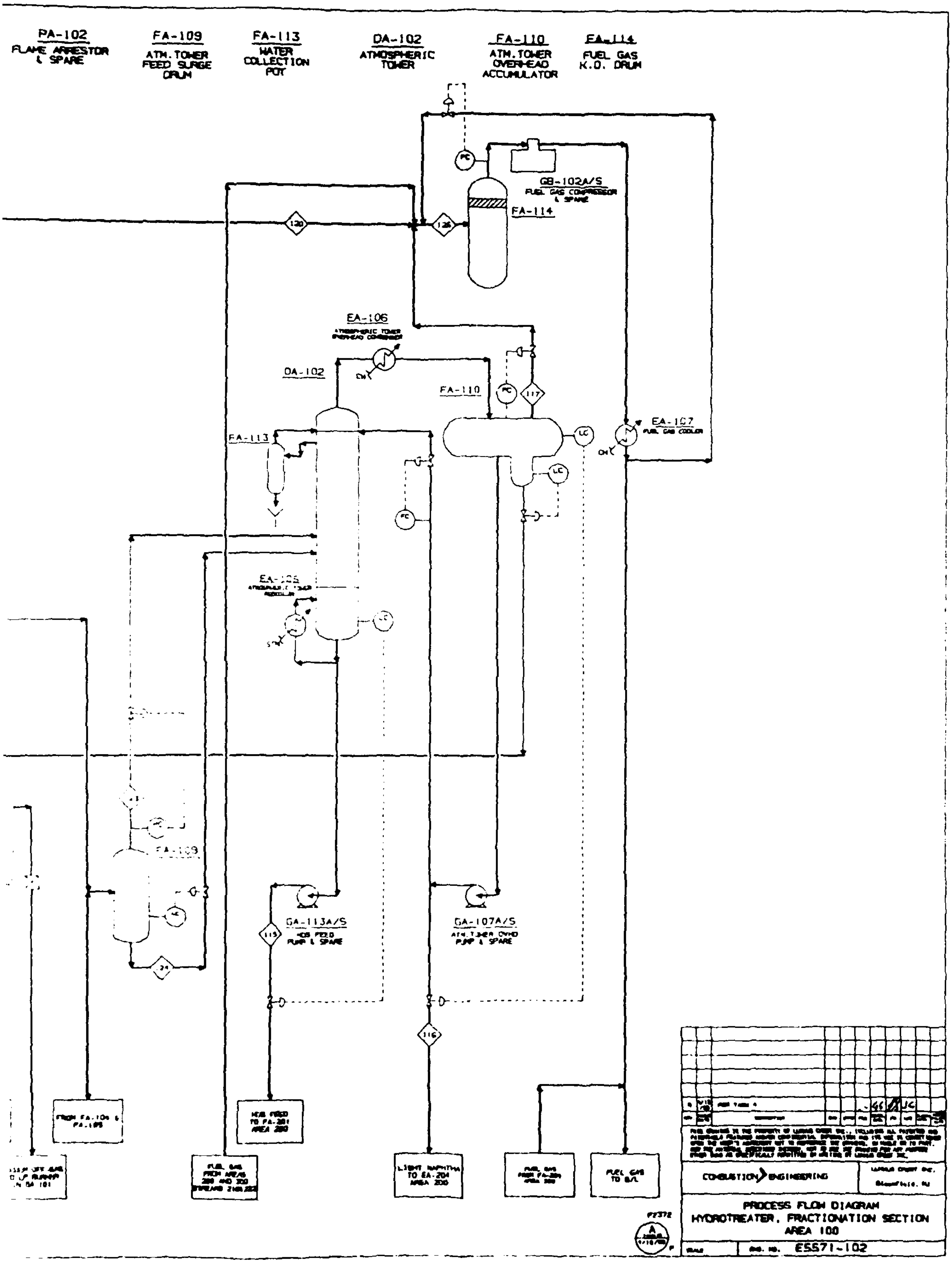


DA-103 VACUUM TOWER
EA-106 HVGO ACCUMULATOR
EA-107 LVGO ACCUMULATOR
PA-101 VACUUM EJECTOR PACKAGE
EA-108 VACUUM HOTWELL
FA-112 WATER SEAL POT
PA-102 FLAME ARRESTOR & SPARE
FA-109 ATM. TOWER FEED SURGE DRUM
FA-113 WATER COLLECTION POT
PA-101
EA-102
FA-107
FA-108
GA-103A/S
HVGO PUMP & SPARE
GA-105A/S
SLOP OIL PUMP
FA-112
PA-102
FA-109
FROM PSA UNIT PA-104
FROM PA-103
SLOP OIL TO B/L
SOUR WATER TO B/L
VACUUM OFF GAS TO LP BURNER IN BA-101
FUEL GAS FROM AREAS 200 AND 300

DATE: 04/21/89



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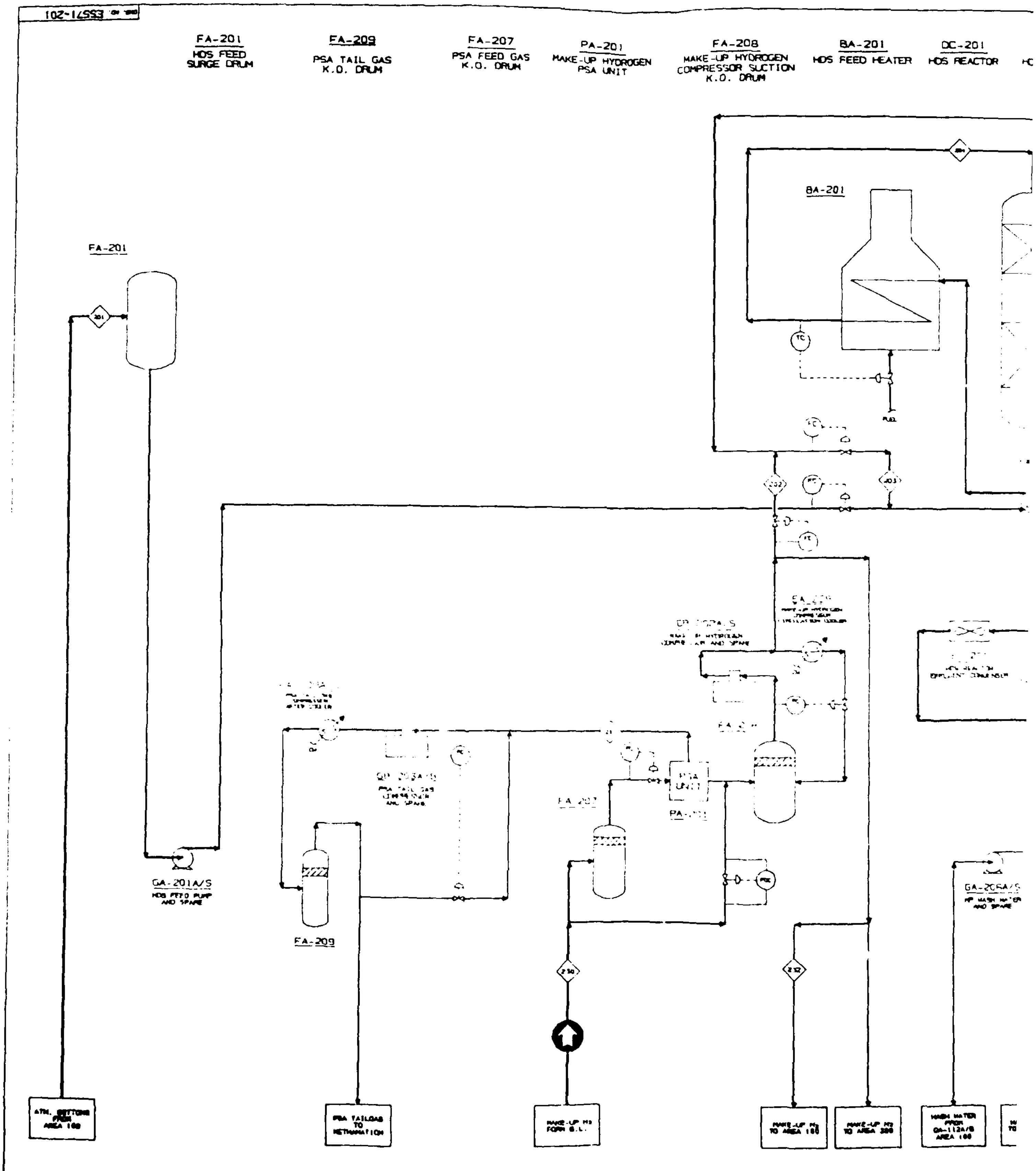
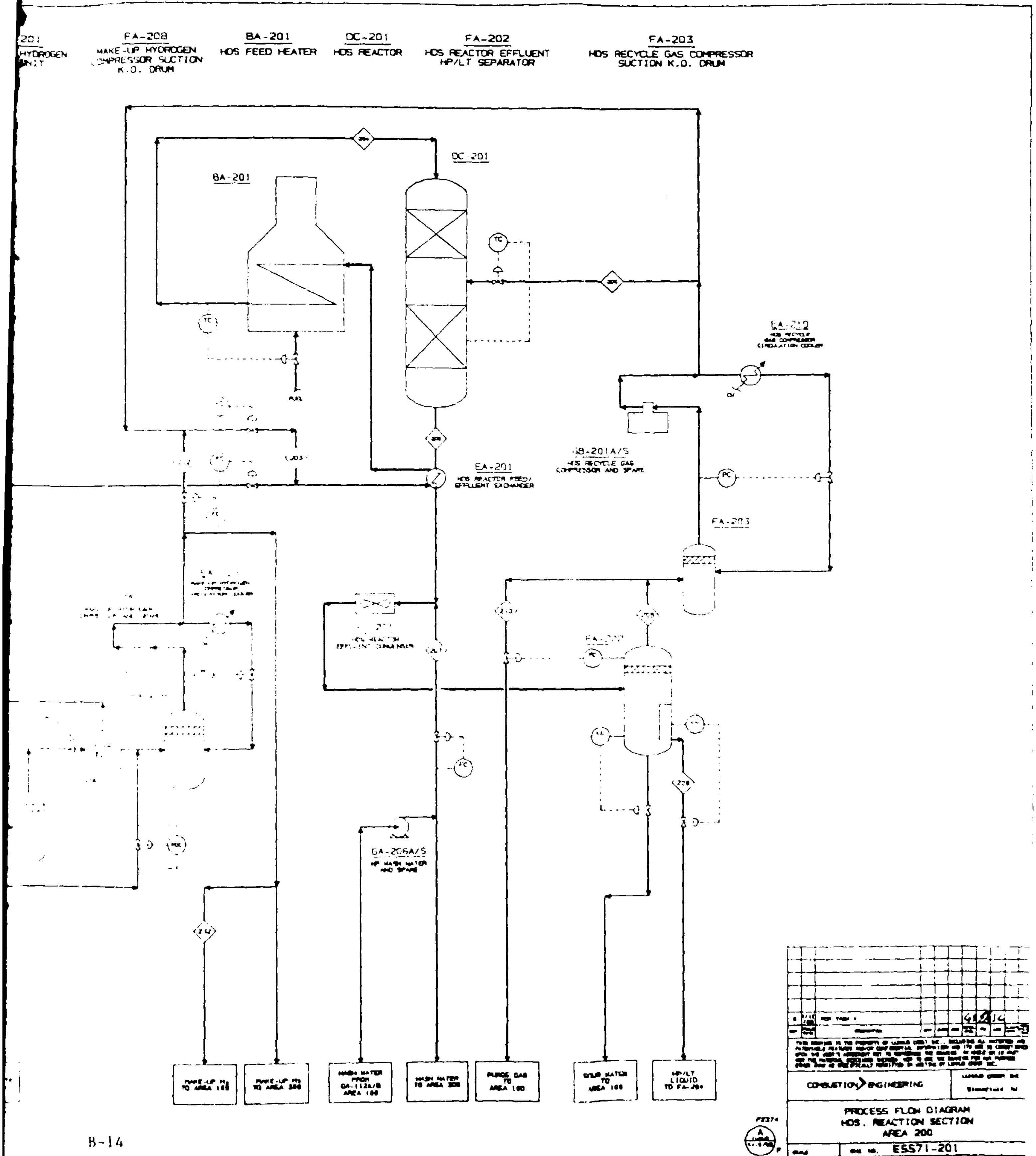
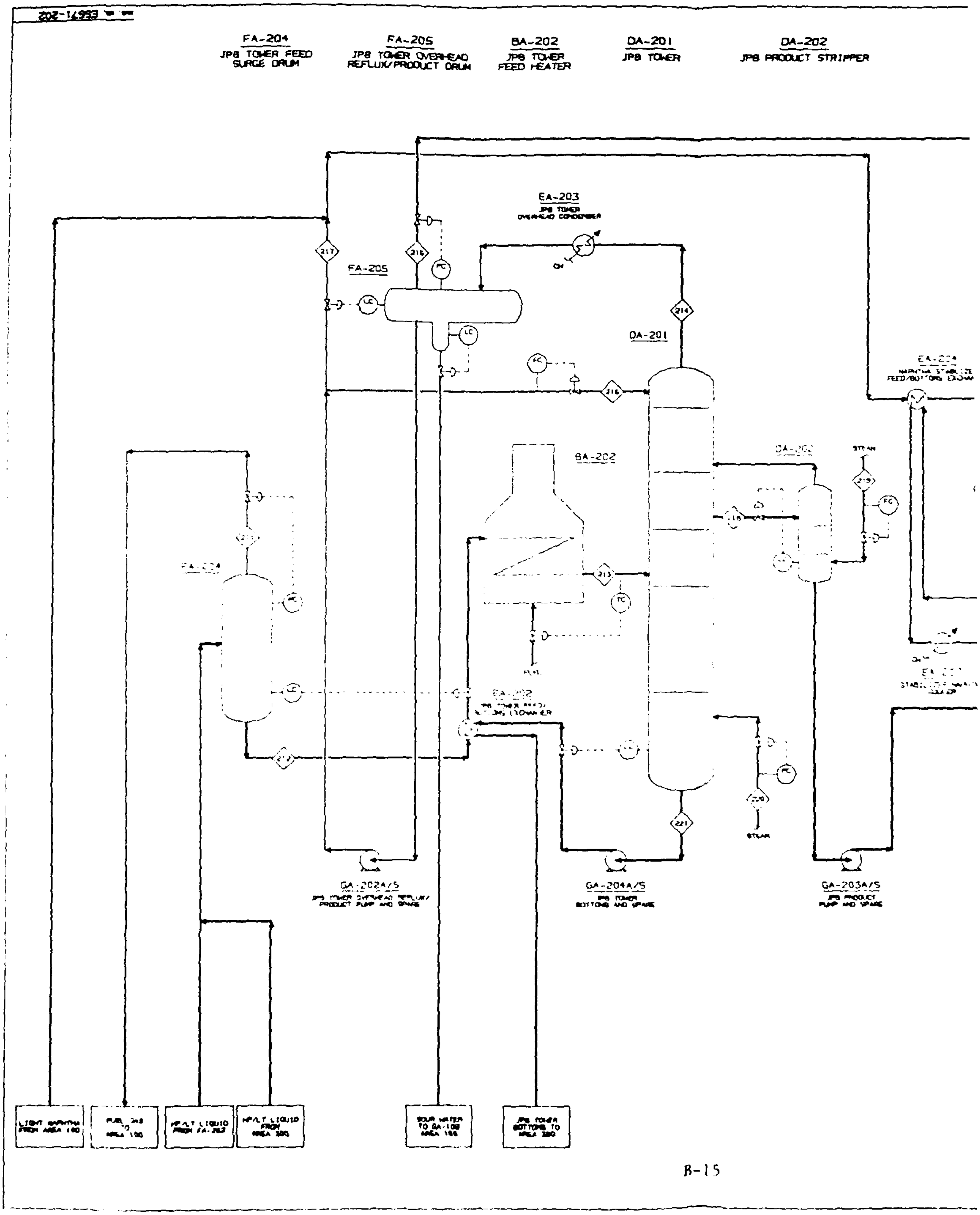
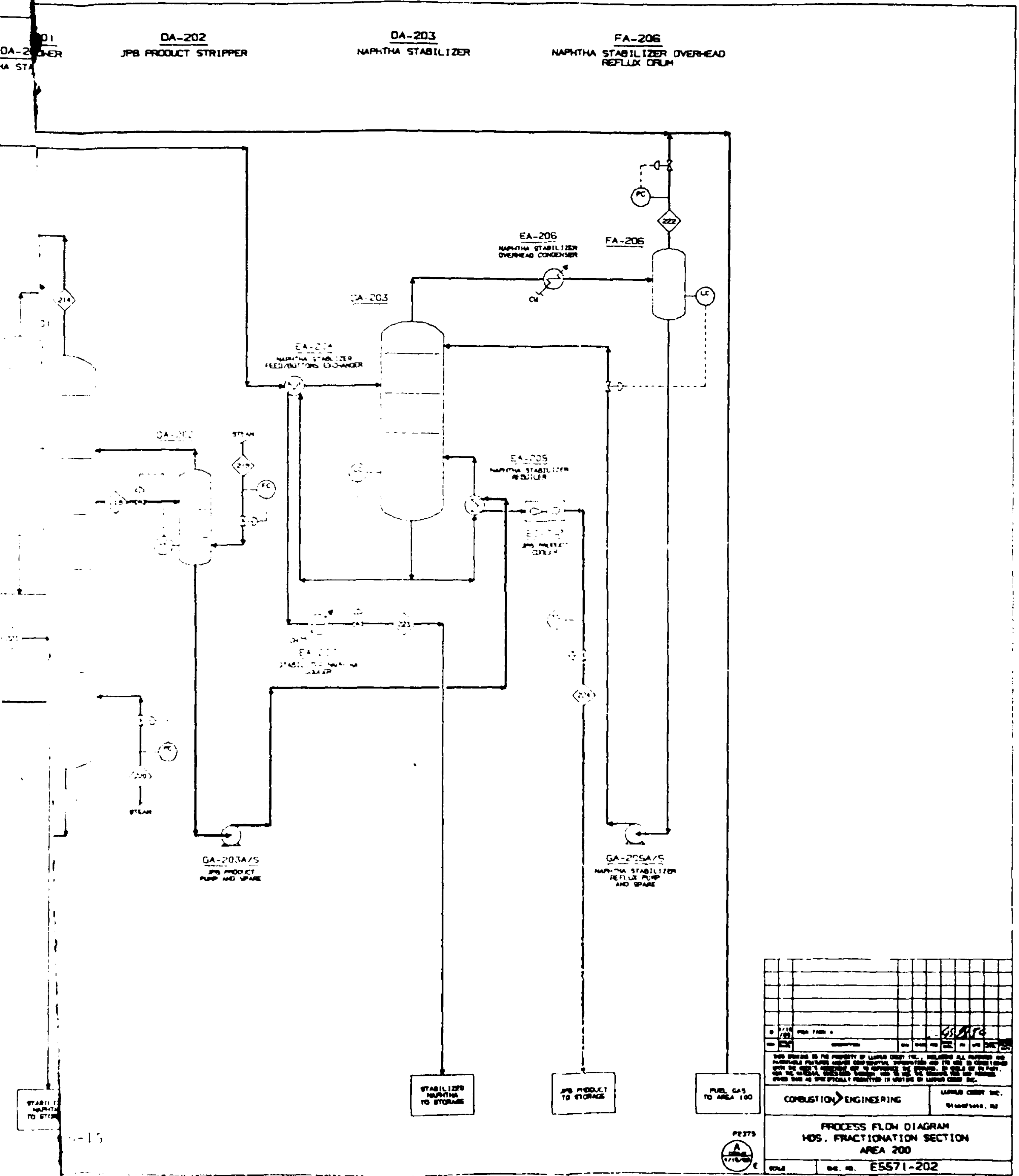
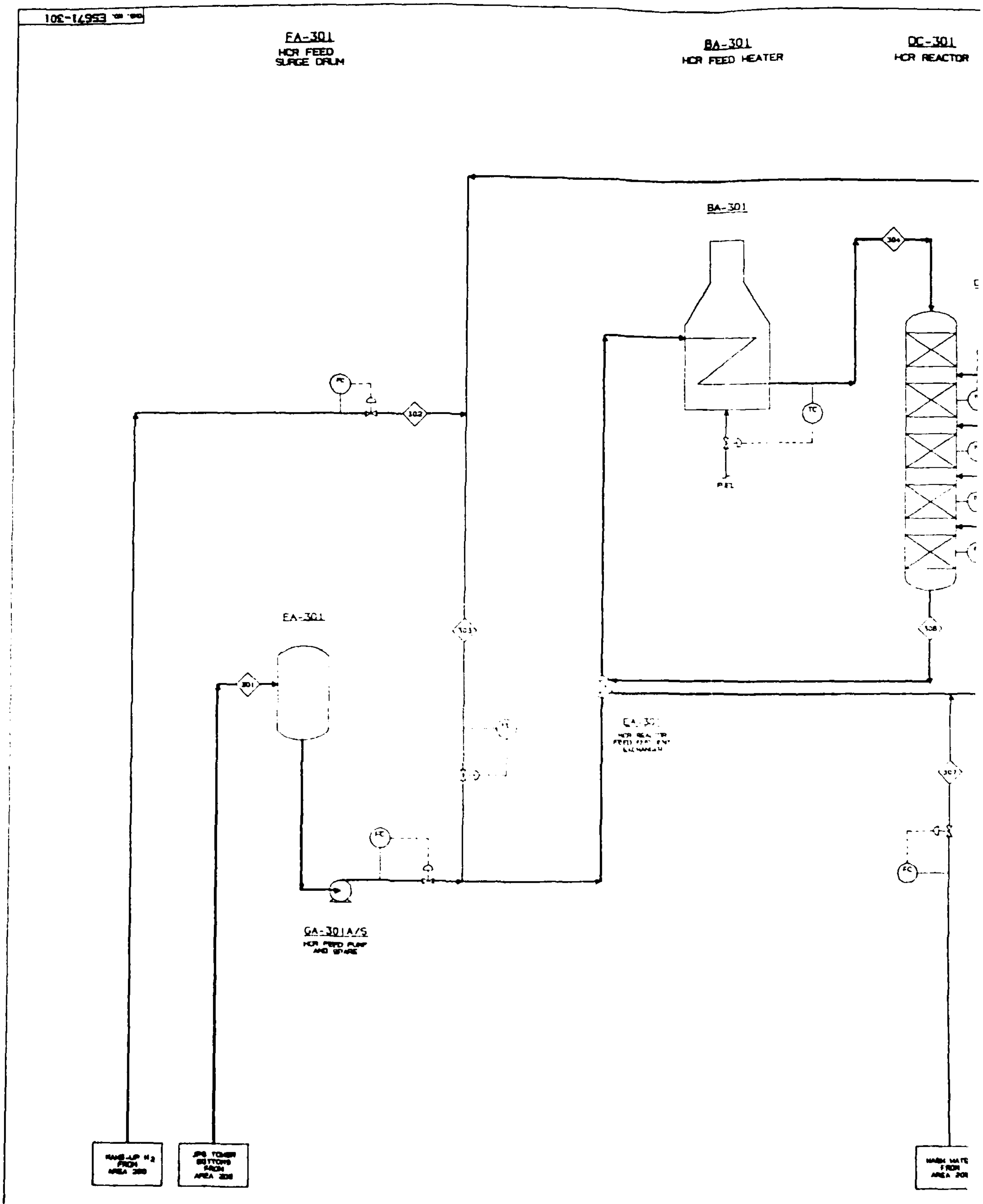

FA-201
HDS FEED SURGE DRUM
FA-209
PSA TAIL GAS K.O. DRUM
FA-207
PSA FEED GAS K.O. DRUM
PA-201
MAKE-UP HYDROGEN PSA UNIT
FA-208
MAKE-UP HYDROGEN COMPRESSOR SUCTION K.O. DRUM
BA-201
HDS FEED HEATER
DC-201
HDS REACTOR
BA-201
FA-201
GA-201A/S
HDS FEED PUMP AND SPARE
FA-209
FA-207
PA-201
PSA UNIT
GA-205A/S
HP WASH WATER AND SPARE
ATM. BOTTOMS FROM AREA 100
PSA TAILGAS TO METHANATION
MAKE-UP H2 FORM B.L.
MAKE-UP H2 TO AREA 100
MAKE-UP H2 TO AREA 300
WASH WATER FROM GA-112A/B AREA 100


201
HYDROGEN
UNIT
FA-208
MAKE-UP HYDROGEN
COMPRESSOR SUCTION
K.O. DRUM
BA-201
HDS FEED HEATER
DC-201
HDS REACTOR
FA-202
HDS REACTOR EFFLUENT
HP/LT SEPARATOR
FA-203
HDS RECYCLE GAS COMPRESSOR
SUCTION K.O. DRUM
DC-201
BA-201
TC
FUEL
EA-201
HDS REACTOR FEED/
EFFLUENT EXCHANGER
GB-201A/S
HDS RECYCLE GAS
COMPRESSOR AND SPARE
PC
FA-203
FA-202
GA-206A/S
HP WASH WATER
AND SPARE
FC
MAKE-UP H2
TO AREA 100
MAKE-UP H2
TO AREA 300
WASH WATER
FROM
GA-112A/B
AREA 100
WASH WATER
TO AREA 200
PURGE GAS
TO
AREA 100
SOUR WATER
TO
AREA 100
HP/LT
LIQUID
TO FA-204
COMBUSTION ENGINEERING
PROCESS FLOW DIAGRAM
HDS. REACTION SECTION
AREA 200
E5571-201

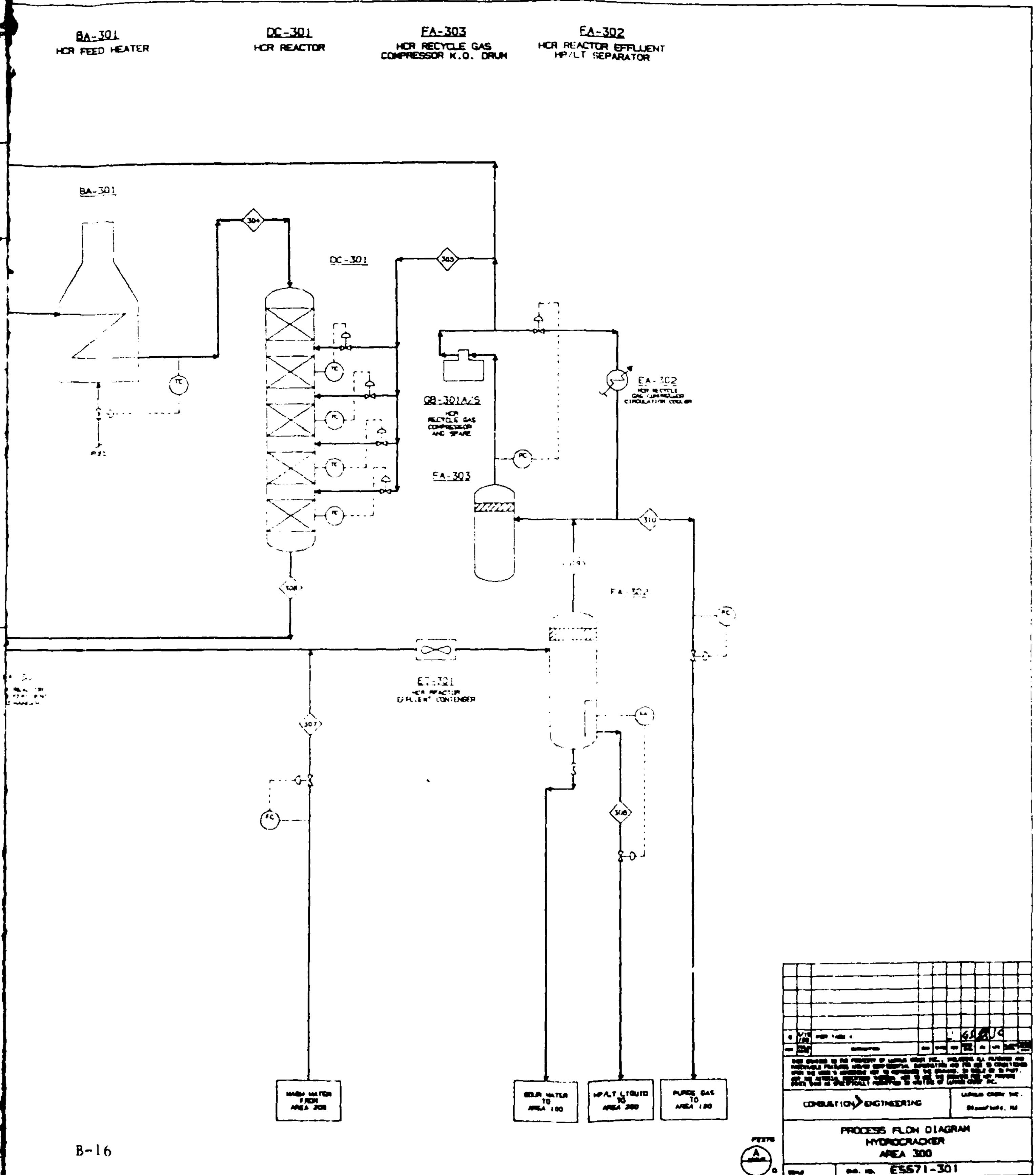

FA-204
JP8 TOWER FEED SURGE DRUM
FA-205
JP8 TOWER OVERHEAD REFLUX/PRODUCT DRUM
BA-202
JP8 TOWER FEED HEATER
DA-201
JP8 TOWER
DA-202
JP8 PRODUCT STRIPPER
EA-203
JP8 TOWER OVERHEAD CONDENSER
FA-205
DA-201
BA-202
GA-202A/S
GA-204A/S
GA-203A/S
LIGHT NAPHTHA FROM AREA 100
SOUR WATER TO GA-108 AREA 100
JP8 TOWER BOTTOMS TO AREA 300



DA-202
JPB PRODUCT STRIPPER
DA-203
NAPHTHA STABILIZER
FA-206
NAPHTHA STABILIZER OVERHEAD REFLUX DRUM
PC
222
EA-206
NAPHTHA STABILIZER OVERHEAD CONDENSER
FA-206
LC
CW
DA-203
214
EA-204
NAPHTHA STABILIZER FEED/BOTTOMS EXCHANGER
EA-205
NAPHTHA STABILIZER REBOILER
STEAM
FC
STEAM
GA-203A/S
JPB PRODUCT PUMP AND SPARE
GA-205A/S
NAPHTHA STABILIZER REFLUX PUMP AND SPARE
STABILIZED NAPHTHA TO STORAGE
JPB PRODUCT TO STORAGE
FUEL GAS TO AREA 100
COMBUSTION ENGINEERING
PROCESS FLOW DIAGRAM
HDS. FRACTIONATION SECTION
AREA 200
E5571-202

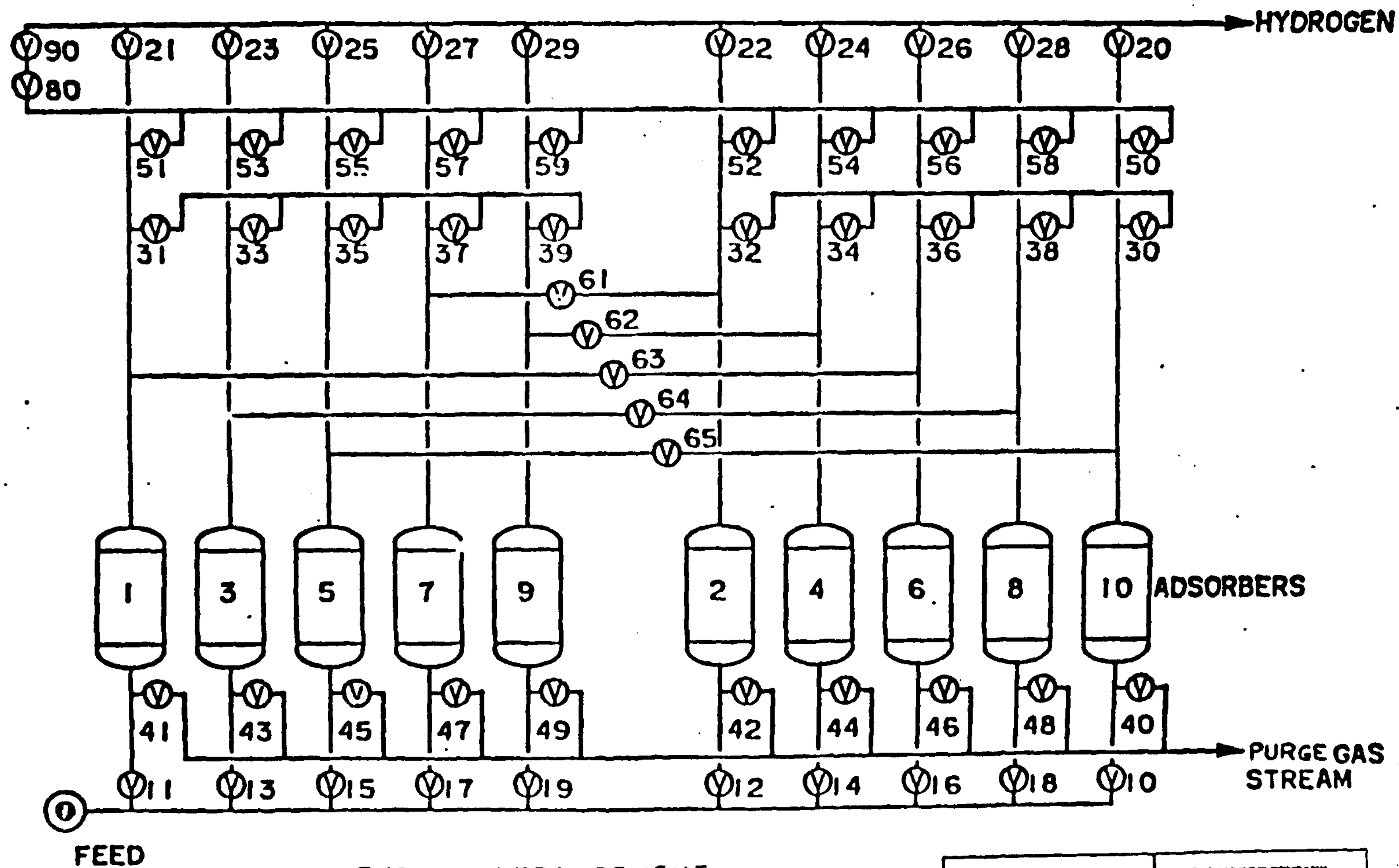

FA-301
HCR FEED
SURGE DRUM
BA-301
HCR FEED HEATER
DC-301
HCR REACTOR
BA-301
GA-301A/S

04/20/89



BA-301
HCR FEED HEATER
DC-301
HCR REACTOR
FA-303
HCR RECYCLE GAS
COMPRESSOR K.O. DRUM
FA-302
HCR REACTOR EFFLUENT
HP/LT SEPARATOR
BA-301
DC-301
GB-301A/S
HCR
RECYCLE GAS
COMPRESSOR
AND SPARE
FA-303
FA-302
EA-302
EC-301
HCR REACTOR
EFFLUENT CONDENSER
304
305
306
307
308
310
TC
FC
PC
LC
WASH WATER
FROM
AREA 200
SOUR WATER
TO
AREA 100
HP/LT LIQUID
TO
AREA 300
PURGE GAS
TO
AREA 100
COMBUSTION ENGINEERING
PROCESS FLOW DIAGRAM
HYDROCRACKER
AREA 300
E5571-301

SCHEMATIC FLOW SHEET - POLYBED PSA UNIT



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ITEM NUMBER PA-104

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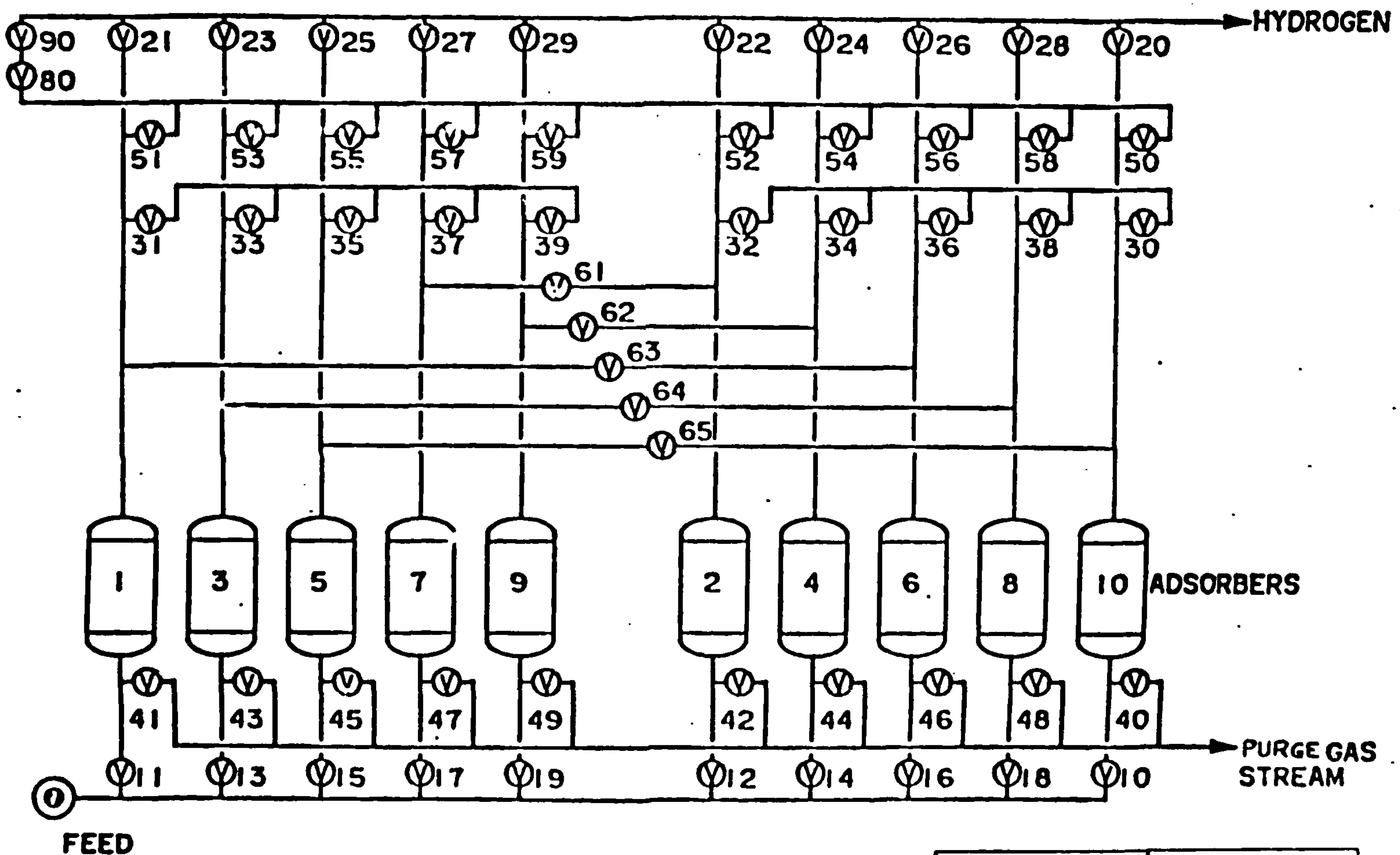
△	[illegible]	[illegible]	ML	[illegible]			
REV	ISSUE DATE	DESCRIPTION	PREP	PROJ	APPR	APPR	

LUMMUS — THE LUMMUS COMPANY

TITLE PSA (HYDROGEN UNIT)
CLIENT AMOCO/DOE JET FUEL STUDY
PROJ NO 5571 AREA 100
PROFITABLE JP-8 DESIGN
VESSEL NO
DWG NO 5571- 3

SCHEMATIC FLOW SHEET - POLYBED PSA UNIT



TYPICAL ARRANGEMENT
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ITEM NUMBER PA-201

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△	1/1..	FOR SUBTASK 1.2	ML	E.S.
REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR

CE LUMMUS — 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-...3

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
SULPHUR	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	18.61	MOL%
CO2	1.48	MOL%
CH4	16.21	MOL%
C2+	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(JP8)		
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 PROJECT
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
JOB 5571
[illegible]
100, 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/HT 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 5571
MTL BAL ...
100, 200, 300

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
JOB 5571
MTL BAL A...
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 BAL 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

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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 C .
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.[illegible]	0.05	17.32	167.58	150.28	1.25
180 F NBP	0.10	0.01	0.04	17.00	[illegible]	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

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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		

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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	

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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
200-515	57.50	63.87	40.00	0.83	13041.00	1084.49
515+	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 (515+) : 72.66 WT%

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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

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SECTION 300 - HYDROCRACKING
MATERIAL BALANCE

STREAM ID	309	310
STREAM NAME	HP/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

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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	$160^{o}F$+ Naphtha
Reactor Type	Fixed Bed
Number of Stages	1
LHSV Hr^{-1}	1.0
Average Reactor Temperature	$450^{o}F$
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.

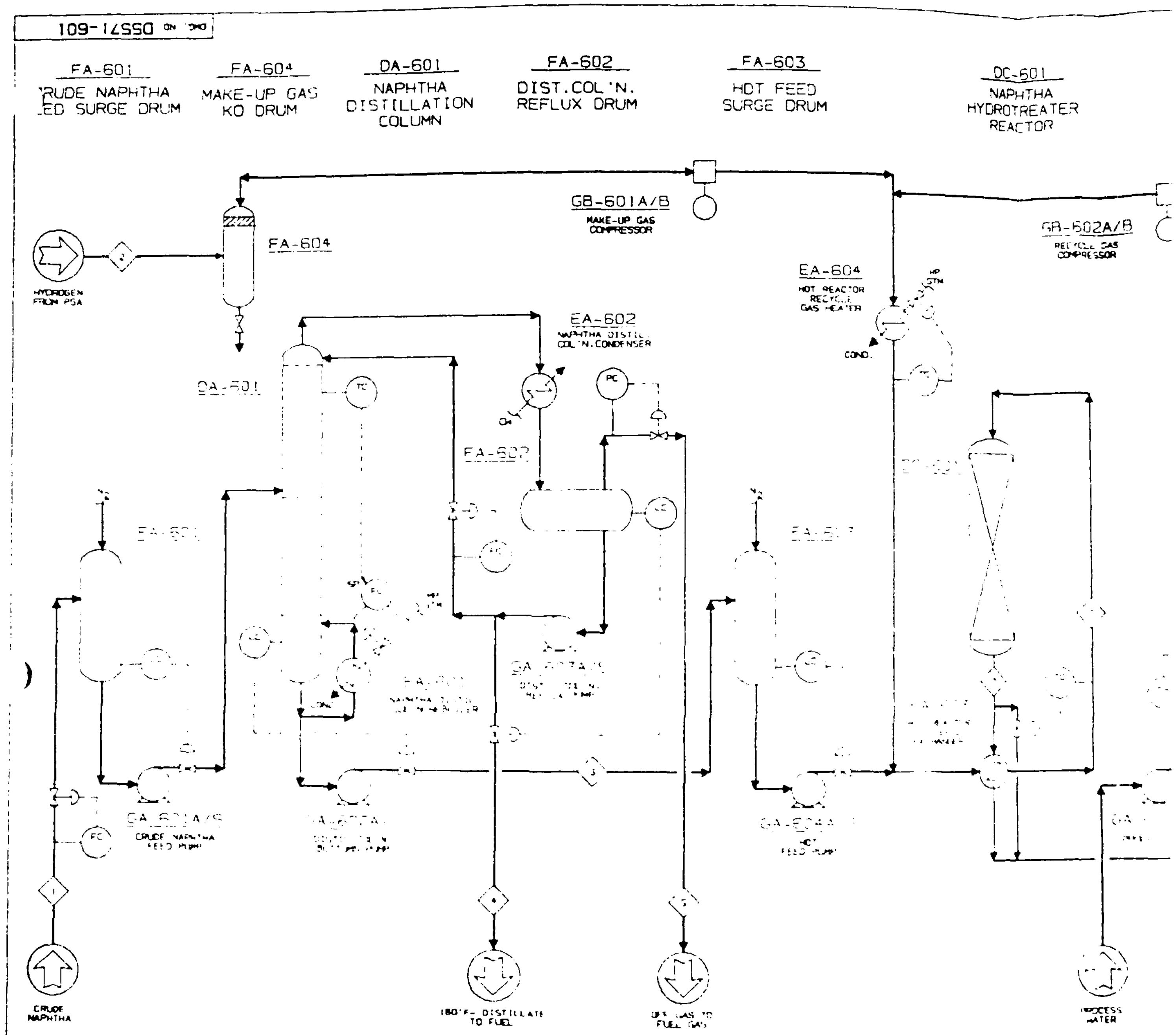
Benzene column bottoms are pumped by Benzene Column Bottoms Pump GA-716 to Toluene Column DA-709. The toluene product leaves overhead. Toluene is pumped from Toluene Column Reflux Drum FA-709 by Toluene Column Reflux Pump GA-721 through Toluene Product Cooler EA-720 to Toluene Day Tanks FB-706A/B. Toluene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

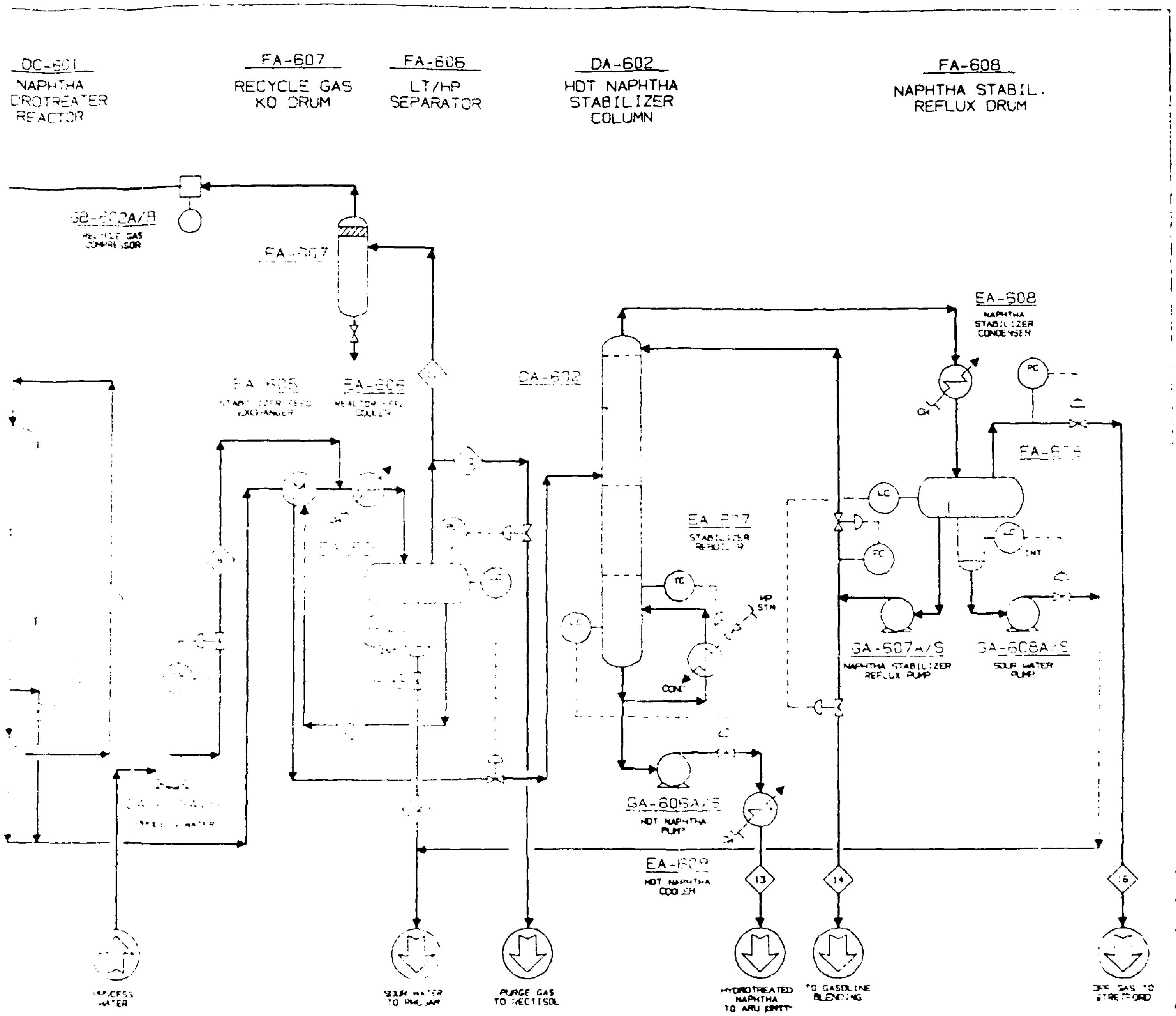
Xylene is taken as bottoms product from Toluene Column DA-709. Xylene is pumped by Toluene Column Bottoms Pump GA-720 through Xylene Product Cooler EA-718 to Xylene Day Tank FB-705. Xylene from FB-705 is pumped to storage by Xylene Product Pump GA-722.

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


DWG NO DS571-601
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
HOT FEED SURGE DRUM
DC-601
NAPHTHA HYDROTREATER REACTOR
GB-601A/B
MAKE-UP GAS COMPRESSOR
GB-602A/B
FA-604
HYDROGEN FROM PSA
EA-604
HOT REACTOR RECYCLE GAS HEATER
COND.
EA-602
NAPHTHA DISTILL. COL'N. CONDENSER
DA-601
PC
TC
FA-602
CRUDE NAPHTHA FEED PUMP
CRUDE NAPHTHA
180°F- DISTILLATE TO FUEL
PROCESS WATER



0	8/16/89	FOR TASK 4								
REV.	ISSUE DATE	DESCRIPTION								

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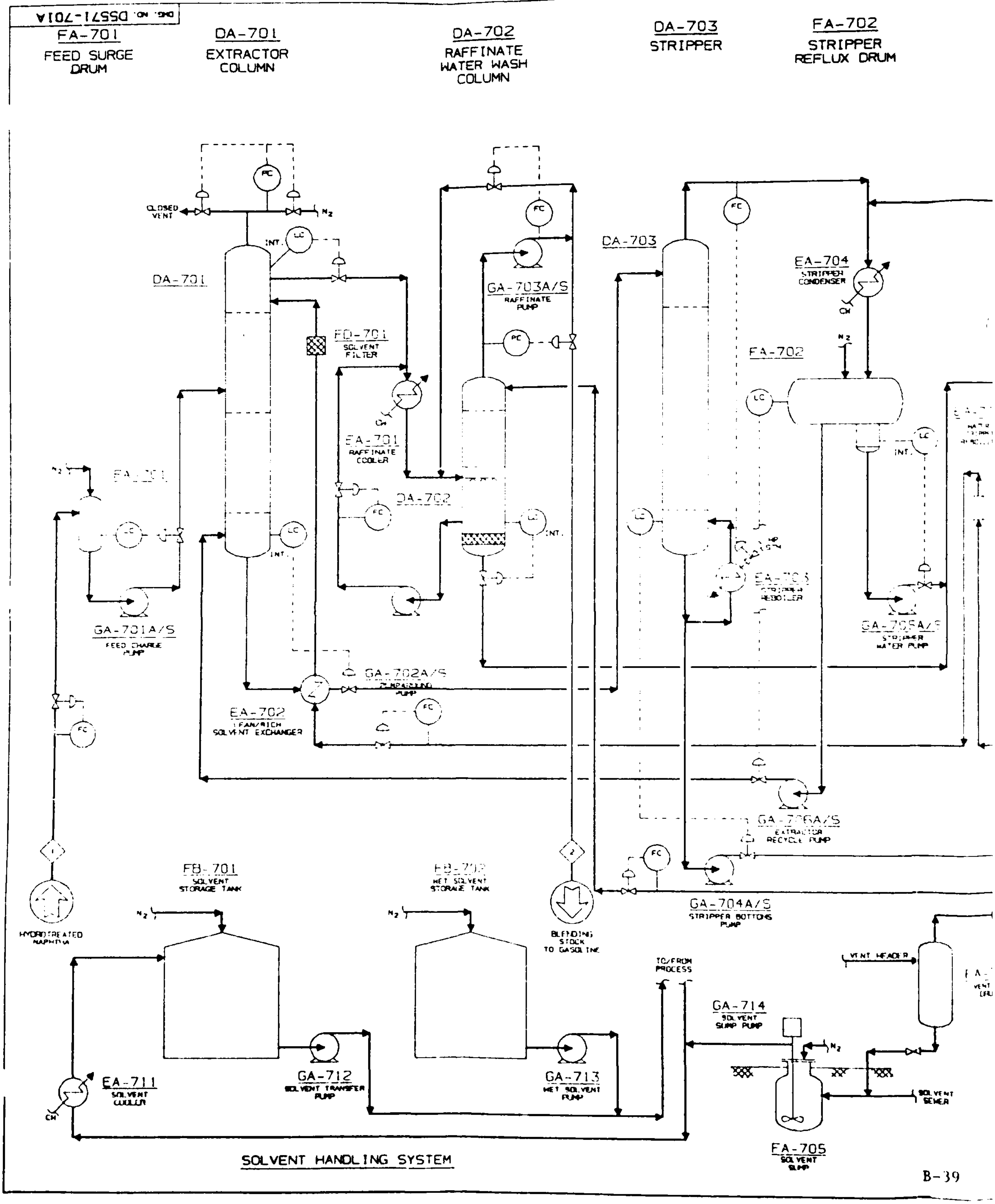
COMBUSTION ENGINEERING

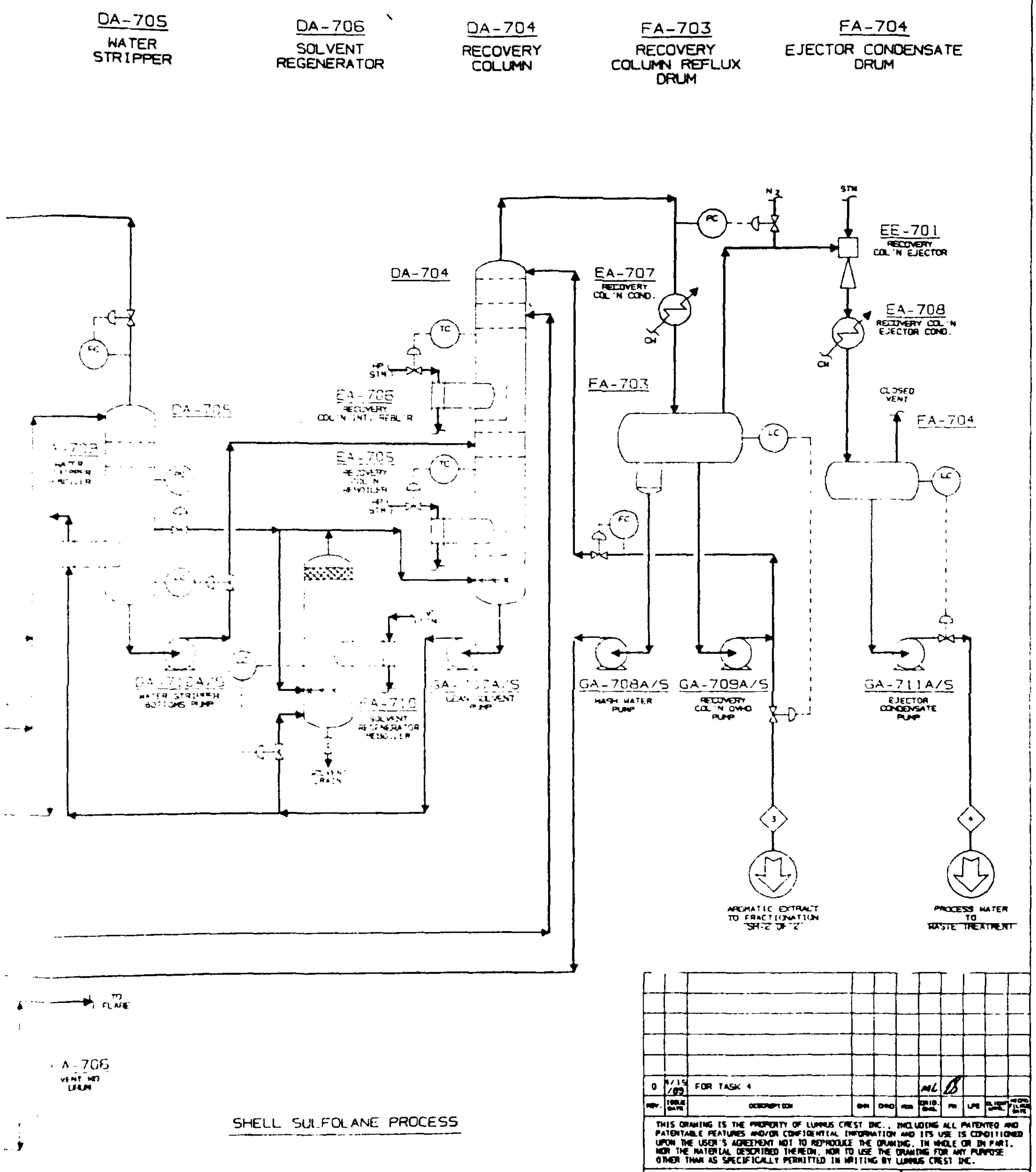
LUMMUS CREST INC.
Bloomfield, NJ

PROCESS FLOW DIAGRAM
NAPHTHA DISTILLATION
AND HYDROTREATING
AREA 600

SCALE | DWG. NO. 05571-601

E1466
A
ISSUE
6/16/89
0


DWG. NO. DS571-701A
FA-701
FEED SURGE DRUM
DA-701
EXTRACTOR COLUMN
DA-702
RAFFINATE WATER WASH COLUMN
DA-703
STRIPPER
FA-702
STRIPPER REFLUX DRUM
CLOSED VENT
N_2
PC
INT.
LC
DA-701
FC
GA-703A/S
RAFFINATE PUMP
DA-703
EA-704
STRIPPER CONDENSER
CW
FD-701
SOLVENT FILTER
FA-702
EA-701
RAFFINATE COOLER
DA-702
GA-701A/S
FEED CHARGE PUMP
GA-702A/S
EA-702
LEAN/RICH SOLVENT EXCHANGER
GA-704A/S
STRIPPER BOTTOMS PUMP
FB-701
SOLVENT STORAGE TANK
HYDROTREATED NAPHTHA
BLENDING STOCK TO GASOLINE
TO/FROM PROCESS
GA-714
SOLVENT SUMP PUMP
VENT HEADER
EA-711
SOLVENT COOLER
GA-712
SOLVENT TRANSFER PUMP
GA-713
WET SOLVENT PUMP
SOLVENT SEWER
FA-705
SOLVENT SUMP
SOLVENT HANDLING SYSTEM



0	4/15/89	FOR TASK 4									
REV.	ISSUE DATE	DESCRIPTION									

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COMBUSTION ENGINEERING

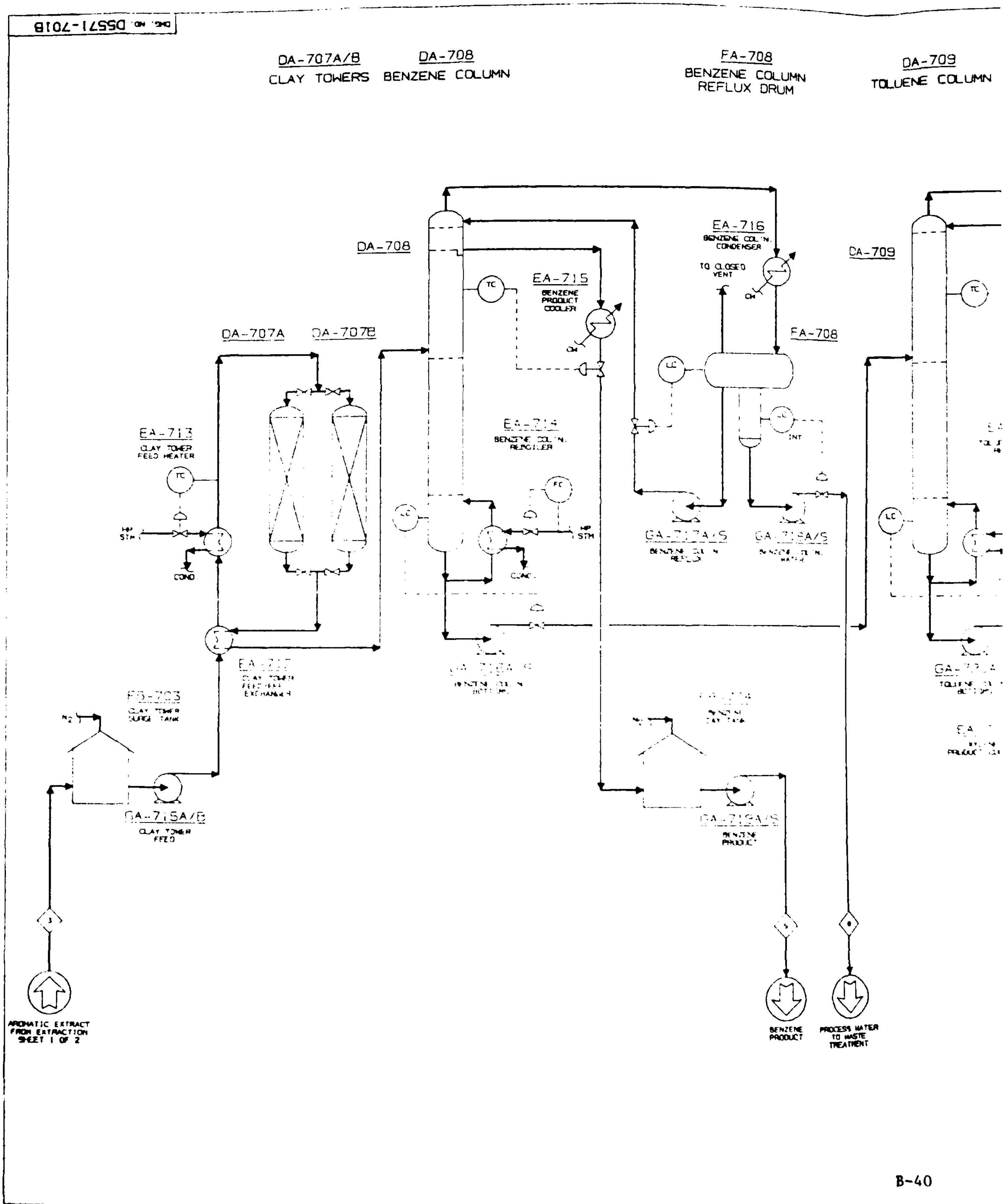
LUMMUS CREST INC.
Bloomfield, NJ

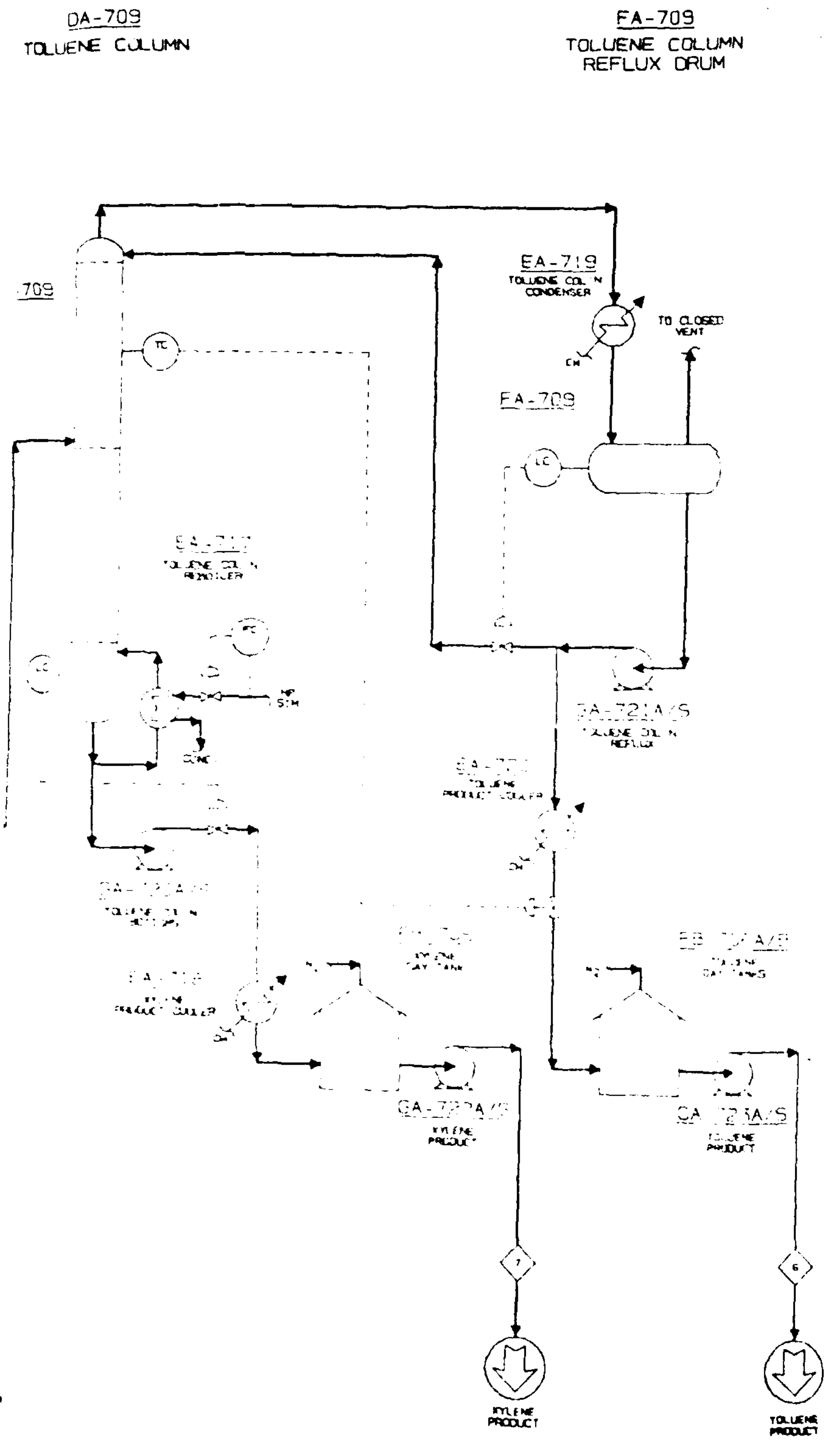
PROCESS FLOW DIAGRAM
AROMATICS RECOVERY UNIT
EXTRACTION SECTION
AREA 700

E1464
A ISSUE 4/15/89 0

SCALE
DWG. NO. D5571-701A

PLOT:132/ USERID:RAPI 312 DR: JF2373 LOC: EXT: PAPER:M DATE: 04/21/89


DWG. NO. DSS71-701B
DA-707A/B
CLAY TOWERS
DA-708
BENZENE COLUMN
FA-708
BENZENE COLUMN
REFLUX DRUM
DA-709
TOLUENE COLUMN
DA-708
EA-716
BENZENE COL'N. CONDENSER
TO CLOSED VENT
EA-715
BENZENE PRODUCT COOLER
DA-709
FA-708
DA-707A
DA-707B
EA-713
CLAY TOWER FEED HEATER
TC
LC
FC
HP STM
COND.
INT
GA-715A/B
CLAY TOWER FEED
BENZENE PRODUCT
AROMATIC EXTRACT FROM EXTRACTION SHEET 1 OF 2
BENZENE PRODUCT
PROCESS WATER TO WASTE TREATMENT



SHELL SULFOLANE PROCESS

0	4/15/89	FOR TASK 4

COMBUSTION ENGINEERING

LUMMUS CREST INC.
Bloomfield, NJ

PROCESS FLOW DIAGRAM
AROMATICS RECOVERY UNIT
AROMATICS FRACTIONATION SECTION
AREA 700

E1465

A ISSUE 4/15/89 0

SCALE | DWG. NO. 05571-7018

2.2 Naphtha Stream

2.2.4 Material Balances

The following Material Balances were developed for Area 600.

VERSION 2.C1
SIMULATION SCIENCES INC. PROCESS™
PROJECT GP JET FUELS
PROBLEM NAPSTAB SOLUTION ML 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	~~710.0000~~	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	29.3215	112.4480	208.5772	67.9931
MOLECULAR WEIGHT....	18.0875	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....	18.0875	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....	[illegible]	[illegible]	0.0000	0.0000
VISCOSITY, CP	[illegible]	[illegible]	[illegible]	[illegible]

JET FUEL STUDY
JOB 5571

VERSION 2.01
SIMULATION SCIENCES INC. PROCESS™
PROJECT GP JET FUELS
PROBLEM NAPHOT SOLUTION 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	82.3024	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	[illegible]	0.0000	0.0000	78.4475	0.0000	0.0000
ACT.DENS LB /FT3	[illegible]	[illegible]	[illegible]	[illegible]	50.8653	0.0000	0.0000
STD. API GRAVITY....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

JET FUEL STUDY
JOB 5571

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

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	[illegible]	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....	76.5209	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	0.4193	0.5621	0.4886	0.0000
MOLECULAR WEIGHT....	76.5209	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	63.3445	83.9986	0.0000
ACT.DENS LB /FT3	52.3297	44.2255	46.2197	0.0000
STD. API GRAVITY....	[illegible]	[illegible]	[illegible]	0.0000
VISCOSITY	[illegible]	[illegible]	[illegible]	[illegible]

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.

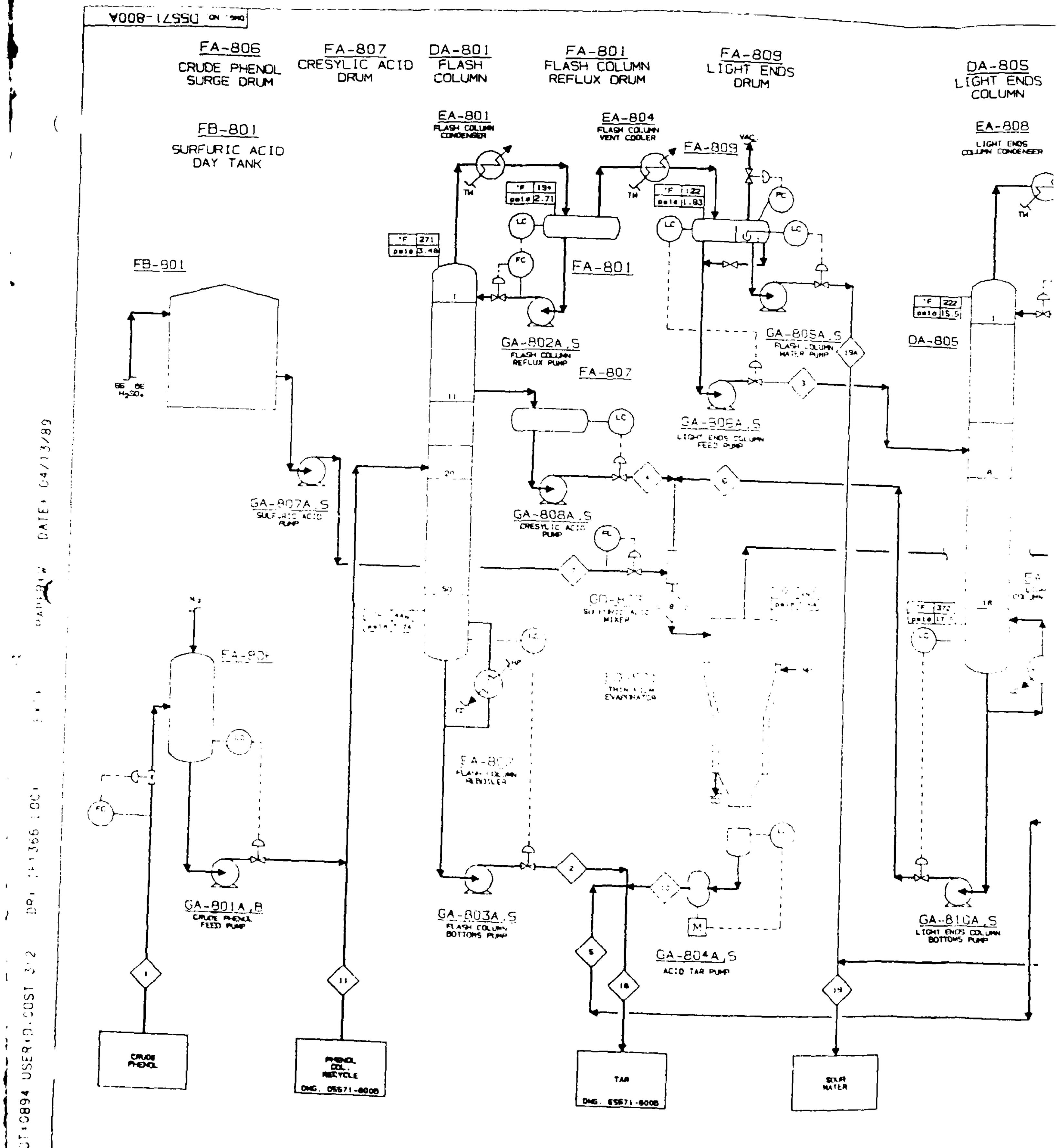
References

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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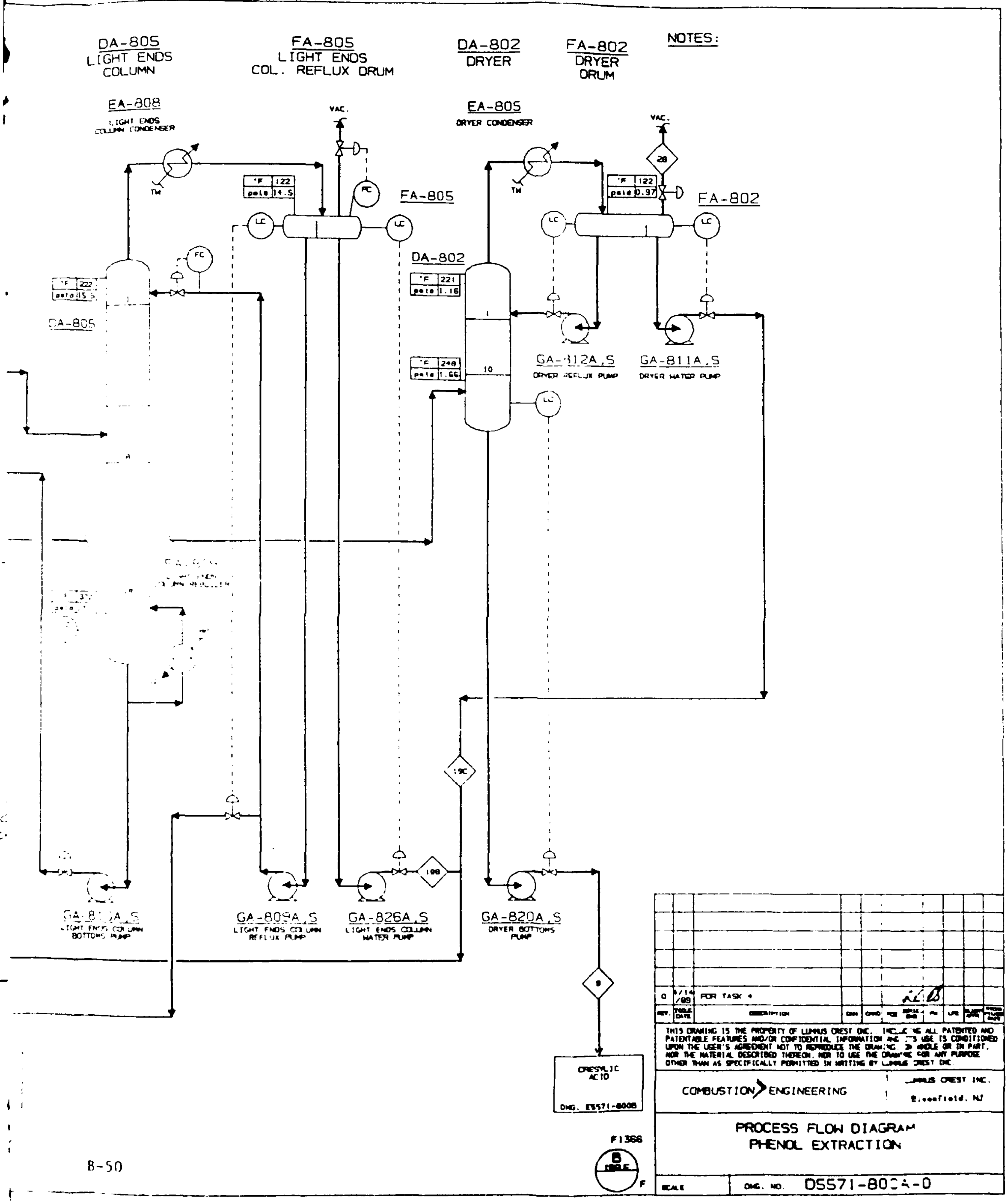
FA-806
CRUDE PHENOL SURGE DRUM
FA-807
CRESYLIC ACID DRUM
DA-801
FLASH COLUMN
FA-801
FLASH COLUMN REFLUX DRUM
FA-809
LIGHT ENDS DRUM
DA-805
LIGHT ENDS COLUMN
FB-801
SURFURIC ACID DAY TANK
EA-801
FLASH COLUMN CONDENSER
EA-804
FLASH COLUMN VENT COOLER
EA-808
LIGHT ENDS COLUMN CONDENSER
GA-802A,S
FLASH COLUMN REFLUX 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-801A,B
CRUDE PHENOL FEED PUMP
GA-803A,S
FLASH COLUMN BOTTOMS PUMP
GA-804A,S
ACID TAR PUMP
GA-810A,S
LIGHT ENDS COLUMN BOTTOMS PUMP
FLASH COLUMN REBOILER
THIN FILM EVAPORATOR
SULFURIC ACID MIXER
66 BE H_2SO_4
CRUDE PHENOL
PHENOL COL. RECYCLE
DWG. D5571-800B
TAR
DWG. E5571-800B
SOUR WATER
PLOT:0894 USER:D.COST 3/2 DR: 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.
VAC.
TW
TW
°F 122
psia 14.5
°F 122
psia 0.97
PC
FC
LC
FA-805
FA-802
DA-802
°F 222
psia 15.5
DA-805
°F 221
psia 1.16
°F 248
psia 1.66
10
28
19C
19B
8
GA-812A,S
DRYER REFLUX PUMP
GA-811A,S
DRYER WATER PUMP
GA-809A,S
LIGHT ENDS COLUMN
REFLUX PUMP
GA-826A,S
LIGHT ENDS COLUMN
WATER PUMP
GA-820A,S
DRYER BOTTOMS
PUMP
LIGHT ENDS COLUMN
BOTTOMS PUMP
CRESYLIC
ACID
DWG. E5571-8008
0
FOR TASK 4
REV.
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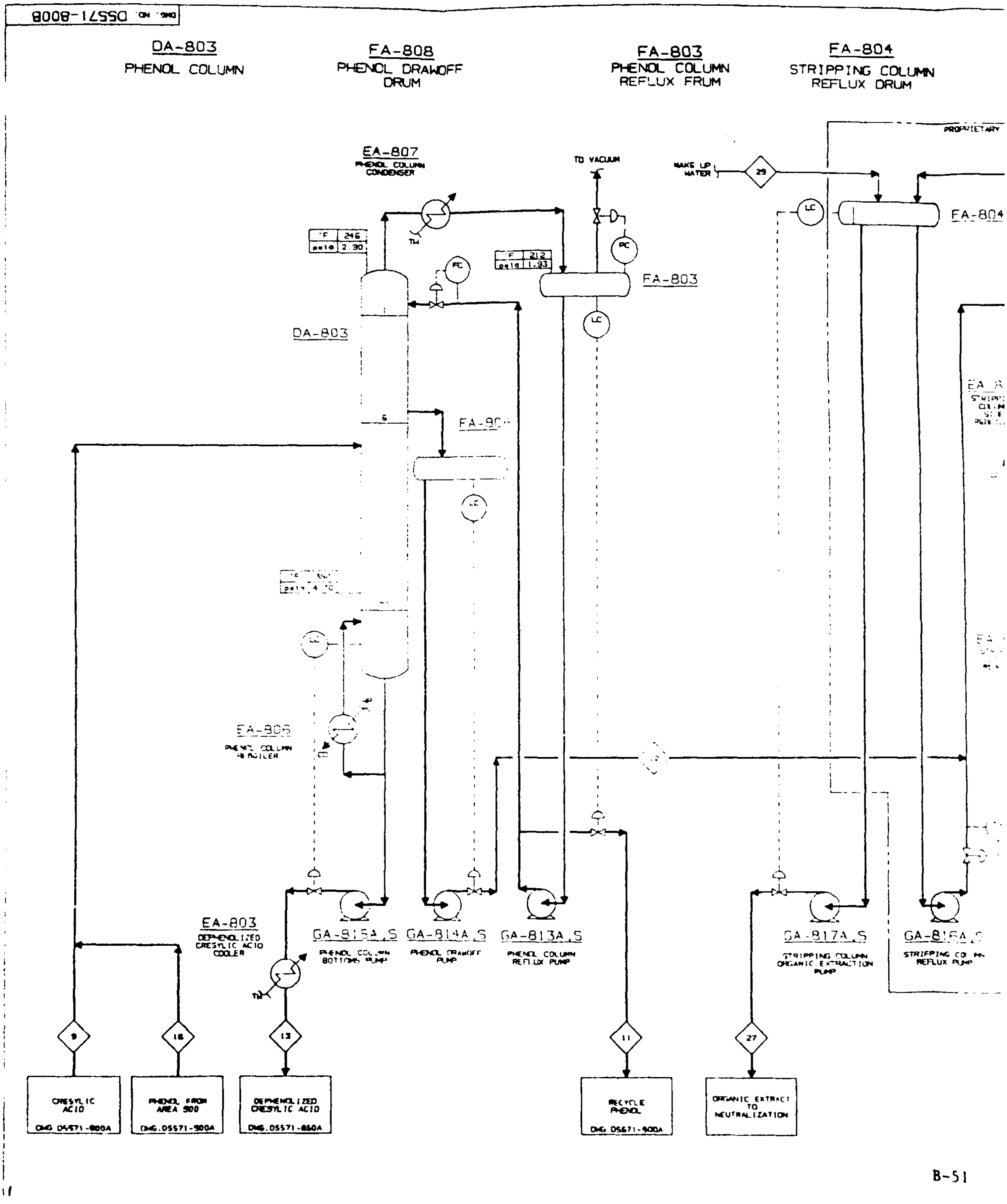
PROCESS FLOW DIAGRAM
PHENOL EXTRACTION
F1366
SCALE
DWG. NO.
D5571-80
F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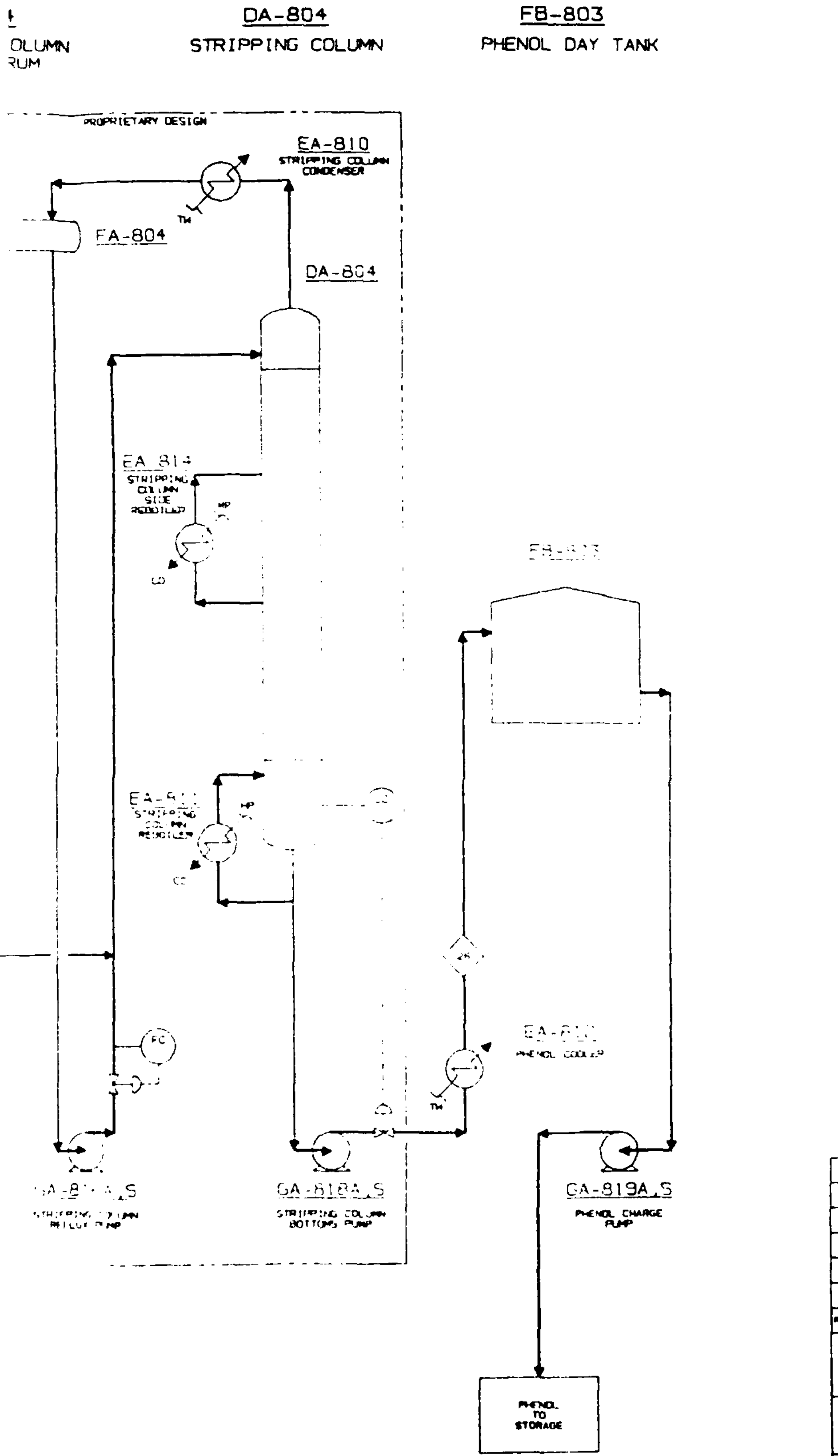
DA-803
PHENOL COLUMN
FA-808
PHENOL DRAWOFF DRUM
FA-803
PHENOL COLUMN REFLUX FRUM
FA-804
STRIPPING COLUMN REFLUX DRUM
PROPRIETARY
EA-807
PHENOL COLUMN CONDENSER
TO VACUUM
MAKE UP WATER
29
°F 246
psig 2.30
°F 212
psig 1.93
FC
PC
LC
FA-803
FA-804
DA-803
EA-806
PHENOL COLUMN REBOILER
EA-803
DEPHENOLIZED 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-816A,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
DF:10896 USER:K.MAJO 312 DR: IF1980 LOC: EXT: PAPER: DATE: 04/13/89



NOTES:

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

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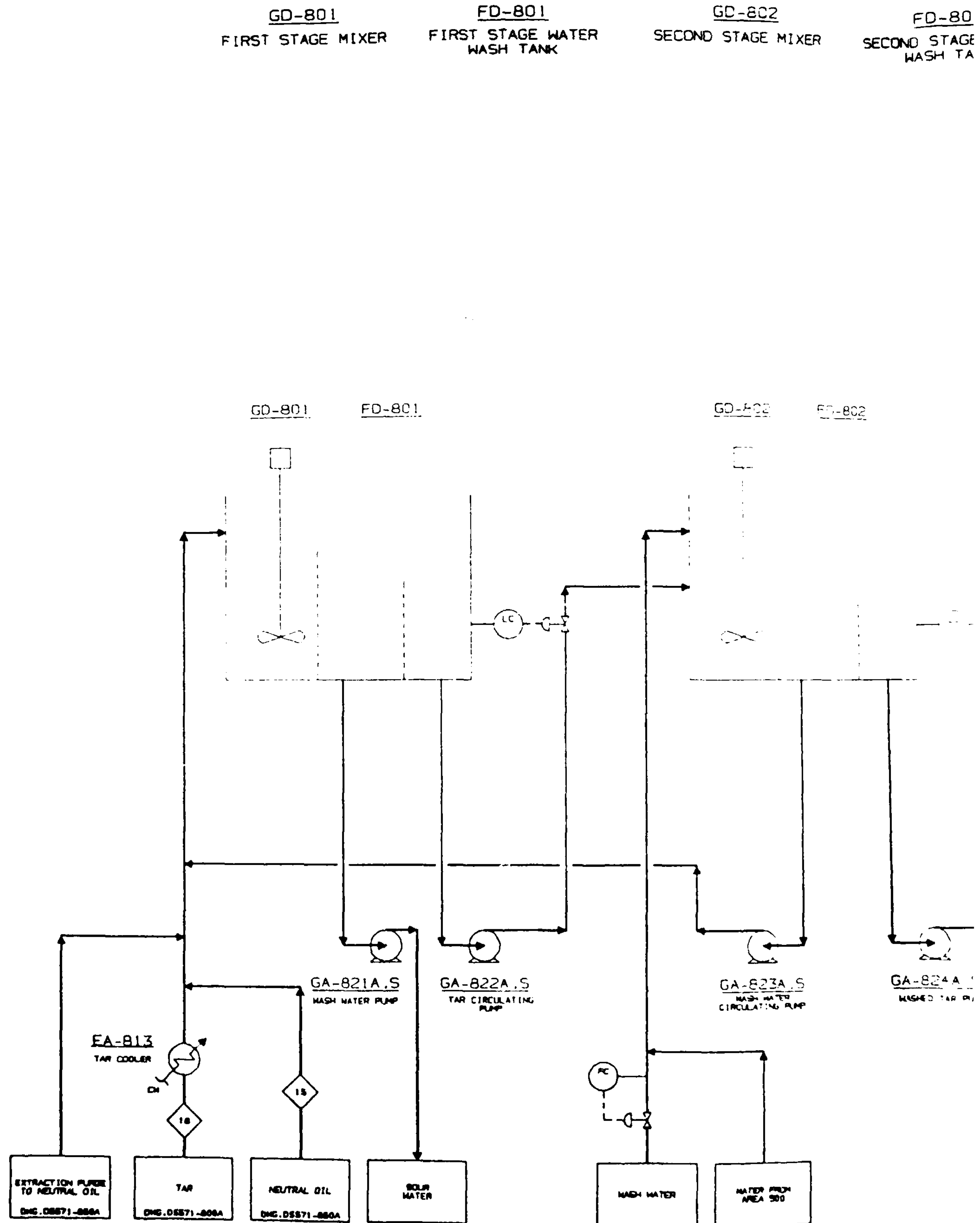
F1367 A ISSUE E

DWG. NO. DSS71-800C



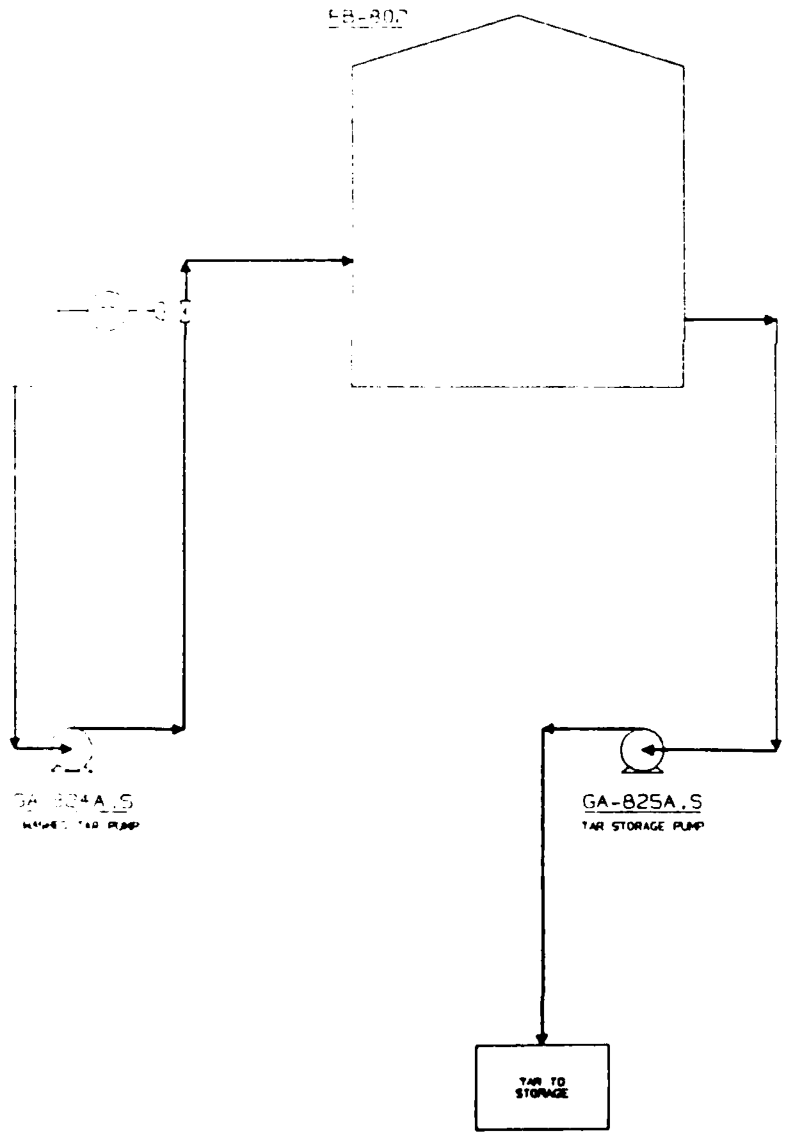
PLOT: 0909 USER: D.COST 312 DR: IF1366 LCC: EXT: PAPER: W DATE: 04/13/89

FD-802
SECOND STAGE WATER WASH TANK

FB-802
TAR DAY TANK

NOTES:

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



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PHENOL EXTRACTION

F1376

SCALE

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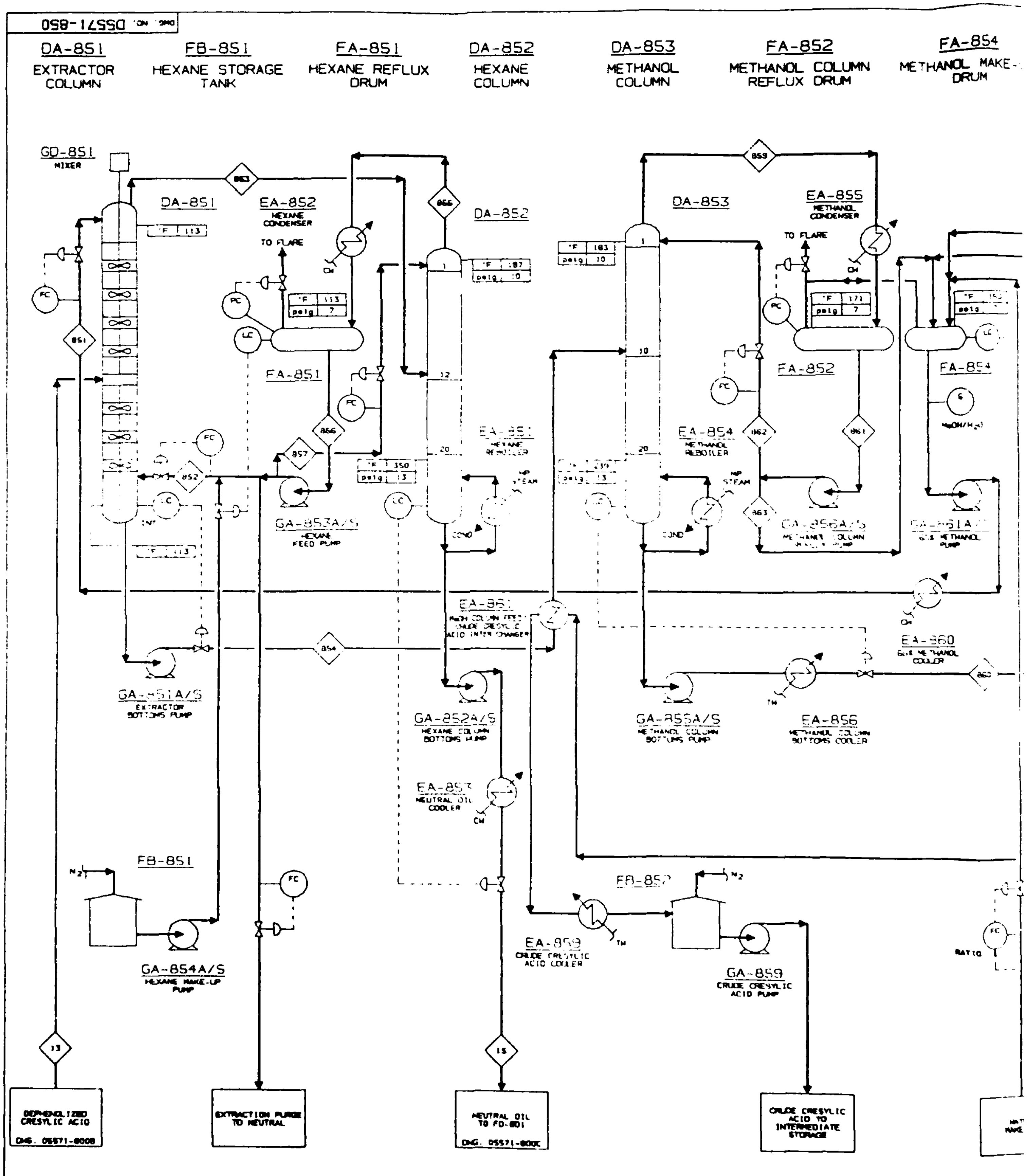

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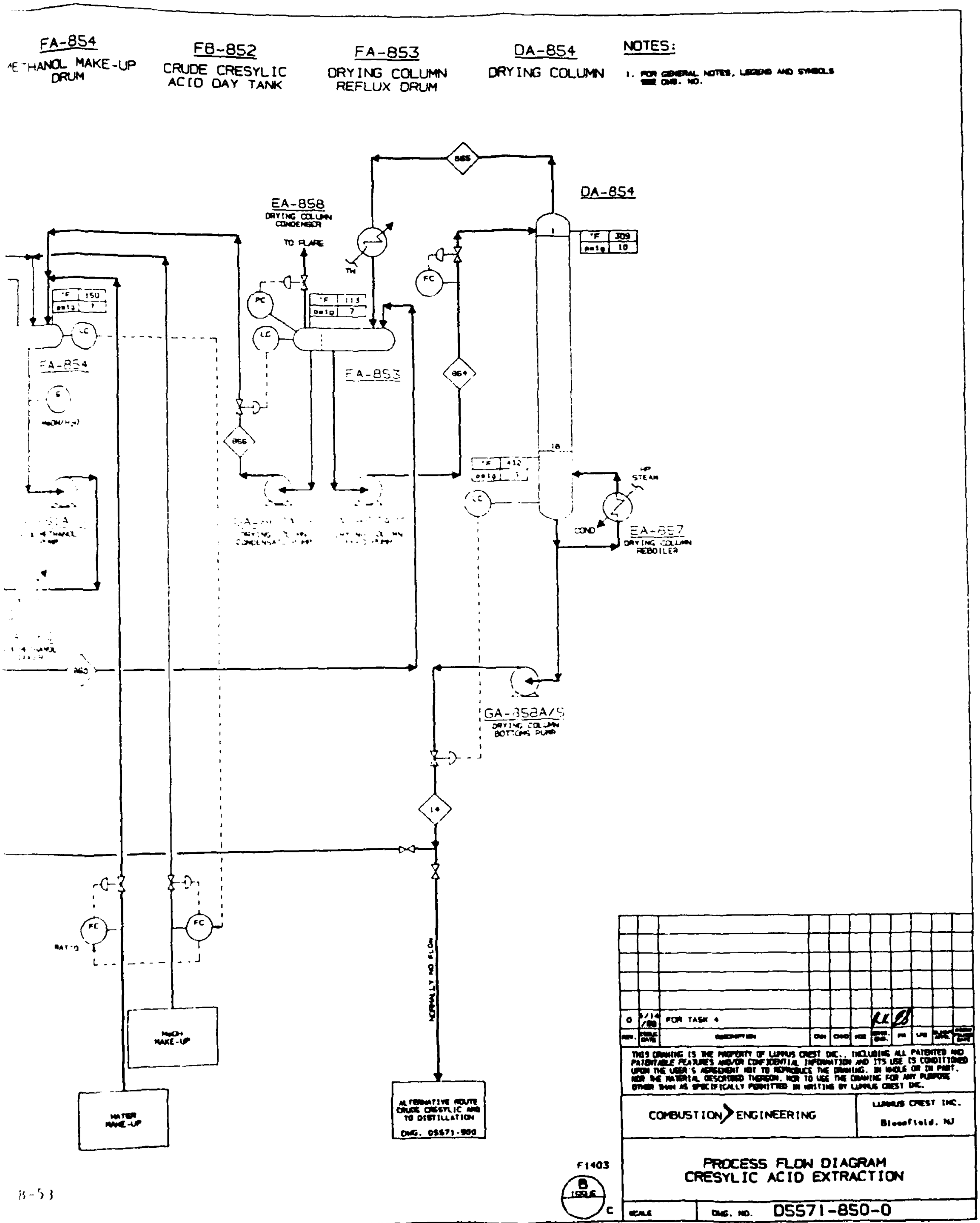

FA-854
METHANOL MAKE-UP DRUM
FB-852
CRUDE CRESYLIC ACID DAY TANK
FA-853
DRYING COLUMN REFLUX DRUM
DA-854
DRYING COLUMN
NOTES:
1. FOR GENERAL NOTES, LEGEND AND SYMBOLS SEE DWG. NO.
DA-854
EA-858
DRYING COLUMN CONDENSER
TO FLARE
CW
°F 309
psig 10
°F 150
psig 7
°F 113
psig 7
°F 412
PC
LC
FC
865
864
866
860
14
FA-854
FA-853
18
HP STEAM
COND
EA-857
DRYING COLUMN REBOILER
GA-858A/S
DRYING COLUMN BOTTOMS PUMP
NORMALLY NO FLOW
RATIO
MeOH MAKE-UP
WATER MAKE-UP
ALTERNATIVE ROUTE CRUDE CRESYLIC ACID TO DISTILLATION
DWG. 05571-900
0
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PROCESS FLOW DIAGRAM
CRESYLIC ACID EXTRACTION
F1403
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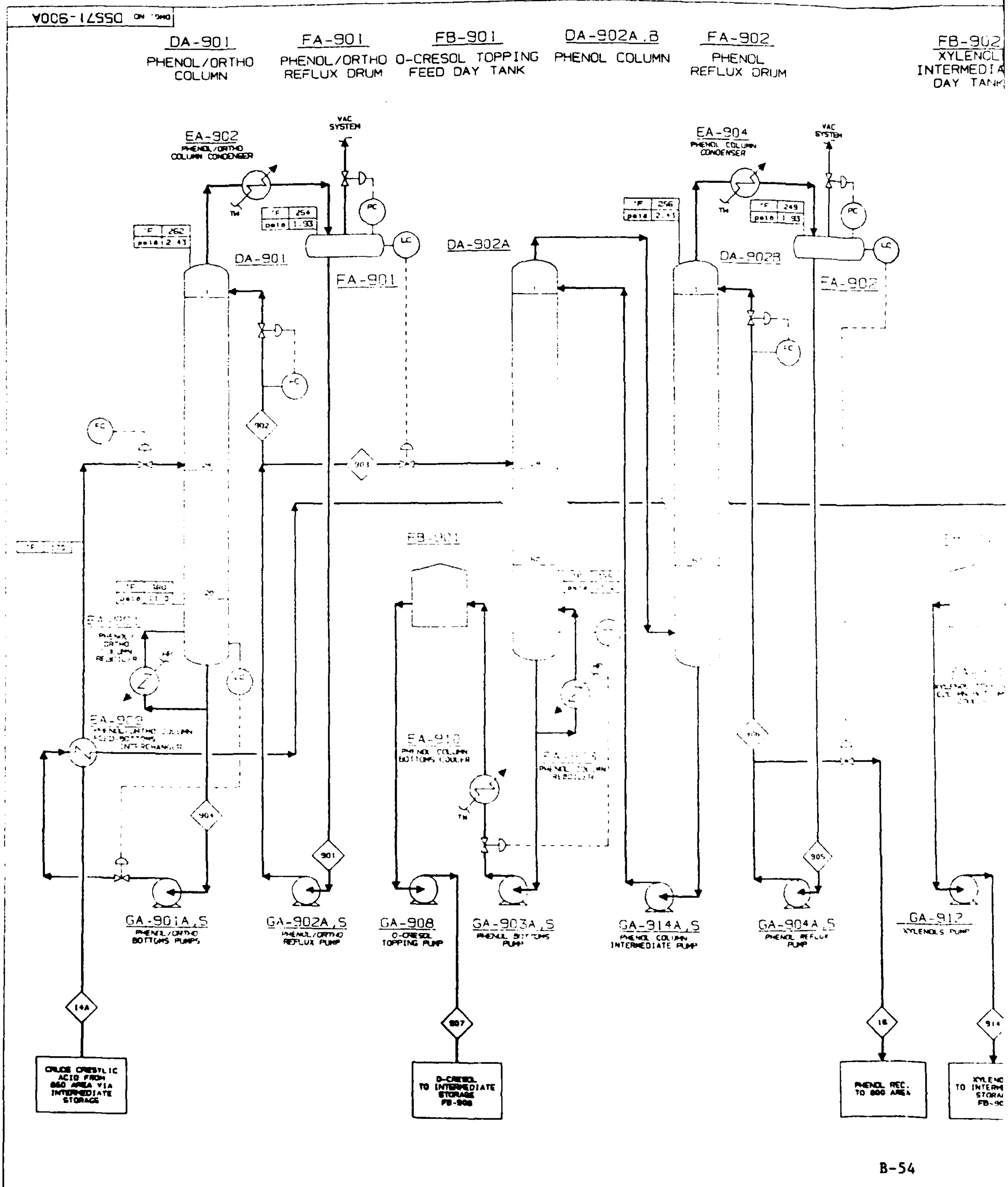
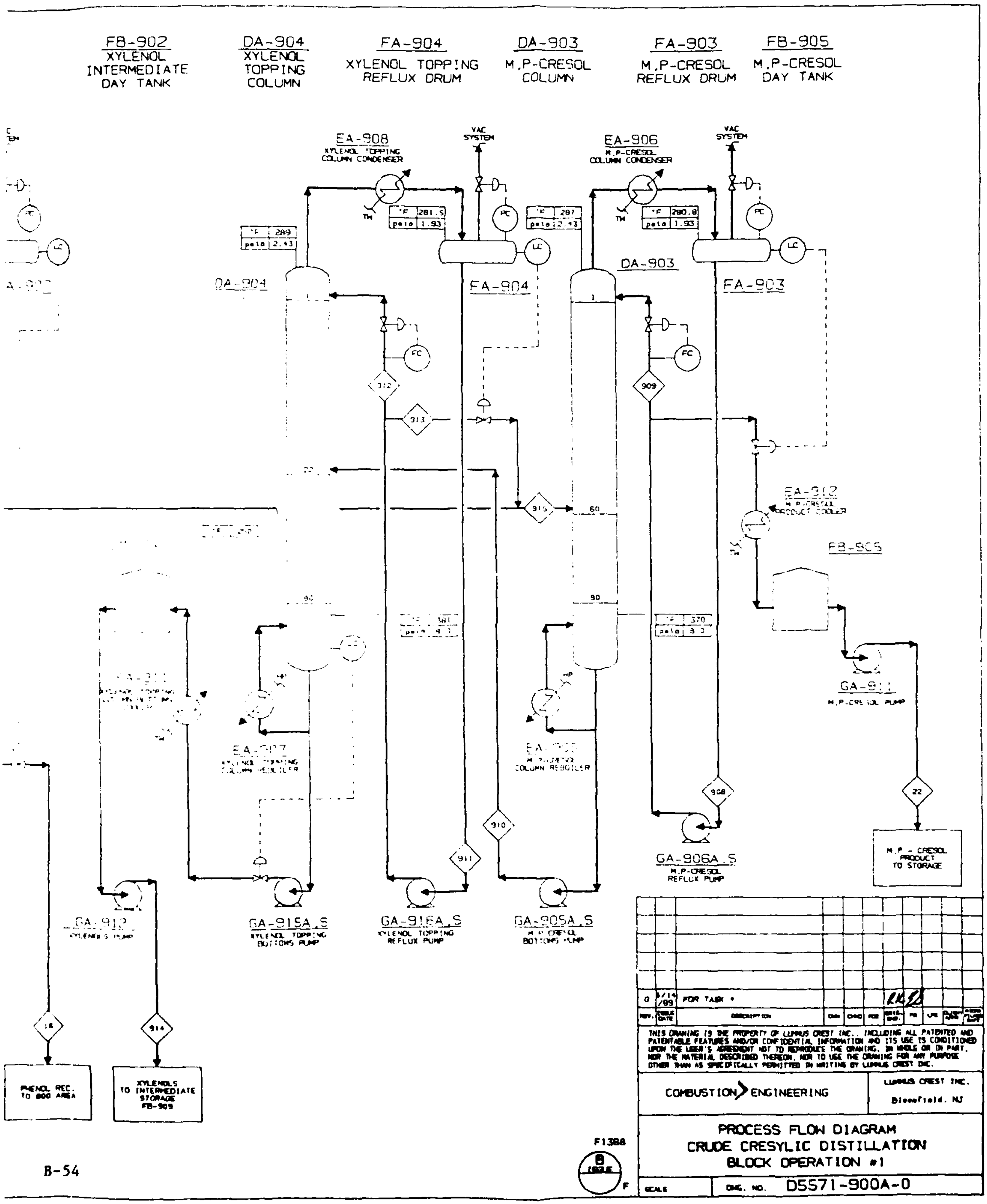
ISSUE
C
SCALE
DWG. NO. 05571-850-0



DWG. NO. D5571-900A
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 INTERMEDIATE DAY TANK
VAC SYSTEM
EA-902
PHENOL/ORTHO COLUMN CONDENSER
EA-904
PHENOL COLUMN CONDENSER
DA-901
FA-901
DA-902A
DA-902B
FA-902
FB-901
EA-909
EA-910
PHENOL COLUMN BOTTOMS COOLER
GA-901A,S
PHENOL/ORTHO BOTTOMS PUMPS
GA-902A,S
PHENOL/ORTHO REFLUX PUMP
GA-908
O-CRESOL TOPPING PUMP
GA-903A,S
PHENOL BOTTOMS PUMP
GA-914A,S
PHENOL COLUMN INTERMEDIATE PUMP
GA-904A,S
PHENOL REFLUX PUMP
GA-912
XYLENOLS PUMP
CRUDE CRESYLIC ACID FROM 860 AREA VIA INTERMEDIATE STORAGE
O-CRESOL TO INTERMEDIATE STORAGE FB-908
PHENOL REC. TO 800 AREA


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
EA-908
XYLENOL TOPPING COLUMN CONDENSER
VAC SYSTEM
EA-906
M,P-CRESOL COLUMN CONDENSER
°F 281.5
psia 1.93
°F 287
psia 2.43
°F 280.8
psia 1.93
°F 289
psia 2.43
PC
LC
FC
TW
DA-904
FA-904
DA-903
FA-903
912
913
909
915
60
90
EA-912
M,P-CRESOL PRODUCT COOLER
FB-905
°F 370
GA-911
M,P-CRESOL PUMP
EA-907
XYLENOL TOPPING COLUMN REBOILER
M,P-CRESOL COLUMN REBOILER
908
910
911
22
GA-906A,S
M,P-CRESOL REFLUX PUMP
M,P-CRESOL PRODUCT TO STORAGE
GA-912
XYLENOLS PUMP
GA-915A,S
XYLENOL TOPPING BOTTOMS PUMP
GA-916A,S
XYLENOL TOPPING REFLUX PUMP
GA-905A,S
M,P-CRESOL BOTTOMS PUMP
16
914
PHENOL REC. TO 800 AREA
XYLENOLS TO INTERMEDIATE STORAGE FB-909
0
8/14/89
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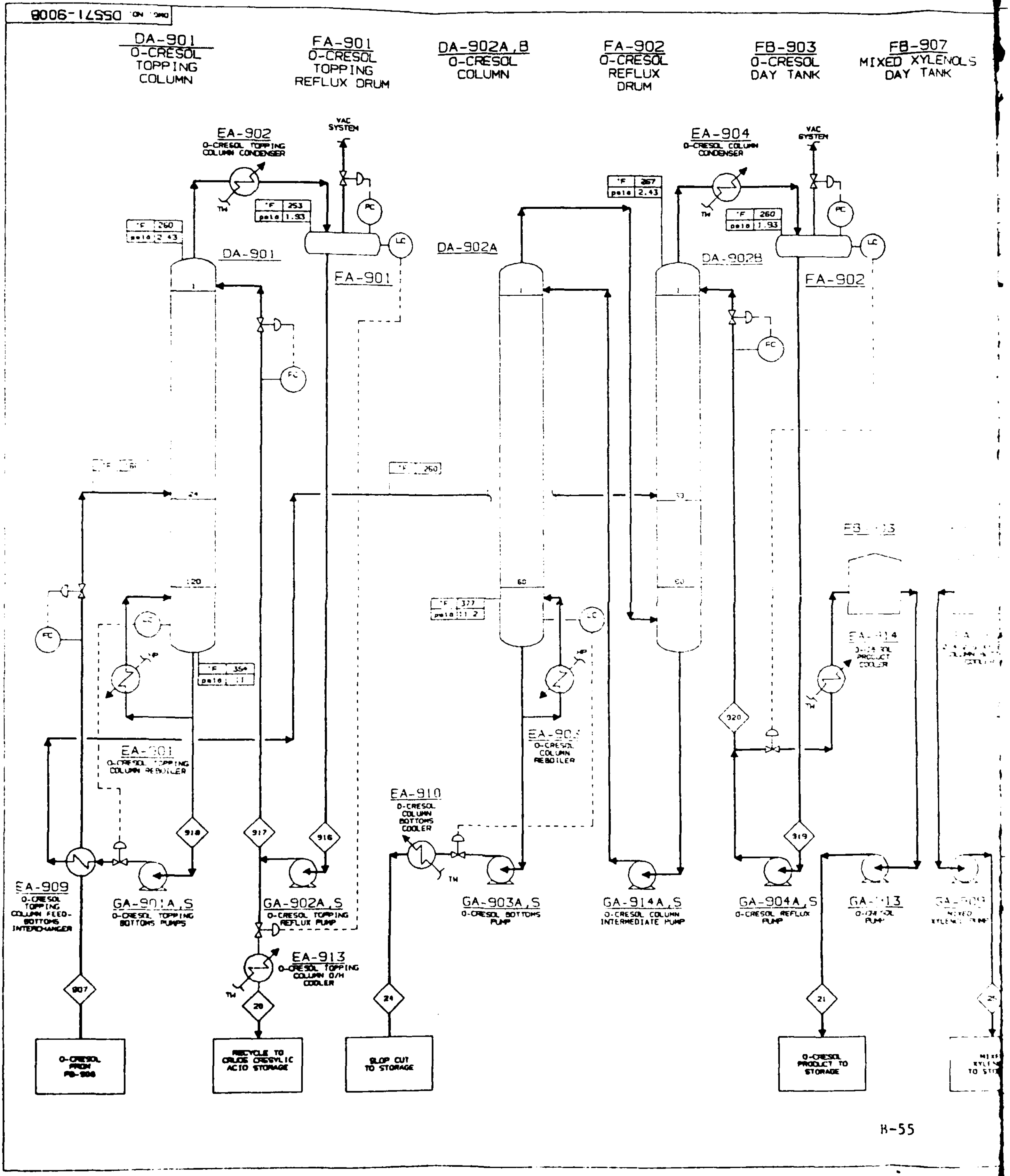
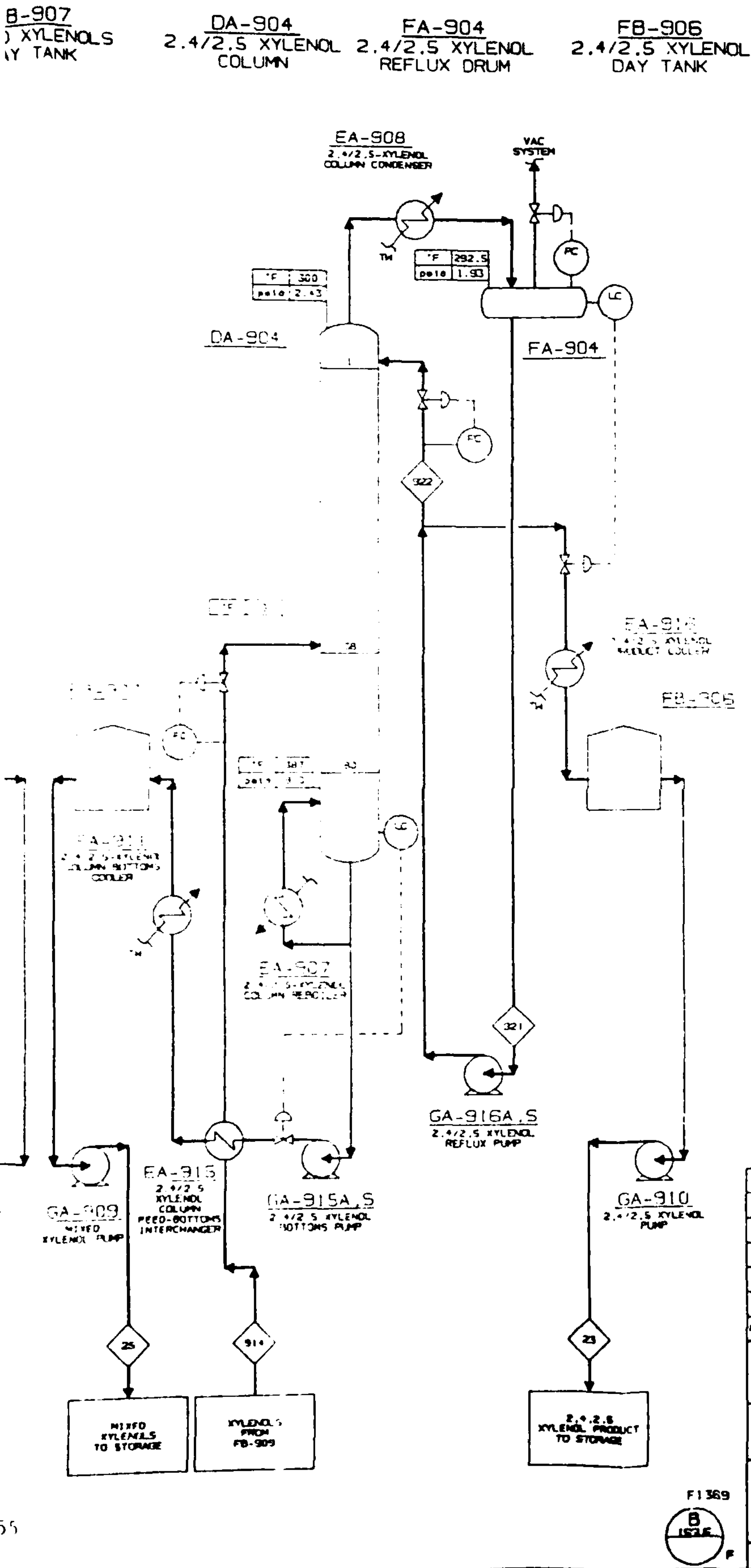
PROCESS FLOW DIAGRAM
CRUDE CRESYLIC DISTILLATION
BLOCK OPERATION #1
F1388
SCALE
DWG. NO. D5571-900A-0


DWG. NO. 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
EA-902
O-CRESOL TOPPING
COLUMN CONDENSER
VAC
SYSTEM
EA-904
O-CRESOL COLUMN
CONDENSER
DA-901
FA-901
DA-902A
DA-902B
FA-902
EA-909
O-CRESOL
TOPPING
COLUMN FEED-
BOTTOMS
INTERCHANGER
GA-901A,S
O-CRESOL TOPPING
BOTTOMS PUMPS
GA-902A,S
O-CRESOL TOPPING
REFLUX PUMP
EA-913
O-CRESOL TOPPING
COLUMN O/H
COOLER
EA-910
O-CRESOL
COLUMN
BOTTOMS
COOLER
GA-903A,S
O-CRESOL BOTTOMS
PUMP
GA-914A,S
O-CRESOL COLUMN
INTERMEDIATE PUMP
GA-904A,S
O-CRESOL REFLUX
PUMP
O-CRESOL
FROM
FB-906
RECYCLE TO
CRUDE CRESYLIC
ACID STORAGE
SLOP CUT
TO STORAGE
O-CRESOL
PRODUCT TO
STORAGE



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Bloomfield, NJ

PROCESS FLOW DIAGRAM
CRUDE CRESYLIC DISTILLATION
BLOCK OPERATION #2

SCALE | DWG. NO. D5571-9008-0

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	0	99	0	0	0	[illegible]
26XYLENOL	51	2	0	48	0	0	0	49
M-ETHYLPHENOL	102	41	0	61	0	0	0	61
P-ETYLPHENOL	141	57		84	0	0	0	84
23XYLENOL	[illegible]	[illegible]	0	[illegible]	0	0	0	[illegible]
34XYLENOL	64	26	0	38	0	0	0	38
35XYLENOL	141	57	0	84	0	0	0	84
CATECHOL	[illegible]	1479	0	[illegible]	0	0	0	[illegible]
RESIDUES	[illegible]	[illegible]	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
SULFUR DIOXIDE	0	0	0	0	0	0	0	0
TOTAL # HR	[illegible]	4728	[illegible]	[illegible]	246	[illegible]	[illegible]	[illegible]
API	[illegible]	-1.9	5.9	[illegible]	[illegible]	0.4		[illegible]
SPGR	1.06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.83	1.06
BSD	876	[illegible]	[illegible]	445	19	83	5	533

JET FUEL PROJECT

AMOCO [illegible] GREAT PLAINS GAS

JOB NO. 5571

MATERIAL BALANCE - [illegible]

STRM	9	10	11	12	13	14	15	16
LBS/HR	FEED	T.F.E	PHENOL	PHENOL	EXTRACT	FEED	NEUTRAL	AREA900
	DAB[illegible]	BOTTOM	RECYCLE	PRODUCT	FEED	AREA900	OIL	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	602
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	[illegible]
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	95	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 # HR	7682	519	273	3657	4355	3631	723	602
API	3.1	-7.9	-0.1	-0.7	6.0	4.4	14.3	-0.7
SPGR	1.05	1.15	1.08	1.08	1.03	1.04	0.97	1.08
BSD	501	31	17	232	290	239	51	38

JET FUEL PROJECT
AMOCO/DOE - GREAT PLAINS GAS
JOB NO 05571
MATERIAL BALANCE - 800 AREA

STRM LBS/HR	18 TAR	19 SOUR WATER	19A AQU. PHASE OF FA-809	19B AQU. PHASE OF FA-805	19C 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
AMOCO/DOE - GREAT PLAINS [illegible]
JOB NO. 05571
MATERIAL BALANCE - 800 AREA

STRM LBS/HR	26 PHENOL PRODUCT	27 ORGANIC STREAM	28 VENT GAS	29 MAKE UP 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	-0.7	-0.6		
SPGR	1.08	1.08		1.00
BSD	226	5		

JET FUEL PROJECT
[illegible] DOE - GREAT PLAINS
JOB NO 05571
MATERIAL BALANCE [illegible]

STREAM NO.	17 CRUDE PHENOL	851 METHANOL TO EXTRCTR	852 HEXANE TO EXTRCTR	853 HEXANE FR EXTRCTR	854 METHANOL FR EXTRCTR	855 VAPOR FR HEX. COL.	856 COND. FR REF. DRUM	857 REFLUX TO HEX. COL.	15 NEUTRAL OIL
PHENOL	67[illegible]	13.3		74.[illegible]	5[illegible]				74.[illegible]
NEUTRAL OIL	38[illegible]	[illegible]	5.5	391.5	[illegible]	25.3	25.3	19.6	38[illegible]
O-CRESOL	745.	5.5		60.6	65[illegible]				60.[illegible]
M-CRESOL	1082[illegible]	7.5		87.[illegible]	1[illegible].5				87.[illegible]
P-CRESOL	7[illegible]	5.[illegible]		61.[illegible]	71[illegible]				61.[illegible]
[illegible]	[illegible]	[illegible]		6.0	90.7				6.0
[illegible]	45.	[illegible]		4.0	44.[illegible]				4.0
[illegible]	[illegible]	[illegible]		[illegible]	11[illegible]				[illegible]
[illegible]	95.	[illegible]		5.[illegible]	87.[illegible]				8.[illegible]
[illegible]	4[illegible]	[illegible]		[illegible]	4[illegible]				[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	5[illegible]				4.[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	7[illegible]				[illegible]
[illegible]	[illegible]	[illegible]		2.[illegible]	25.[illegible]				[illegible]
[illegible]	[illegible]	[illegible]		[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]	3[illegible]	3[illegible]	[illegible]	
METHANOL		[illegible]		[illegible]	[illegible]				
TOTAL [illegible]	4[illegible]	55[illegible]	845[illegible].5	[illegible].5	[illegible]	38899.5	38899.5	30440.4	7[illegible]
TEMP., °F	[illegible]	[illegible]	[illegible]	113	113	167	113	[illegible]	[illegible]
DENSITY [illegible]	[illegible]	[illegible]	[illegible]	4[illegible]	55.6		3[illegible]	[illegible]	[illegible]
GPM	[illegible]	15.2[illegible]	26.56	26.19	20.50		122.16	95.[illegible]	1.[illegible]
SP. GR. [illegible]	1.0[illegible]								[illegible]
API	[illegible]								14.[illegible]
SSU	25[illegible]								51

JET FUEL PROJECT

AMOCO/AOE-GREAT PLAINS GASIF CO.

JOB NO. 05571

MATERIAL BALANCE - 850 AREA

STREAM NO.	859 VAPOR FR MEOH COL	860 MEOH COL BOTTOMS	861 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 DECANT'D WATR TO MEOH MAKE UP DRUM	14 CRUDE CRESYLIC [illegible]	
PHENOL		622.8				1009.9	404.9	18.9	605.[illegible]	
NEUTRAL O								0.0	0.0	
O CRESOL		690.9				911.7	226.7	5.9	685.0	
M-CRESOL		[illegible]				1162.8	167.9	7.5	995.[illegible]	
P CRESOL		71[illegible]				[illegible]	118.9	5.3	105.[illegible]	
GUAIACOL		90.7				105.2	15.2	0.7	90.[illegible]	
O-ETH PH		44.3				51.4	7.4	0.3	44.[illegible]	
24X LENOL		115.3				132.2	13.2	0.3	115.[illegible]	
25XYLENOL		87.2				96.7	9.7	0.2	87.[illegible]	
26XYLENOL		43.1				47.8	4.8	[illegible]	43.[illegible]	
M-ETHYLPH		51.2				55.6	4.[illegible]	[illegible]	[illegible]	
P-ETHYLPH		70.[illegible]				75.4	5.4	[illegible]	[illegible]	
23XYLENOL		25.[illegible]				26.9	1.9	[illegible]	25.[illegible]	
34XYLENOL		3[illegible]				34.5	2.5	[illegible]	32.[illegible]	
35XYLENOL		7[illegible]				75.4	5.4	[illegible]	7[illegible]	
CATECHOL		10.[illegible]				11.4	0.4	[illegible]	11.[illegible]	
RESIDUES		0.0								
WATER	976.4	1547.9	976.4	[illegible]	[illegible]	675.2	675.2	1547.9		
HEXANE	[illegible]	0.0	0.0	[illegible]	0.0	0.0	0.0	0.0		
METHANOL	[illegible]	4.0	9281.6	57[illegible]	[illegible]	5.2	8.2	4.0		
TOTAL # H	[illegible]	[illegible]	10261.9	[illegible]	[illegible]	[illegible]	[illegible]	1594.0	[illegible]	[illegible]
TEMP., OF	[illegible]	[illegible]	171	171	171	113	[illegible]	113	40[illegible]	[illegible]
DENSITY,# CF		62.9	47.[illegible]	47.0	47.0	63.3		61.7	57.[illegible]	[illegible]
GPM		10.35	27.22	[illegible]	10.47	10.44		3.22	6.53	[illegible]
S. G. [illegible]									1.04	
API									4.4	
ESD									239	

JET FUEL PROJECT
AMOCO LURGI GREAT PLAINS GASIF. PROJ
JOB NO. 08571
MATERIAL BALANCE - 860 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 - GREAT PLAINS [illegible]
JOB NO 05571
MATERIAL BALANCE - 900 AREA

STREAM NO.	16	907	915	908	909	22	910	911
	PHENOL RECYCLE TO 800 AREA	FEED TO O-CRESOL TOPPING COL.	FEED TO M,P-CRESOL COLUMN	COND. FROM M,P-CRESOL REFLUX DRUM	REFLUX TO M,P-CRESOL COLUMN	M,P-CRESOL PRODUCT	FEED TO XYLENOL TOPP. COL.	COND. FROM XYLENOL TOPP. 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
THANOL	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. @60/60	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
[illegible] - 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

JET FUEL PROJECT
AMOCO 1032 - GREAT PLAINS CASE
JOB NO 05571
MATERIAL BALANCE - 900 ACRES

STREAM NO.	920 REFLUX TO O-CRESOL COL	21 O-CRESOL PRODUCT	24 SLOP CUT	921 COND FROM XYLENOL REFLUX DRUM	922 REFLUX TO XYLENOL COL	23 2,4/2,5-XYL PRODUCT	25 MIXED 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 [illegible] - GREAT PLAINS CASE
JOB NO. 05571
MATERIAL BALANCE - 900 [illegible]

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

RR5571-4.TXT

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:

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

RR5571-4.TXT

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

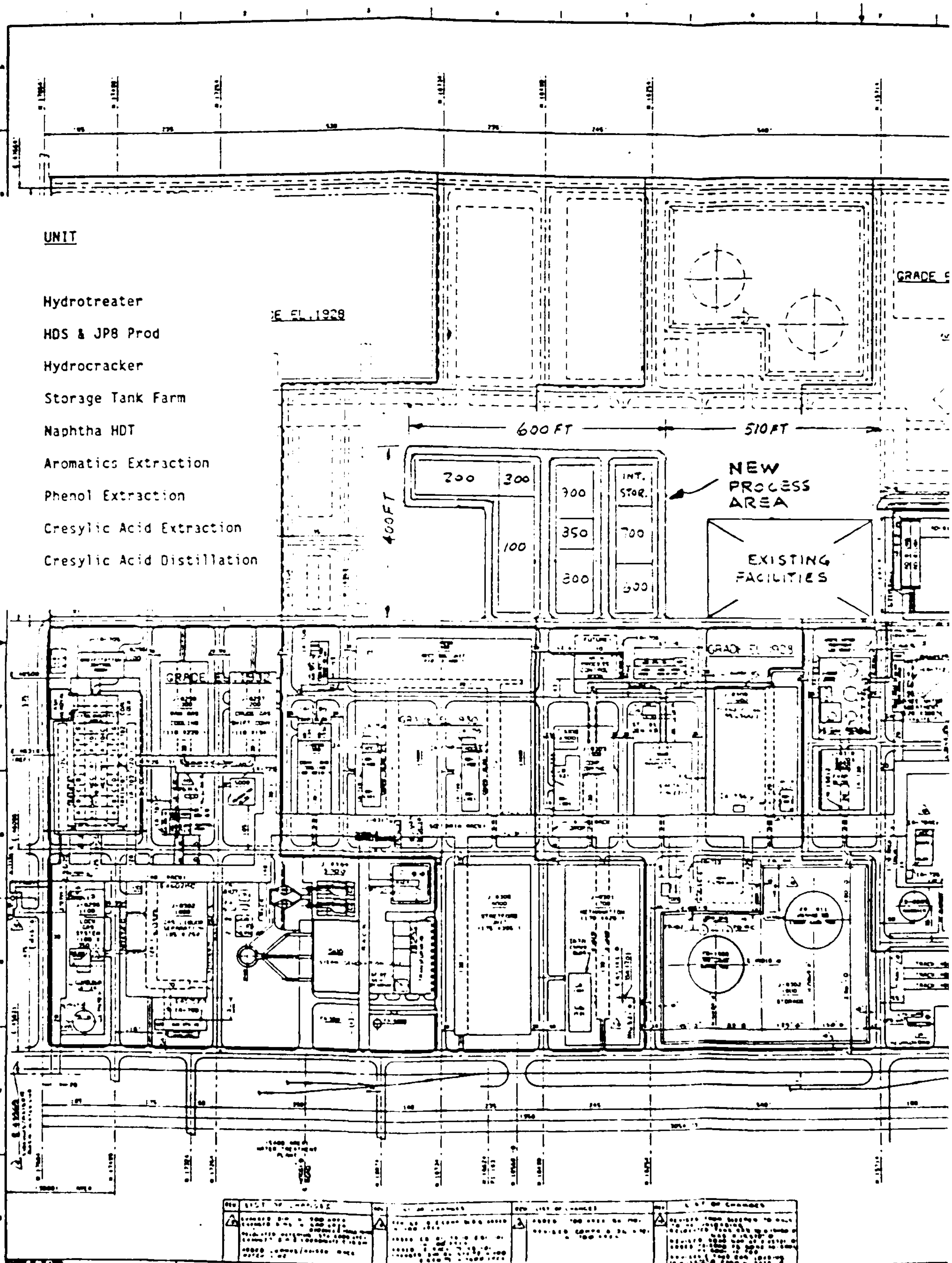
III. PHENOL STREAM

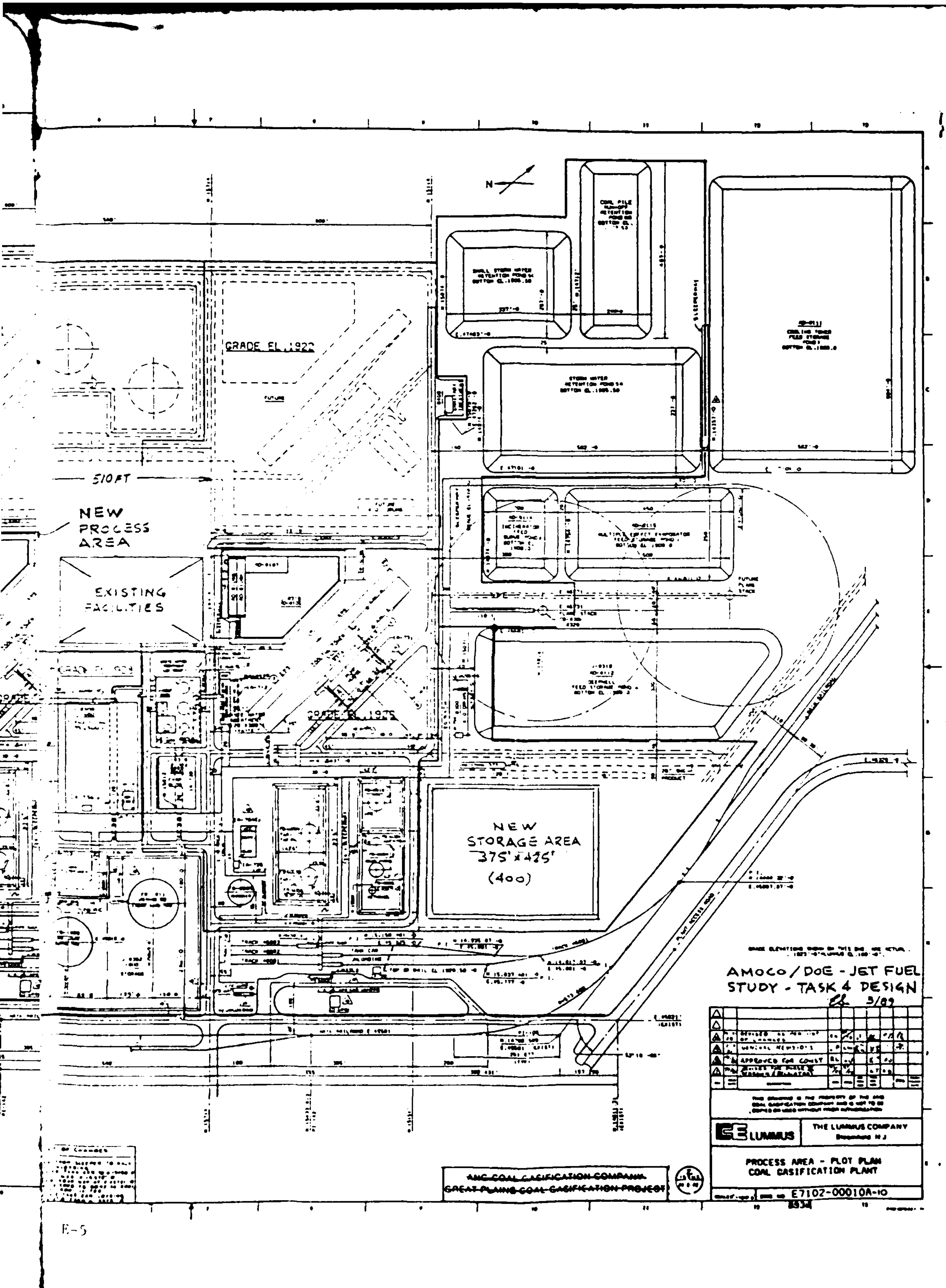
EST. SIZE	SERVICE	TO/FROM
2"	Crude Phenol (Elec. Tr.)	Storage
2"	Tar Product	Storage
3"	Phenol Product (Elec. Tr.)	Storage
2"	Crude Cresylic Acid (Elec. Tr.)	Int. Storage & Return
2"	Crude O-Cresol (Elec. Tr.)	Int. Storage & Return
1 1/2"	Crude Xylenol (Elec. Tr.)	Int. Storage & Return
1 1/2"	Crude Cresylic 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

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




GRADE EL. 1922
510 FT
NEW PROCESS AREA
EXISTING FACILITIES
GRADE EL. 1925
NEW STORAGE AREA 375' x 425' (400)
AMOCO / DOE - JET FUEL STUDY - TASK 4 DESIGN
3/89
APPROVED FOR CONST
THE LUMMUS COMPANY
LUMMUS
PROCESS AREA - PLOT PLAN
COAL GASIFICATION PLANT
ANG COAL GASIFICATION COMPANY
GREAT PLAINS COAL GASIFICATION PROJECT
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

No.	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	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO. 5571	ACCT BA
LOCATION BEULAH, NORTH DEKOTA	WAGE RATE	LAB. COST	DATE 2/15/89		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 1		

A122 [illegible] 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	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' x 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 [X] 18 VALVE TRAYS							
9								
10	INSUL [X] 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 + 11/13 Cr 6' BELT CLAD [X] LINING [ ] CA 1/4" / mm							
15	DES PRESS (@ MIDSECTION) 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 [X] 20 VALVE TRAYS							
19								
20	INSUL [X] 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	3.50	25 000			
23	m [ ] mm [ ]							
24	MAT CS + 11/13 CLAD [X] 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 [X] GRID (GLITSCH)							
29								
30	INSUL [X] DA = lbs DB = lbs ERECT WT		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC MH	BY GS
LOCATION BEULAH, NORTH DAKOTA			DATE 2/15/89
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 2
JOB/EST NO. 5571	ACCT DA		

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) / 3'-0" / / 410 SS / ONE			300	5400			
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	6000			
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 (8'-0") / 3'6" / / 410 SS / -		83 FT²	40	3300			
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	PROD FACT	LOC MH	BY GS	JOB NO 5571 / ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 2/15/89	EST / DB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 1	

AREA 100

LUMMUS
Bloomfield

ESTIMATE WORKSHEET

No.	DESCRIPTION	QUANTITY AMOUNT	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 2¼-1Mo CLAD SS (347 or 304) CA							2100 000		
5	DES PRESS 2500 PSIG DES TEMP 800 °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
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 GS
DATE 2/18/89
REV. 1

JOB EST. NO. 5571

ACCT DC

A122 0578-5

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/BFW 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		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 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		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 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	21000			
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	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 2/21/89		EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV 2		

A??? 1001 6 REV 2

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. m²/SHELL TOTAL m² /SERV		m²					
5	SHELL SIDE C.A. 1/8" mm TUBE SIDE C.A. 1/8" mm							
6	MAT CS SS							
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. 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/ 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. 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/ 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	PROD FACT	LOC M H	BY GS	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 2/21/89	ACCT EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 1	

A 122 1/81 A REV 2

AREA 100

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- 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		5600			
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	13000			
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	PROD FACT	LOC M H.	BY GS	JOB EST NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 2-21-89		EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 2		

AREA 100

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	EC-101 RECYCLE GAS COOLER	1						
2	TOTAL BARE SURF / FINNED 2800 SQ FT EA		2800 SQ FT	35	98000			
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	18000			
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 300 °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/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC. M.H.	BY GS	JOB EST NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 2-21-89		EC
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV 2		

A122 0001 / REV 3

AREA 100

LUMMUS	ESTIMATE SHEET			THE LUMMUS COMPANY Bloomfield

No.	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 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: 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 ☒ SHPERE ☐ ERECT. WT		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

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

A122 1051 B 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-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	1.54	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-	4 500			
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 ☒ SHPERE ☐ ERECT WT		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 FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV. 2	

A122 10P1 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	2'-6" 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 ☒ SHPERE ☐ ERECT. WT		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 FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 1	

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-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 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		9000 LBS	2	18000			
13	m ☐ mm ☐							
14	MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm							
15	DES PRESS 150 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:							
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 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:							
29								
30	INSUL ☐ HORIZ ☐ VERT ☒ SHPERE ☐ ERECT. WT		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 FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 1	

A122 10R1 R 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
FA- 113 WATER COLLECTION POT	1						
18" OD 3'-0" TT TK SKIRT HT		1000 LBS	4-	4 000			
m ☐ mm ☐							
MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm							
DES PRESS 75 PSIG DES TEMP 300 °F							
DES PRESS kPa kg/cm² DES TEMP °C							
X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐							
INTERNALS							
INSUL ☒ HORIZ ☐ VERT ☑ SPHERE ☐ ERECT. WT		TONS					
FA- 114 FUEL GAS K.O. DRUM	1						
2'-6" ID 8'-0" TT TK SKIRT HT		2000 LBS	4-	8 000			
m ☐ mm ☐							
MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm							
DES PRESS 350 PSIG DES TEMP 150 °F							
DES PRESS kPa kg/cm² DES TEMP °C							
X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐							
INTERNALS: MIST ELIMINATOR							
INSUL ☐ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT		TONS					
FA- 115 RECYCLE GAS K.O. DRUM	1						
2'-6" ID 8'-0" TT TK SKIRT HT		1500 LBS	4-	4 500			
m ☐ mm							
MAT CS CLAD ☐ LINING ☐ CA 1/4" / mm							
DES PRESS 450 PSIG DES TEMP 150 °F							
DES PRESS kPa kg/cm² DES TEMP °C							
X-RAY-SPOT ☐ 100% ☐ STRESS REL ☐ FAB-SHOP ☐ FIELD ☐							
INTERNALS: MIST ELIMINATOR							
INSUL ☐ HORIZ ☐ VERT ☒ SHPERE ☐ ERECT. WT		TONS					
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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 FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 1	

A122 108 1-8 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					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 3/6/89	ACCT FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 1	

A122 1081 R 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	GA-101 A/S FEED	2						
2	GPM 110 · SUCT PSIG · DISCH PSI · TEMP 150 °F				150 000			
3	m³/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	m³/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	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 · 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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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 2/21/89		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 1		

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ESTIMATE SHEET

LUMMUS

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						
2	GPM 5 · SUCT PSIG · DISCH PSI · TEMP 120 °F							
3	m³/h · SUCT kPa kg/cm² · DISCH kPa kg/cm² · TEMP °C				15 000			
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						
12	GPM 0.2 · SUCT PSIG · DISCH PSI · TEMP 120 °F							
13	m³/h · SUCT kPa kg/cm² · DISCH kPa kg/cm² · TEMP °C				15 000			
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 A/S SOUR WATER							
22	GPM · SUCT PSIG · DISCH PSI · TEMP 120 °F	2						
23	m³/h · SUCT kPa kg/cm² · DISCH kPa kg/cm² · TEMP °C				15 000			
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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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
WAGE RATE		LAB COST		DATE 2/22/89	ACCT GA
				REV. 1	

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ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

	DESCRIPTION				QUANTITY REC	QUANTITY EA	UNIT COST	MATERIAL COST	STD LABOR MH UNIT	STD LABOR MH TOTAL	SUBCONTRACT COST
1	GA-107AS 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 CS	IMPELLER CS		3 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-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 ☒ SLURRY			kW							
18	TYPE CENT – ☐ RECIP ☒ PROP ☐ OTHERS ☐ API ☐ ANSI ☐										
19	MECH. SEAL ☐										
20	INSUL ☒	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 SS	IMPELLER SS		50 HP EACH							
27	DRIVE EM – ☒ TURB ☐ DIESEL ☐ OTHER ☐			kW							
28	TYPE CENT – ☒ RECIP ☐ PROP ☐ OTHERS ☐ API ☐ ANSI ☐										
29	MECH. SEAL ☒ TUNGSTEN CARB. – SPECIAL VERTICAL										
30	INSUL ☐	ERECT. WT. PUMP & DRIVER				TONS					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 2/21/79		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.		

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 H.P.							
7	DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] / kW							
8	TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ]							
9	MECH. SEAL [ ]							
10	INSUL [X] / 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 H.P.							
17	DRIVE EM – [ ] TURB [ ] DIESEL [ ] OTHER [ ] / kW							
18	TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ]							
19	MECH. SEAL [ ]							
20	INSUL [X] / 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 H.P.							
27	DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] / kW							
28	TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ]							
29	MECH. SEAL [ ]							
30	INSUL [ ] / ERECT. WT. PUMP & DRIVER		TONS					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF PLANT	PROD. FACT	LOC. M.H.	BY GS
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 2/21/89
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 1
JOB EST NO. 5571	ACCT GA		

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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 33 SUCT PSIG DISCH PSI TEMP 200 °F				15 000			
3	m³/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 4 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	m³/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	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 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					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY GS	JOB EST NO. 5571
LOCATION BEULA, NORTH DAKOTA			DATE 3-6-89	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 1	

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	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 [X] INTERCOOLER [X] COND [X] + 3 STAGE UNITS							
9	TYPE: CENT [ ] RECIP [X] 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 [X] INTERCOOLER [ ] COND [ ]							
19	TYPE: CENT [ ] RECIP [X] 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					
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CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT	PROD FACT	LOC M.H.	BY GS	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 2/21/89	ACCT GB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			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	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	ESTIM. 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	MOTIV. 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)							
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	PROD FACT	LOC. M.H.	BY GS	JOB / EST NO. 5571 — ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 2/23/89	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 1	

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						T/K
2					1,000 000			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_6^+ — 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	PROD FACT	LOC MH	BY GS	JOB EST NO 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE 2/23/89	ACCT
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 2	

LCI PROJECT 5571
TASK 4.0

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

CE 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: TOTAL 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 JP8 TOWER FEED HEATER ✓	1			300 000			
12	ABSORBED DUTY: RAD / CONV / TOTAL							
13	MM Btu/h: RAD 24.00 / CONV 1.00 (*) / TOTAL 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	(*) 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	PROD FACT	LOC M.H.	BY [illegible]	JOB EST NO. 5571	ACCT BA
LOCATION BEULAH, NORTH DAKOTA			DATE FEB [illegible]		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV		

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 JP8 TOWER ✓	1						
2	7'-6" ID 50'-0" TT TK 25' SKIRT HT		33000 LBS	1.20	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 JP8 PRODUCT STRIPPER ✓	1						
12	3'-0" ID 20'-0" TT TK 25' SKIRT HT		7000 LBS	2.20	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. SKIRT HT		5000 LBS	2.50	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 ANG/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC MH	BY HHK	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE FEB 1989	ACCT DA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			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	DC 201 HDS REACTOR ✓	1	260,000	3.45	900 000			
2	6'-0" ID 30'-0" TT TK MIN SKIRT HT							
3	m [ ] mm [ ]							
4	MAT 2¼Cr - ½Mo 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					
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CLIENT DOE/AMOCO - GREAT PLAINS GASIF. PLANT
LOCATION BEULAH, NORTH DAKOTA
PROD FACT
LOC MH
BY HHK
DATE FEB 1971
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. m²/SHELL TOTAL m² /SERV		m²					
5	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
6	MAT 2¼Cr - ½Mo 2¼Cr - ½Mo							
7	DES PRESS 2300 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 JP8 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 m²/SHELL TOTAL m² /SERV		m²					
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 JP8 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 m²/SHELL TOTAL m² /SERV		m²					
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/DOE - GREAT PLAINS GASIF PLANT	PROD FACT	LOC MH	BY GS HHK	JOB EST NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA		LAB COST	DATE FEB. 1983		

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 AMOCO/DOE - GREAT PLAINS GASIF PLANT	PROD FACT	LOC MH	BY GS HHK	JOB NO. 5571
LOCATION BEULAH NORTH DAKOTA	WAGE RATE	LAB COST	DATE FEB 1979	EST
			REV 0	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-	9000			
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-	13500			
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 BA 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-	36300			
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 GASIF PLANT	PROD FACT	LOC M H	BY GS	JOB EST NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE		

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 210 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. m2/SHELL TOTAL m2 /SERV		m2					
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. m2/SHELL TOTAL m2 /SERV		m2					
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. m2/SHELL TOTAL m2 /SERV		m2					
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 AMOCO/DOE GREAT PLAINS GASIFICATION PLANT
LOCATION BEULAH, NORTH DAKOTA
PROJECT ET & EL FROM COAL ... [illegible]

PROD FACT	LOC MH	BY GS	JOB EST NO 5571	ACCT EA
WAGE RATE	LAB COST	DATE 4-10-80		
		REV		

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^2EA		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^2EA		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^2EA		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 HHK	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE FEB. 1981	ACCT EC
PROJECT JET FUEL FROM COAL DERIVED 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 3/4	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		71000 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 ☑ SHPERE ☐ ERECT WT		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC MH	BY HHK	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH NORTH DAKOTA	WAGE RATE	LAB COST	DATE FEB. 1979		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			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 JP8 TOWER FEED SURGE DRUM ✓	1						
2	5'-0" ID 20'-0" TT TK MIN. SKIRT HT		21000 LBS	1.54	32000			
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 JP8 TOWER OVERHEAD REFLUX/PROD. DRUM ✓	1						
12	5'-0" ID 20'-0" TT TK 30' SKIRT HT		13000 LBS	1.75	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-	4500			
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 ☑ SHPERE ☐ ERECT. WT		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

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

A122 1081-R REV. 2

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	PROD FACT	LOC M H.	BY HHK	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH NORTH DAKOTA			DATE FEB 1981		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 0		

A122 1081 B REV 2

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-	4 500			
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-	4 500			
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 NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE 4-19-89	EST	FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 1		

Area 200

LUMMUS
Bloomfield

ESTIMATE WORKSHEET

	DESCRIPTION	QUANTITY AMOUNT	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 JP8 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 JP8 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	TYPE OF ESTIMATE	PRODUCTIVITY FACTOR (2)	BY HHK	JOB EST NO 5571
32 LOCATION BEULAH, NORTH DAKOTA		LOCATION MH	DATE FEB. 1989	ACCT GA
33 PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		WAGE RATE (3) $/MH	REV 0	

Area 200

LUMMUS
Bloomfield

ESTIMATE WORKSHEET

	DESCRIPTION	QUANTITY AMOUNT	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 - 204 A/S JPB TOWER BOTTS. PUMP & SPARE ✓	TWO	No							
2	GPM 65 SUCT 20 PSIG DISCH 105 PSIG							15000		
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 #							
10	GA - 205 A/S NAP. STABILISER REFLUX PUMPS ✓	TWO	No							
11	GPM 10 SUCT 110 PSIG DISCH 170 PSIG							15000		
12	TEMP 100 °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 #							
19	GA - 206 A/S HP WASH WATER PUMP & SPARE ✓	TWO	No							
20	GPM 10 SUCT 350 PSIG DISCH 2450 PSIG							50000		
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 #							
28										
29	TOTAL THIS PAGE									
30	TOTAL ACCOUNT GA									

31 CLIENT DOE/ANUCO - GREAT PLAINS GASIF PLANT | TYPE OF ESTIMATE | PRODUCTIVITY FACTOR (2) | BY HHK | JOB EST NO 5571 | ACCT GA

32 LOCATION BEULAH, NORTH DAKOTA | LOCATION MH | DATE FEB. 1983

33 PROJECT SET FUEL FROM COAL DERIVED LIQUIDS | WAGE RATE (3) $/MH | REV 0

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 HDS 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 2 MOL% H_2S, 96% H_2 / IMPELLER / VOLTS							
7	DRIVER EM [X] TURB [ ] DIESEL [ ] 88 BHP / kW							
8	INCL GEAR [ ] LUBE & SEAL [ ] INTERCOOLER [ ] COND [ ]							
9	TYPE CENT [ ] RECIP [X] 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 [X] TURB [ ] DIESEL [ ] 2870 BHP / kW							
18	INCL GEAR [ ] LUBE & SEAL [X] INTERCOOLER [X] COND [X]							
19	TYPE CENT [ ] RECIP [X] 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 [X] TURB [ ] DIESEL [ ] 4000 BHP / kW							
28	INCL GEAR [ ] LUBE & SEAL [X] INTERCOOLER [X] COND [X]							
29	TYPE CENT [ ] RECIP [X] ROTARY [ ] SCREW [ ]							
30	INSUL [ ] ERECT WT COMPR + DRIVE		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

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

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								T/C
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 16.21 "							
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.							
27								
28								
29								
30								
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

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

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				60000			
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 - 1/2 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 ANNGCO/DOE - GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY HHK	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE FEB 198[illegible]	ACCT BA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

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 32'-0" TT TK MIN SKIRT HT		140,000#	4 -	560000			
3	m [ ] mm [ ]							
4	MAT 2 1/4 Cr - 1/2 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	PROD FACT	LOC MH	BY HHK	JOB / EST NO 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE FEB 1983	ACCT DC
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 0	

AREA 300

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

No.	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	80000			
4	NO SHELL/SERV. m²/SHELL TOTAL m² /SERV		m²					
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 kg/cm² — 1900 PSIG / kPa kg/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. m²/SHELL TOTAL m² /SERV		m²					
15	SHELL SIDE C.A. 1/8" / mm — TUBE SIDE C.A. / mm							
16	MAT CS — CS							
17	DES PRESS 150 PSIG / kPa kg/cm² — 1900 PSIG / kPa kg/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. m²/SHELL TOTAL m² /SERV		m²					
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	PROD FACT	LOC MH	BY GS HHK
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE FEB 19[illegible]
JOB EST NO. 5571	ACCT EA		REV

AREA 300

ESTIMATE SHEET

CE LUMMUS — 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^2EA		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^2EA		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^2EA		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 MMK	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE FEB 1983	ACCT EC
PROJECT JET FUEL FROM COAL [illegible] LIQUIDS	WAGE RATE	LAB COST	REV 0	

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 ☐ SHPERE ☐	ERECT WT				TONS					
	TOTAL THIS PAGE										
	TOTAL ACCOUNT										

CLIENT AMOCO/DOE - GREAT PLAINS GASIF. PLANT	PROD FACT	LOC. M.H.	BY HHK	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH NORTH DAKOTA			DATE FEB 1981		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV. 1		

A-17-1081 R REV. 2

Area 300

LUMMUS Bloomfield

ESTIMATE WORKSHEET

	DESCRIPTION	QUANTITY AMOUNT	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/S 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		tons 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		tons 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		tons 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
32 LOCATION BEULAH, NORTH DAKOTA		LOCATION MH	DATE FEB. 1989	ACCT GA
33 PROJECT JET FUEL FROM COAL DERIVED LIQUIDS		WAGE RATE (3) $/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.							
2	CAP. ACTUAL SUCTION CFM 182.1							400 000		
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
32 LOCATION BEULAH NORTH DAKOTA		LOCATION MH	DATE FEB. 1983	ACCT GB
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 CS 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 CS 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 1/4 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	PROD. FACT	LOC. M.H.	BY M.L.	JOB / EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 11/25/87	ACCT FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	-

A122 10R1-8 REV. 2

CASE I 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 CS 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	PROD FACT	LOC. M.H.	BY MC.
LOCATION BEULAH, NORTH DAKOTA			DATE 11/25/87
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0

JOB EST NO. 5571 ACCT FA

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	GA. 501A/S 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. 502A/S 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	PROD. FACT	LOC. M.H.	BY MLL	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 11/25/82		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	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
OCATION: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 600AREA (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		7000 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 [X] FIELD [ ]							
9								
10	INSUL [X] DA - lbs DB - lbs ERECT WT		TONS					
11	DA 602 HDT NAPHTHA STABILIZER	1						
12	2'-6" ID 32'-0" TT TK SKIRT HT		7000 LBS	3-	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 [X] FIELD [ ]							
19								
20	INSUL [X] DA - lbs DB - lbs ERECT WT		TONS					
21	DA							
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' 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	PROD FACT	LOC MH	BY MIL
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 86
PROJECT JET FUEL FROM COAD DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 0

JOB EST NO. 5571 — ACCT DA

CASE 7 MAX PROFIT

600 AREA

LUMMUS ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

DESCRIPTION					QUANTITY		UNIT COST	MATERIAL COST	STD LABOR MH		SUBCONTRACT COST
					REQ	EA			UNIT	TOTAL	
DB 601 NAPHTHA DISTILL. TRAYS											
TYPE	DIA	DIA m[ ] mm[ ]	MAT	NO PASSES							
Valve	2'-6"		CS	1	30		$150-	4500			
OTHER INTERNALS											
				ERECT WT		TONS					
DB 602 HDT NAPHTHA STABIL. TRAYS											
TYPE	DIA	DIA m[ ] mm[ ]	MAT	NO PASSES							
Valve	2'-6"		CS	1	18		$150-	2700			
OTHER INTERNALS											
				ERECT WT		TONS					
DB											
TYPE	DIA	DIA m[ ] mm[ ]	MAT	NO PASSES							
OTHER INTERNALS											
				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 | WAGE RATE | LOC M.H. | LAB COST

BY HL
DATE 4JAN88
REV 0

JOB/EST NO. 5571

ACCT

DB

CASE 7 MAX PROFIT 600 AREA

LUMMUS
Bloomfield

ESTIMATE WORKSHEET

	DESCRIPTION	QUANTITY AMOUNT	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	25000	lbs. ea.				5.00	125000		
3										
4	MAT'L C-1/2Mo 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

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 MC

DATE 4 JAN 88

REV. 0

JOB EST. NO. 5571

ACCT DC

A122 0578-5

SE 7 MAX PROFIT 609 EA

LUMMUS — ESTIMATE SHEET — THE LUMM... 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. 1 SQ FT/SHELL 700 TOTAL SQ FT 700 /SERV		1	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 kg/cm² 140 PSIG / kPa kg/cm²								
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. 1 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 kg/cm² 130 PSIG / kPa kg/cm²								
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 kg/cm² 870 PSIG / kPa kg/cm²								
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 WJC.	JOB EST NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 88		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A122 1081-6 REV. 2

C .E 7 MAX PROFIT 600' EA

THE LUMMUS COMPANY
Bloomfield

CE LUMMUS

ESTIMATE SHEET

	DESCRIPTION	QUANTITY REQ	QUANTITY TOTAL		UNIT COST	MATERIAL COST	STD LABOR MH UNIT	STD LABOR MH TOTAL	SUBCONTRACT COST
1	EA-604 HDT REACTOR RECYCLE GAS HEATER	1							
2	SIZE-IN. D/L mm D/L TYPE AEU								
3	NO SHELL/SERV. 1 SQ FT/SHELL 2000 TOTAL SQ FT 2000 /SERV			SQ FT	20-	40000			
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 kg/cm² 635 PSIG / kPa kg/cm²								
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. 1 SQ FT/SHELL 175 TOTAL SQ FT 175 /SERV			SQ FT	40-	7000			
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 kg/cm² 870 PSIG / kPa kg/cm²								
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. 1 SQ FT/SHELL 350 TOTAL SQ FT 350 /SERV			SQ FT	25-	9000			
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 kg/cm² 870 PSIG / kPa kg/cm²								
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					
	TOTAL THIS PAGE								
	TOTAL ACCOUNT								

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC M.H.	BY MC.	JOB/EST NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 88		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A172 1081-6 REV. 2

SE 7 MAX PROFIT 600 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-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-	10000			
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 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-	7000			
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 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 HDT 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	6000			
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 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	PROD. FACT	LOC. M.H.	BY MIL	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 80	ACCT EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

A172 1081-8 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-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 ☒ SHPERE ☐ ERECT. WT.		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY [illegible]	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH, NORTH DAKOTA			DATE 17JAN86		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

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 MIN 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 ☐ SHPERE ☐ ERECT. WT.		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

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CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MK.	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 88		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A172 1081-8 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 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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC M.H.	BY MC	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 1 Jan 88	ACCT FA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB COST	REV 0	

A172 1081 8 REV. 2

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	m³/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 602 A/S DISTIL. COL'N BOTTOMS	2			8000			
12	GPM 18 | SUCT PSIG | DISCH PSI | TEMP 275 °F							
13	m³/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	m³/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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MLL	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 88		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A122 0482 10 REV. 3

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	m³/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			8000			
12	GPM 6 / SUCT PSIG / DISCH PSI / TEMP 70 °F							
13	m³/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	m³/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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT		LOC. M.H.		BY MLL
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE		LAB. COST		DATE 4 JAN 86
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS					REV. 0

JOB/EST NO. 5571 — ACCT GA

A122 0482-10 REV. 3

CA. 7 MAX PROFIT 600 A[illegible]

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			8000			
2	GPM 30 · 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 30 PSI · STGS							
5	ΔP m kPa kg/cm² · RPM							
6	MAT CASE CS · IMPELLER CS · 1.5 HP							
7	DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] · kW							
8	TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ]							
9	MECH. SEAL [X]							
10	INSUL [X] · ERECT. WT PUMP & DRIVER		TONS					
11	GA 608A/S SOUR WATER	2			8000			
12	GPM 1/2 · SUCT PSIG · DISCH PSI · TEMP °F							
13	m³/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 Cr · 1/2 HP							
17	DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] · kW							
18	TYPE CENT – [ ] RECIP [ ] PROP [X] OTHERS [ ] API [ ] ANSI [ ]							
19	MECH. SEAL [ ]							
20	INSUL [ ] · ERECT. WT PUMP & DRIVER		TONS					
21	GA.							
22	GPM · SUCT PSIG · DISCH PSI · TEMP °F							
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 · 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	PROD. FACT	LOC. M.H.	BY MJL	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 1/JAN/88		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A122 0482-10 REV 3

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	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 [X] TURB [ ] DIESEL [ ] 20 BHP/ kW							
8	INCL: GEAR [X] LUBE & SEAL [X] INTERCOOLER [ ] COND [ ]							
9	TYPE CENT [ ] RECIP [X] ROTARY [ ] SCREW [ ]							
10	INSUL [X] 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 [X] TURB [ ] DIESEL [ ] 20 BHP/ kW							
18	INCL: GEAR [X] LUBE & SEAL [X] INTERCOOLER [ ] COND [ ]							
19	TYPE CENT [ ] RECIP [X] ROTARY [ ] SCREW [ ]							
20	INSUL [X] 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 ML.
LOCATION BEULAH, NORTH DAKOTA			DATE 4 JAN 88
PROJECT JET FUEL FROM COAL DERIVED LIQ	WAGE RATE	LAB. COST	REV 0

JOB EST NO. 5571

ACCT GB

A122 1081 11 REV 2

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	

C.ise 7 MAX PROFIT 700 AREA

THE LUMMUS COMPANY
Bloomfield

LUMMUS

ESTIMATE SHEET

	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	45000			
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-	24000			
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" SKIRT HT		15,000 LBS	2.50	38000			
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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB COST	DATE 12/18/87	ACCT DA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0	

A122 1081 3 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-704 RECOVERY COLUMN	1						
2	3'-0" ID 112'-0" TT TK 18'-0" SKIRT HT		23,000 LBS	2.50	58000			
3	m ☐ mm ☐							
4	MAT. C.S. 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" SKIRT 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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT DA
PROJECT JET FUEL FROM COAD DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

CASE 7 MAX PROFIT 700 AREA

ESTIMATE SHEET

LUMMUS — 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" SKIRT 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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT DA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

CASE 7 MAX PROFIT

700 AREA

LUMMUS

ESTIMATE SHEET

THE LUMMUS COMPANY
Bloomfield

	DESCRIPTION	DIA	DIA m ☐ mm ☐	MAT.	NO. PASSES	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	STIRLING TRAY	2'-6"		CS		1		150	14,000			
4	RAIN DECK	2'-6"		CS	2	94		150				
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	1,000			
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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571	ACCT DB
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV 0		

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 GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87		DB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV		

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 42A		240 FT³						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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/14/87	ACCT DB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV 0	

C SE 7 MAX PROFIT 700 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 CS / CS							
7	DES PRESS 130 PSIG kPa/kg/cm² 130 PSIG kPa/kg/cm²							
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 CS / CS							
17	DES PRESS 150 PSIG kPa/kg/cm² 310 PSIG kPa/kg/cm²							
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 REBOILER	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/kg/cm² 635 PSIG kPa/kg/cm²							
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					
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	TOTAL ACCOUNT							

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

A122 1081-6 REV. 2

C. .E 7 MAX PROFIT 700 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		SQ FT	20-	4000			
3	NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 200 /SERV		m^2					
4	NO SHELL/SERV. m^2/SHELL TOTAL m^2 /SERV							
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		SQ FT		5000			
13	NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 60 /SERV		m^2					
14	NO SHELL/SERV. m^2/SHELL TOTAL m^2 /SERV							
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			5000			
22	SIZE-IN. D/L mm D/L TYPE STABBED-IN. B-U		SQ FT					
23	NO SHELL/SERV. 1 SQ FT/SHELL TOTAL SQ FT 40 /SERV		m^2					
24	NO SHELL/SERV. m^2/SHELL TOTAL m^2 /SERV							
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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CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MML
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/18/87
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0

JOB/EST NO. 5571 ACCT EA

A172 1081-6 REV. 2

CA. = 7 MAX PROFIT 700 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-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. 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/ 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. 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/ 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. 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/ 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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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571	ACCT EA
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A122 10814 REV. 2

C. E-7 MAX PROFIT 700 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-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. m²/SHELL TOTAL m² /SERV		m²					
5	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
6	MAT COLUMN CS (FINNED TUBE)							
7	DES PRESS PSIG/ kPa kgf/cm² 635 PSIG/ kPa kgf/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 [X] 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. m²/SHELL TOTAL m² /SERV		m²					
15	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
16	MAT CS C.S.							
17	DES PRESS 310 PSIG/ kPa kgf/cm² 130 PSIG/ kPa kgf/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. m²/SHELL TOTAL m² /SERV		m²	40-	3000			
25	SHELL SIDE C.A. / mm TUBE SIDE C.A. / mm							
26	MAT CS CS							
27	DES PRESS 365 PSIG/ kPa kgf/cm² 365 PSIG/ kPa kgf/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 [X] ERECT. WT		TONS EA					
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CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0

JOB EST NO. 5571 ACCT EA
7

A122 1081-6 REV. 2

C. SE 7 MAX PROFIT 700 A

LUMMUS

ESTIMATE SHEET

THE LUMMU. 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 kg/cm² 635 PSIG/ kPa kg/cm²							
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	25-	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 kg/cm² 635 PSIG/ kPa kg/cm²							
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 kg/cm² 130 PSIG/ kPa kg/cm²							
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					
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CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/18/87	ACCT EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0	

A122 1081-6 REV.

C. 6 7 MAX PROFIT 700 A

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

No.	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 / 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- 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 / kPa kg/cm² 635 PSIG / kPa 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 / kPa kg/cm² 130 PSIG / kPa 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					
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CLIENT Amoco /DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/18/87	ACCT EA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0	

A122 1081-6 REV. 2

C. . E 7 MAX PROFIT 700 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- 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 kg/cm² 130 PSIG / kPa kg/cm²							
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 kg/cm² 130 PSIG / kPa kg/cm²							
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 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	PROD. FACT		LOC. M.H.		BY ML
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE		LAB. COST		DATE 12/14/87
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS					REV.

JOB EST NO. 5571

ACCT EA

A122 1081-8 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 CS. 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 & VORTEX BKRS.							
19	18"φ x 2'6"- 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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MC.	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH, NORTH DAKOTA			DATE 12/14/82		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.	7	

A122 10R1-8 REV. 2

CASE 7 MAX PRAFIT 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 1/3							
30	INSUL ☒ HORIZ ☐ VERT ☒ SPHERE ☐ ERECT. WT.		TONS					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT Amoco/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT		LOC. M.H.		BY MK.	JOB/EST NO. 5571	ACCT FA
LOCATION BEULAH, NORTH DAKOTA					DATE 12/15/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE		LAB. COST		REV. 0		

A122 10R1 8 REV. 2

CASE 7 MAX PROFIT 700 AREA

ESTIMATE SHEET

LUMMUS — 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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MC.	JOB EST NO. 5571	ACCT FA
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV 0		

A122 10R1-8 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	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				30000
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	15000			
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				25000
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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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/1X/87	ACCT FB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

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	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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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MC.	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT FB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

A122-1120 R REV. 1

CA-:7 MAX PROFIT 700 Ah..

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	m³/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 – [X] TURB [ ] DIESEL [ ] OTHER [ ] · kW							
8	TYPE CENT – [X] RECIP [ ] PROP [ ] OTHERS [ ] API [ ] ANSI [ ]							
9	MECH. SEAL [X]							
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	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 · ½ HP							
17	DRIVE EM – [X] TURB [ ] DIESEL [ ] OTHER [ ] · kW							
18	TYPE CENT – [ ] RECIP [ ] PROP [X] 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	m³/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 – [X] TURB [ ] DIESEL [ ] OTHER [ ] · kW							
28	TYPE CENT – [ ] RECIP [ ] PROP [X] OTHERS [ ] API [ ] ANSI [ ]							
29	MECH. SEAL [ ]							
30	INSUL [ ] · ERECT. WT. PUMP & DRIVER		TONS					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0	

A122 0482-10 REV. 3

CASE 7 MAX PROFIT 700 ARLR

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			6000			
2	GPM 80 | SUCT 20 PSIG | DISCH PSI | TEMP 350 °F							
3	m³/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	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- 706A&S EXTRACTOR RECYCLE PUMP	2			6000			
22	GPM 15 | SUCT 5 PSIG | DISCH PSI | TEMP 100 °F							
23	m³/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					
	TOTAL THIS PAGE							
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/18/87	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0	

A122 0482-10 REV. 3

CASE 7 MAX PROFIT 700 Ah-R

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				12000			
3	m³/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			8000			
12	GPM 3 / 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 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 COL'N OVHD PUMP	2			8000			
22	GPM 25 / SUCT -5 PSIG / DISCH PSI / TEMP 100 °F							
23	m³/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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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571 / ACCT GA
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 12/18/87	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV. 0	

A122 0482-10 REV 3

CASE 7 MAX PROFIT 700 AHLR

CE 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	m^3/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	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-712 SOLVENT TRANSFER PUMP	1			4 000			
22	GPM 50 · SUCT 0 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 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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV. 0		

A122 0482-10 REV. 3

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	GA-713 WET SOLVENT PUMP	1			7000			
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 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-714A&B SOLVENT SUMP PUMP (MARCH'S 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 · 2½ 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					
	TOTAL THIS PAGE							
	TOTAL ACCOUNT							

CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.		BY ML	JOB EST NO. 5571 / ACCT GA
LOCATION BEULAH, NORTH DAKOTA				DATE 12/18/87	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST		REV. 0	

A122 0482 10 REV. 3

CASE 7 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- 716A/S BENZENE COL'N BTMS PUMP	2			8000			
2	GPM 15 · SUCT 15 PSIG · DISCH PSI · TEMP 300 °F							
3	m³/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 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- 717A/S BENZENE COL'N REFLUX PUMP	2			8000			
12	GPM 50 · SUCT 5 PSIG · DISCH PSI · TEMP 140 °F							
13	m³/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 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- 718A/S BENZENE COL'N WATER PUMP	2			8000			
22	GPM 1/3 · SUCT 10 PSIG · DISCH PSI · TEMP 140 °F							
23	m³/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 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	PROD. FACT	LOC. M.H.	BY ML	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE [illegible]	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.	

A122 0482-10 REV. 3

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 719 A?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 720 A?S TOLUENE COL'N 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 721 A?S TOLUENE COL'N 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 [illegible] LIQUIDS

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

BY MIL
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	PROD. FACT	LOC. M.H.	BY MLL	JOB EST NO 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 12/18/87	ACCT GA
PROJECT JET FUEL FROM COAL [illegible]	WAGE RATE	LAB. COST	REV. [illegible]	

A122 0482-10 REV. 3

CASE 1 MAX FILOF17

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 = 300 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 (~200 F)
1 LOADING CHUTE

$15,000

A2.601

0	12/18/57						
REV.	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE

LUMMUS

THE LUMMUS COMPANY
Bloomfield N. J.

DWG. NO.

A106 03 0778-1 REV.1

6.0 EQUIPMENT DATA AND ESTIMATE SHEETS

6.3 Phenol Stream

AREA 800

CLIENT: DOE PROJECT: 5571
LOCATION: BEULAH, ND.
PROJECT: JET FUEL 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	

		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" ft-in
VERT HT	85'-0" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH	
OPER TEMP	TOP 194 °F BOTT 445 °F DRUM
MAX TEMP	TOP °F BOTT °F DRUM °F
NORM OPER PRESS	-12.7 (TOP) psig OR -6.9 (BOTTOM) psig
MAX OPER PRESS	psig OR psig
CORROSION ALLOW	SHELL 4.5 mm in DRDS in
DES TEMP	470 °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 Note (2) THK in
INSULATION	CONSERV'N ✓ PROTECT'N NONE
DECK MATL	CS VALVE MATL. 304SS
NOZZLES: FLG CLASS	150 COUPL CLASS

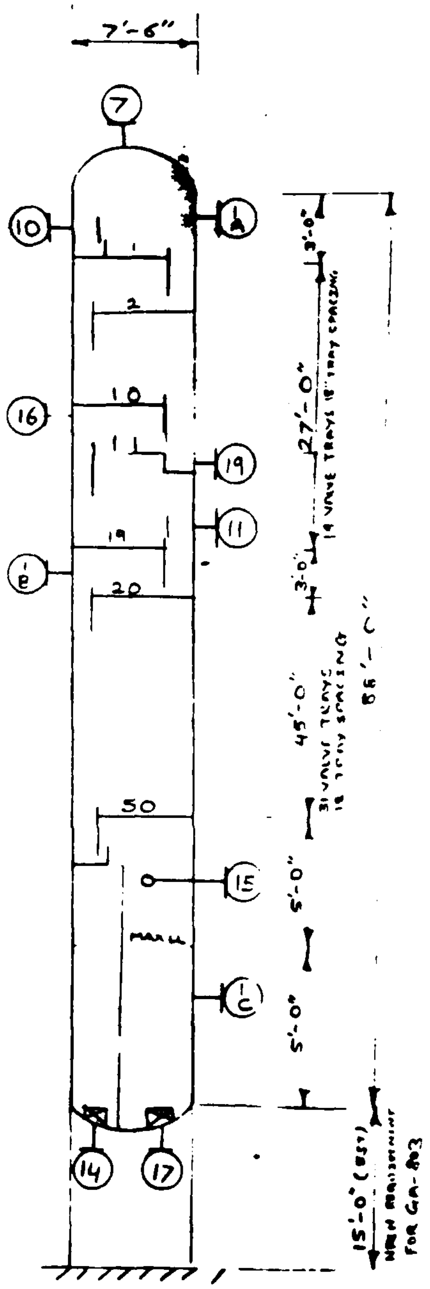
FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 50 TO NOZZLE NO.

ITEM NO.	NO REQD	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	2	REFLUX IN FROM FA-801
11	1	2	FEED FROM GA-8C
12			FEED FROM
13			FEED FROM
14	1	10	TO REBOILER (REB. PUMP)
15	1	20	FROM REBOILER
16	1	2	EQUALIZING LINE WITH FA-807
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 (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	4		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

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



LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE - GASIFICATION BEULAH, NORTH DAKOTA GREAT PLAINS

PROJ NO — JOB NO 71

PROCESS VESSEL SKETCH

VESSEL NO DA-801

REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR		APPR	APPR
△						
△		FOR TASK 4	SR.			

[illegible] BATCH
[illegible] LUMMUS JOB OR ESTIMATE 5571
DA-401 FLASH COLUMN [illegible] DEPT 302 OFFICE 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/FT3	LIQUID RATE [illegible]	LIQUID DENSITY LBS/FT3	SURFACE TENSION DYNES/CM	LIQUID VISCOSITY CENTIPOISE
MAXIMUM =	4967[illegible]	.062[illegible]	84[illegible]	59.[illegible]	26.[illegible]	.34300
(BASED ON [illegible] MAXIMUM LOADED TRAY)						
MINIMUM =	41[illegible]	.095[illegible]	42525.[illegible]	57.[illegible]	[illegible]	.30200
(BASED ON TURNDOWN [illegible] 70.0 [illegible] 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.[illegible]
OUTLET WEIR HEIGHT 1.2[illegible]
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] [illegible]
DOWNCOMER CLEARANCE [illegible] [illegible]
DOWNCOMER BOTTOM TO TRAY [illegible] [illegible]
DOWNCOMER PLATE TO SHELL DISTANCE 9.[illegible]
LENGTH OF DOWNCOMER PLATE [illegible] 5[illegible]

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

[illegible] ATTACH THIS SHEET TO [illegible] SPECIFICATION FOR THIS TRAY * * * * * *

VESSEL NO DA-802 COMB WITH

VESSEL NAME DRYER COLUMN

DIAMETER 4'-0" ft-in & ft-in

VERT HT 24'-3" ft-in SKIRT 15'-0" ft-in

HORIZ LENGTH ft-in

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

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS -12.5 (Top) psig OR -12.7 (Btm) psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW SHELL 1/8" @ 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 NOTE (2) THK in

INSULATION CONSERV'N ✓ PROTECT'N NONE

DECK MATL CS VALVE MATL 304 SS

NOZZLES FLG CLASS 150 COUPL CLASS

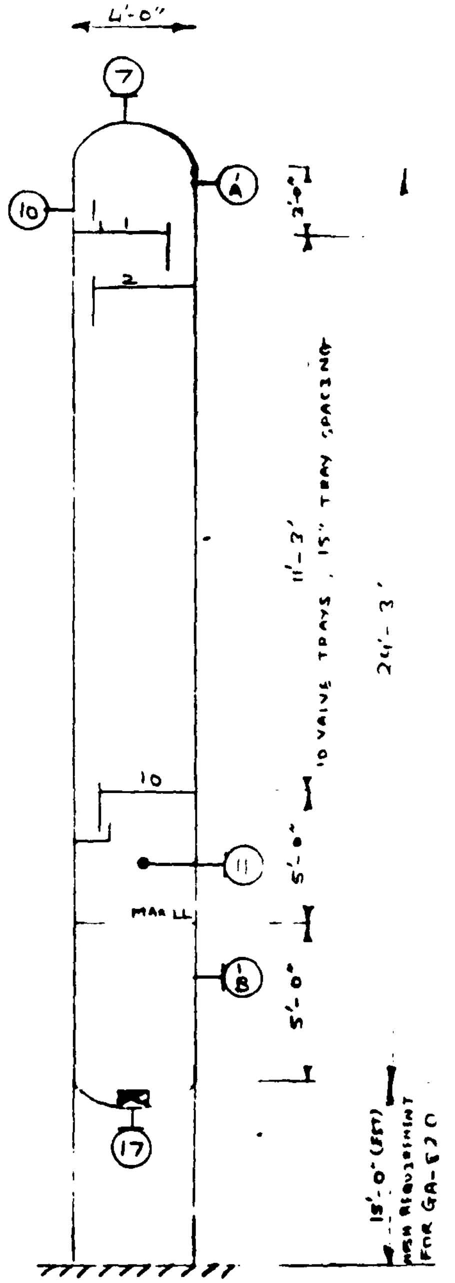
ITEM NO.	NO REQD	SIZE in	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7	1	10	VAPOR OUTLET TO EA-805
8			VENT
9			TO VACUUM EQUIPMENT
10	1	1 1/2	REFLUX IN FROM FA-802
11	1	12	FEED FROM FD-801
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (RES. PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17	1	3	BOTTOM OUTLET TO GA-820
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 (& 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:

(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.



LUMMUS	THE LUMMUS COMPANY					
TITLE JET FUEL PROJECT						
AMOCO/DOE · LUMMUS BEULAH, NORTH DAKOTA						
05571						
	FOR TDR		JL			
PRESSURE VESSEL SKETCH						
REV	DATE	DESCRIPTION				VESSEL NO DA-802

CE LUMMUS VALV TRAY COMPUTER PROGRAM [illegible] RELEASE 03 DATED APR 25 1966 BATCH
BY SUNIL USED AT 09.44.43 ON 88/11/29. DESIGN FINE ROUNDED TO 5X0 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	7773.00	56.94000	20.96	.28300
[illegible]	2742.20	.13700	2487.80	58.13000	23.40	.29000

(BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY)

(BASED ON TURNDOWN TO [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 1)	4.000
[illegible] DISTANCE		4.000
OUTLET WEIR HEIGHT		2.250
HEIGHT [illegible] WEIR NOTCH		1.500
[illegible]	(NOTE 2)	20.395
[illegible]		20.396
[illegible]	(NOTE 1)	4.000
DOWNCOMER [illegible]	(NOTE 3)	.750
DOWNCOMER [illegible] TO TRAY INLET	(NOTE 4)	.000
[illegible]		4.000
[illegible]	(NOTE 2)	20.395

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

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

VESSEL NO. DA 802 COMB WITH
VESSEL NAME PHENOL COLUMN
DIAMETER 9'-0" ft-in & ft-in
VERT HT 118'-0" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP TOP 212 °F BOTT 350 °F DRUM °F
MAX TEMP TOP °F BOTT °F DRUM °F
NORM OPER PRESS -12.7(TOP) psig OR -6.0(Bottom) psig
MAX OPER PRESS psig OR psig
CORROSION ALLOW SHELL 4.5mm in HEADS in

DES TEMP 375 °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

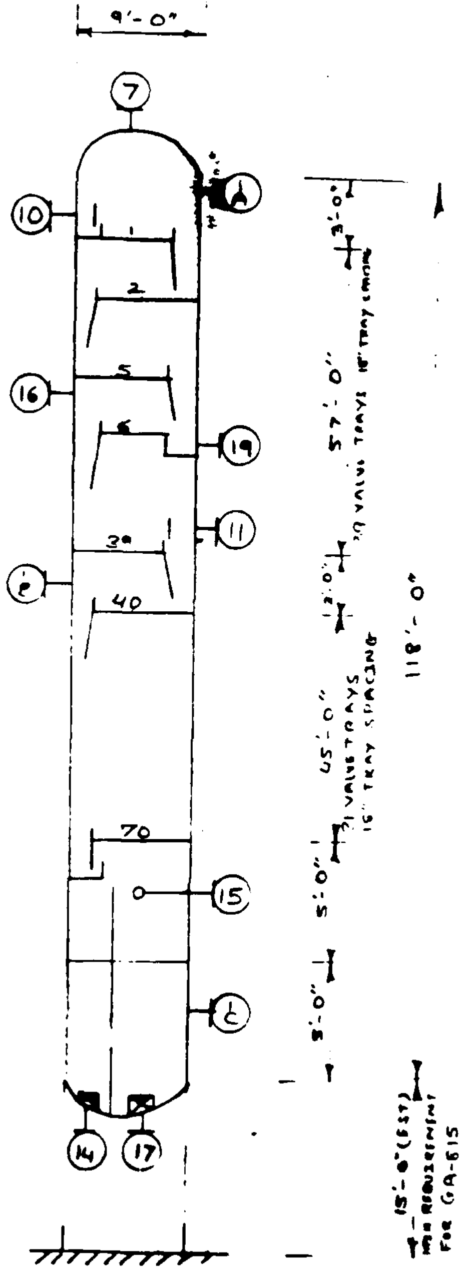
MATL: SHELL CS LINER NOTE(2) THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL: CS VALVE MATL 304 SS

NOZZLES FLG CLASS 150 COUPL CLASS

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

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 EA-807
8			VENT
9			TO VACUUM EQUIPMENT
10	1	4	REFLUX IN FROM FA-803
11	1	1 1/2	FEED FROM GA-820
12			FEED FROM
13			FEED FROM
14		12	TO REBOILER (REB. PUMP)
15		20	FROM REBOILER
16	1	1 1/2	EQUALIZING LINE WITH FA-806
17	1	1 1/2	BOTTOM OUTLET TO GA-815
18			LIQUID OUTLET TO
19	1	3	DRAWOFF TO FA-815
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 (PSVV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PI)
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			

(1) LIQUID SP. GR. = 0.942(avg) @ operating temp.
(2) 316L SS CLAD BELOW TRAY # 5.
NO CORR ALLOW. FOR CS SHELL IN THIS SECTION.



⚠							
⚠		For TRAY					
REV		DESCRIPTION				APPR	APPR

THE LUMMUS COMPANY

LUMMUS

TITLE JET FUEL PROJECT

05571

VESSEL SKETCH

VESSEL NO. DA-802

DA 105

LAYOUT DIMENSIONS

TRAY SPACING,INCHES 15. [illegible] 114.0
TYPE OF FLOW [illegible]

DESIGN LOADS	VAPOR RATE	VAPOR DENSITY	LIQUID RATE	LIQUID DENSITY	SURFACE TENSION	LIQUID VISCOSITY
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CENTIPOISE
MAXIMUM =	69[illegible]	[illegible]	63854.[illegible]	60.98[illegible]	[illegible]	.36000
MINIMUM =	565[illegible]	[illegible]	6068[illegible]	56.[illegible]	22.[illegible]	.29500

(BASED ON OVERDESIGN [illegible] MAXIMUM LOADED TRAY)

(BASED ON TURNDOWN [illegible] MINIMUM LOADED TRAY)

DOWNCOMER LOCATION [illegible]E
DOWNCOMER TYPE [illegible]

DIMENSIONS AT TOP OF DOWNCOMER,INCHES
DOWNCOMER WIDTH [illegible] 1[illegible].
DOWNCOMER PLATE TO SHELL DISTANCE 1[illegible].
OUTLET WEIR HEIGHT [illegible]
OUTLET WEIR LENGTH [illegible] 6[illegible]
CHORD LENGTH AT DOWNCOMER PLATE [illegible] 6[illegible]

DIMENSIONS AT BOTTOM OF DOWNCOMER,INCHES
DOWNCOMER WIDTH [illegible] 8.[illegible]
DOWNCOMER CLEARANCE [illegible]
DOWNCOMER BOTTOM TO TRAY INLET [illegible] 3.[illegible]
INLET WEIR HEIGHT [illegible]
INLET WEIR LENGTH [illegible]
DOWNCOMER PLATE TO SHELL DISTANCE [illegible]
LENGTH OF DOWNCOMER PLATE [illegible]
INLET WEIR TO SHELL DISTANCE [illegible]
CHORD LENGTH AT INLET WEIR [illegible]

NOTE 1 -PER DOWNCOMER. NOTE [illegible] TRAY FLOOR. NOTE 4 -HORIZONTAL DISTANC

NOTE 5 -NUMBERS IN [illegible]

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

VESSEL NO DA-805 COMB WITH
VESSEL NAME LIGHT ENDS COLUMN
DIAMETER 2'-8" ft-in & ft-in
VERT HT 36'-0" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP 222 °F BOTT 372 °F DRUM °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS 0.8 (TOP) psig OR 4.0 (BOTT) psig
MAX OPER PRESS psig OR psig
CORROSION ALLOW: SHELL 4.5mm in DECKS in

DES TEMP 400 °F
DES PRESS 45 psig VAC — psia
HEADS: ELIP ✓ DISHED CONE FLAT
CODE ASME VIII API OTHER
STRESS RELIEVED: YES ✓ CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE: WIND mph

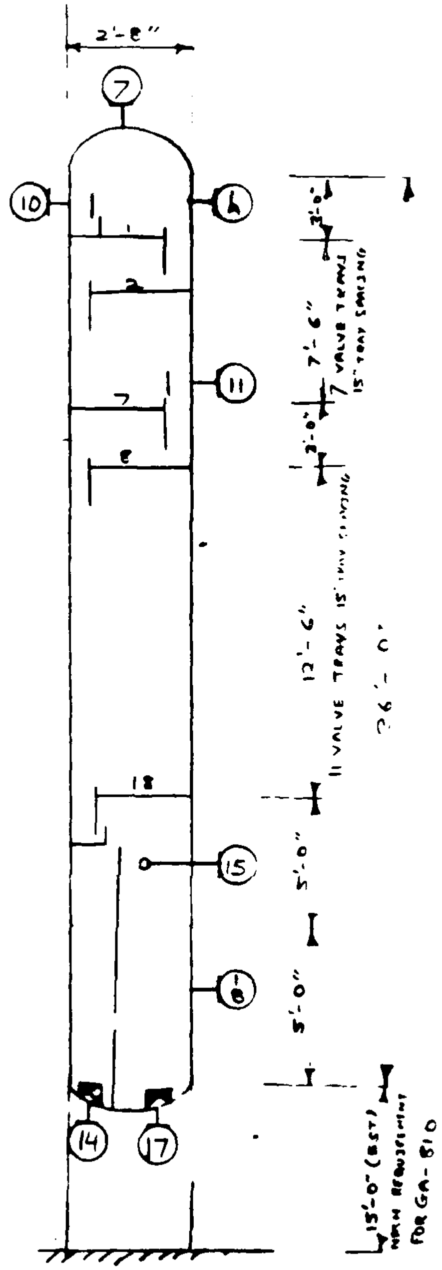
MATL: SHELL CS LINER Note (2) THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL: CS VALVE MATL. 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

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

ITEM NO.	NO. REQD	SIZE in	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7	1	6	VAPOR OUTLET TO EA-808
8			VENT
9			TO VACUUM EQUIPMENT
10	1	1½	REFLUX IN FROM FA-805
11	1	1½	FEED FROM GA-806
12			FEED FROM
13			FEED FROM
14	1	4	TO (REBOILER) (REB. PUMP)
15	1	8	FROM REBOILER EA-809
16			EQUALIZING LINE WITH
17	1	1½	BOTTOM OUTLET TO GA-810
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			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES:
(1) LIQUID SP. GR. = 0.92 (avg) @ operating temp.
(2) 316L SS CLAD BELOW TRAY # 8. NO CORR. ALLOW FOR CS SHELL IN THIS SECTION



THE LUMMUS COMPANY

LUMMUS

TITLE JET FUEL PROJECT

PROCESS VESSEL SKETCH

REV		DESCRIPTION	PROC ENGR	PROJ ENGR	APPD	APPD
		FOR TRAY 4	SR			

VESSEL NO DA-805

CE LUMMUS VALVE TRAY COMPUTER PROGRAM 4-9217 RELEASE 03 DATED APR 25 1986 BATCH
BY SUNIL USED AT 09.19.43 ON 83/11/29. DESIGN - FIND ROUNDED TO SXF LUMMUS JOB OR ESTIMATE 5571
DA-805 LANG JET FUELS PROJECT DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

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

[illegible] 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 =	7643.00	.01640	7802.00	61.42000	29.10	.40800
[illegible]	[illegible]	.01640	5461.40	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] 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
OUTLET WEIR HEIGHT		2.500
[illegible]		1.500
[illegible] LENGTH	(NOTE 2)	29.326
[illegible]	(NOTE 2)	29.326
[illegible] INCHES		
[illegible]	(NOTE 1)	5.000
DOWNCOMER CLEARANCE [illegible]	(NOTE 3)	.750
[illegible] TO TRAY INLET	(NOTE 4)	.000
[illegible]		5.000
[illegible]	(NOTE 2)	29.326

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

NOTE 5 - [illegible] SPECIAL TRAY FEATURE

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

F-112

Item Number	Service	Side	Material	Flow lb/hr	Specific Gravity	Molecular Weight	Viscosity at Avg Temp cP	% Vaporized by Weight	% Condensed by Weight	Temp. In °F	Temp. Out °F	Corr MTD	Design Temp	Duty 1000 Btu/hr	Overall Heat Trans Coeff	Foul Factor	Total Surface ft²	Max Allowable Press. Drop psi	Press. Operating psig	Press. Design psig	No Units and OD by Length	Type TEMA Symbols	Materials Shell	Materials Tubes
EA-801	FLASH COL CONDENSER	SHELL	[illegible] TOLUENE	49000	[illegible]	85	[illegible]		[illegible]	221	190	[illegible]	[illegible]	12500		[illegible]	1195	[illegible]	[illegible]	[illegible]		[illegible]	CS	CS
		TUBE	TEMP WATER	71115						[illegible]	118		[illegible]			[illegible]		10	40	110				
FA 802	FLASH COL REBOILER	SHELL	[illegible]	16,200					[illegible]	[illegible]	160	1	[illegible]	15,800		[illegible]	[illegible]		50	25		[illegible]	CS	[illegible]
		TUBE	TAR (W AVIL)	33500	0.92	118	[illegible]	20		[illegible]	126		[illegible]			[illegible]		[illegible]	69	[illegible]				
EA 803	DEPHENOLYZED CRESYLIC ACID COOLER	SHELL	CRESYLIC ACID	5200	[illegible]	106	0.4			[illegible]	122	67	[illegible]	620		[illegible]	140	10	[illegible]	[illegible]		AES	316 SS	[illegible]
		TUBE	TEMP WATER	34445						[illegible]	118		[illegible]			[illegible]		10	40	110				
FA 804	FLASH COL TRIM COOLER	SHELL	TOLUENE WATER [illegible]	2500	0.99	39	[illegible]		[illegible]	212	122	[illegible]		[illegible]		[illegible]	90	[illegible]	[illegible]	150		AEM	CS	CS
		TUBE	TEMP WATER	72225						[illegible]	118					[illegible]		[illegible]	40	[illegible]				
FA 805	DRYER CONDENSER	SHELL	[illegible]	7000	1.04	91	[illegible]		[illegible]	221	122	144	[illegible]	[illegible]		[illegible]	520	[illegible]	13.2	[illegible]		AEM	CS	CS
		TUBE	TEMP WATER	120000						[illegible]	118		[illegible]					[illegible]	40	110				
FA 806	PHENOL COLUMN REBOILER	SHELL	HP STEAM	20760					100	750	[illegible]	140	775	19000		[illegible]	[illegible]		[illegible]	635		[illegible]	CS	[illegible]
		TUBE	[illegible]	493000	0.9	105	[illegible]	20		[illegible]	[illegible]		[illegible]			[illegible]		[illegible]	[illegible]	[illegible]				
FA 807	PHENOL COLUMN CONDENSER	SHELL	TOLUENE PHENOL	83000	0.91	93	[illegible]		100	[illegible]	[illegible]	[illegible]	[illegible]	18500		[illegible]	1770	0.5	12.5	150		AEM	CS	CS
		TUBE	TEMP WATER	1027250						[illegible]	118		[illegible]			[illegible]		[illegible]	40	110				
FA 808	LIGHT ENDS COL CONDENSER	SHELL	WATER TOLUENE	5400	0.85	23	[illegible]		100	[illegible]	[illegible]	115	[illegible]	11100		[illegible]	245	5	[illegible]	[illegible]		[illegible]	CS	CS
		TUBE	TEMP WATER	72780						[illegible]	118		[illegible]			[illegible]		10	[illegible]	[illegible]				
FA 809	LIGHT ENDS COL. REBOILER	SHELL	HP STEAM	1750					[illegible]	[illegible]	[illegible]	120	[illegible]	1600		[illegible]	150		[illegible]	[illegible]		[illegible]	CS	316L SS
		TUBE	PHENOL [illegible]	10290	0.91	95	[illegible]	20		[illegible]	74		[illegible]			[illegible]		0.5	28	95				
FA 812	PHENOL COOLER	SHELL	PHENOL	4250	[illegible]	94	[illegible]			[illegible]	[illegible]	70	[illegible]	650		[illegible]	16	10	[illegible]	70		AES	316L SS	316L SS
		TUBE	TEMP WATER	3770						[illegible]	[illegible]		[illegible]			[illegible]		10	40	110				
EA 813	TAR COOLER	SHELL	TAR	7350	0.97	105			[illegible]	[illegible]	150	123	[illegible]	1000		[illegible]	175	10	40	70		[illegible]	CS	CS
		TUBE	COOLING WATER	55555						[illegible]	118		[illegible]			[illegible]		10	40	110				
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						

Item Number	Component	Entering Vapor lb/hr	Entering Liquid lb/hr	Entering Bubble or Dew Pt. °F	Entering SP GR	Entering MOL WT	Leaving Vapor lb/hr	Leaving Liquid lb/hr	Leaving Bubble or Dew Pt. °F	Leaving SP GR	Leaving MOL WT

NOTES (1) [illegible] provide [illegible] CORR ALLOW
(2) [illegible] provide [illegible] CORR ALLOW.

REV	DESCRIPTION	BY	APP	APP	DATE
0	[illegible]	[illegible]			[illegible]

LUMMUS

EXCHANGER SCHEDULE

UNIT

JOB NO [illegible]

VESSEL NO FA-801 COMB WITH
VESSEL NAME FLASH COLUMN REFLUX DRUM
DIAMETER 3'-0" ft-in & ft-in
VERT HT ft-in SKIRT ft-in
HORIZ LENGTH 9'-0" ft-in
OPER TEMP TOP °F BOTT °F DRUM 194 °F
MAX TEMP TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR 12 psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW SHELL 45 mm in DECKS in

DES TEMP 220 °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

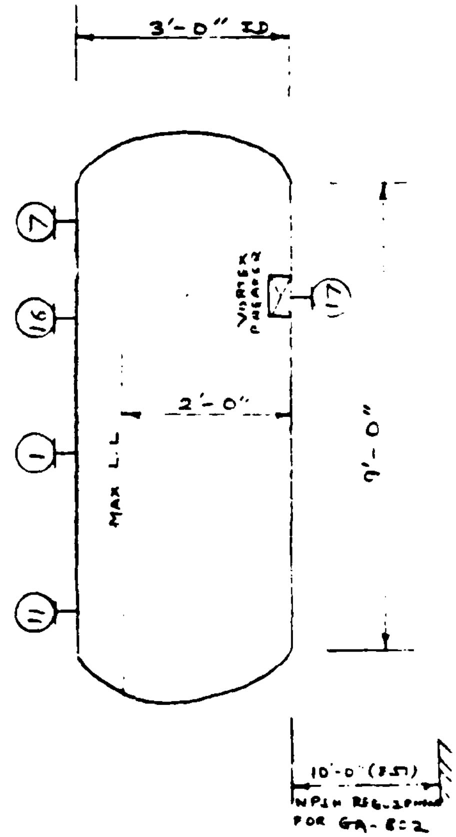
MATL SHELL CS LINER THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

FLANGED NOZZLES ARE NUMBERED 1-80 FOR COUPLING ADD 80 TO NOZZLE NO

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-804
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	4	FEED FROM EA-801
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (REB PUMP)
15			FROM REBOILER
16	1	1½	EQUALIZING LINE WITH EA-801
17	1	4	BOTTOM OUTLET TO GA-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 (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			

IG SP GR = 1.01 @ operating temp



THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMERADA HESS - GREAT PLAINS GASIF. PLANT LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1	4/1	FOR TBK 4				

VESSEL NO FA-801 DWG SKS -

VESSEL NO. FA-8C2 COMB WITH
VESSEL NAME DRYER DRUM
DIAMETER 3'-6" ID & OD
VERT HT ___ SUB SKIRT ___
HORIZ LENGTH 10'-6"
OPER TEMP: TOP ___ °F BOTT ___ °F DRUM 122 °F
MAX TEMP: TOP ___ °F BOTT ___ °F DRUM ___ °F
NORM OPER PRESS ___ psig OR 1.0 psia
MAX OPER PRESS ___ psig OR ___ psia
CORROSION ALLOW: SHELL [illegible] in DECKS ___ in

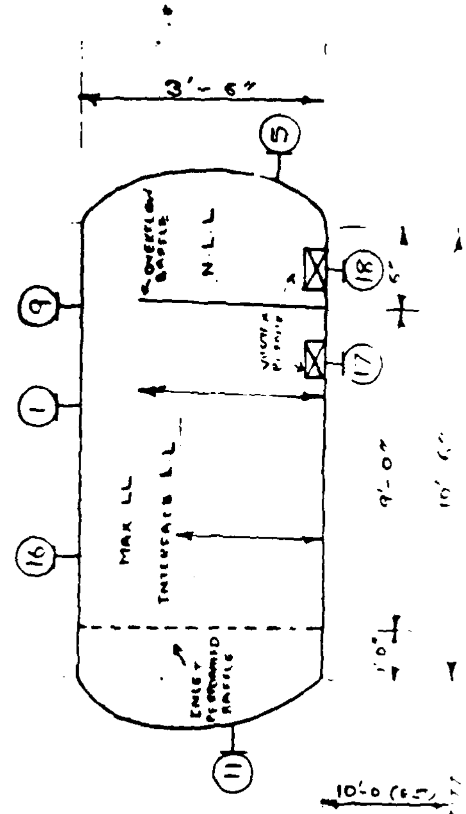
DES TEMP 150 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELIP ___ DISHED ✓ CONE ___ FLAT ___
CODE: ASME VIII API ___ OTHER ___
STRESS RELIEVED: YES ✓ CODE ___
RADIOGRAPHED: YES ___ CODE ___
EARTHQUAKE ___ WIND ___ mph

MATL: SHELL CS LINER ___ THK ___ in
INSULATION: CONSERV'N ✓ PROTECT'N ___ NONE ___
DECK MATL ___

NOZZLES: FLG CLASS 150 COUPL CLASS ___

ITEM NO.	NO. REQD	SIZE in	SERVICE & SYMBOL
1	1	18	MANHOLE
2			MANHOLE
3			
4			
5	1	5	HANDHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9	1	2	TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	2	FEED FROM EA-805
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (FEED PUMP)
15			FROM REBOILER
16	1	$1\frac{1}{2}$	EQUALIZING LINE WITH EA-805
17	1	2	BOTTOM OUTLET TO GA-812
18	1	$1\frac{1}{2}$	LIQUID OUTLET TO GA-811
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			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE DESIGNATED 1-99. FOR COUPLINGS ADD 50 TO NOZZLE NO.



10'-0 (6.5')
NPSH REQ...
FOR GA-811
OR GA-812

LIQUID SP GR = 1.015 (avg) @ operating temp.

THE LUMMUS COMPANY
LUMMUS
JET FUEL [illegible]
[illegible] DRYER DRUM
VESSEL NO FA-802

VESSEL NO FA-802 COMB WITH

VESSEL NAME PHENOL COL REFLUX DRUM

DIAMETER 4'-0" ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HOR'L LENGTH 12'-0" ft-in

OPER TEMP: TOP °F BOTT °F DRUM °F

MAX TEMP: TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR 1.92 psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW: SHELL 4.5mm & SECKS in

DES TEMP 240 °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

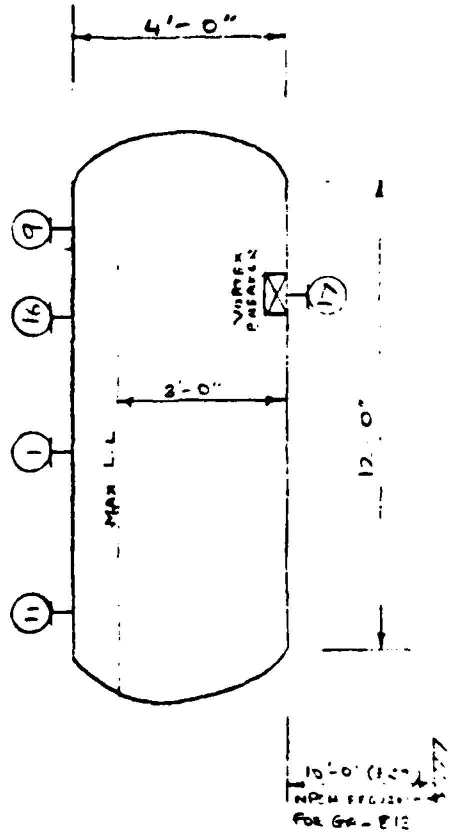
DECK MATL.

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) (REB. PUMP)
15			FROM REBOILER
16	1	2	EQUALIZING LINE WITH FF-807
17	1	2	BOTTOM OUTLET TO GA-812
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.

LIQUID SP GR = 0.91 @ operating temp



REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR	PROJ. MNGR	APPR	APPR
1						
2	4/17/78	FOR TASK 4				

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE LOCATION BEULAH, NORTH DAKOTA
PLAINS GASIF. PLANT

PROJ NO JOB NO 08871

PROCESS VESSEL SKETCH

VESSEL NO FA-802 DWG. NO.

VESSEL NO FA 805 COMB WITH

VESSEL NAME LIGHT ENDS COLUMN REFLUX DRUM

DIAMETER 2'-6" ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HORIZ LENGTH 7'-6" ft-in

OPER TEMP: TOP °F BOTT °F DRUM 122 °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 4.5 mm in HEADS in

DES TEMP 150 °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

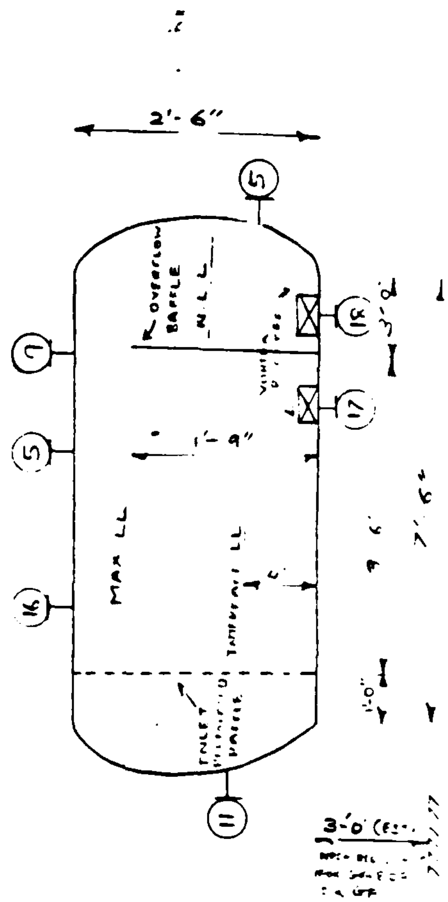
DECK MATL:

NOZZLES: FLG CLASS 150 COUPL CLASS

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

ITEM NO	NO REQD	SIZE in	SERVICE & SYMBOL
1			MANHOLE
2			MANHOLE
3			
4			
5	1	2	HANDHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9	1	2	TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1		FEED FROM EA-802
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB. PUMP)
15			FROM REBOILER
16	1	1½	EQUALIZING LINE WITH EA-802
17	1	1½	BOTTOM OUTLET TO GA-
18	1	2	LIQUID OUTLET TO GA-809
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			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	2		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

LIQUID SP GR = 0.92 (avg) @ operating temp



1				
0	9/19/80	FOR TSK 4	SR	
REV	ISSUE DATE	DESCRIPTION	PROC ENGR	

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE LOCATION BEULAH, NORTH DAKOTA

ORDER NO 08571

PROCESS VESSEL SKETCH

FA-805 DRAWING -

VESSEL NO FA-806 COMB WITH
VESSEL NAME CRUDE PHENOL SURGE DRUM
DIAMETER 6'-8" | FLAN & ____
VERT HT 20'-0" | F/O BOTT ____
HORIZ LENGTH ____
OPER TEMP: TOP ____ °F BOTT ____ °F DRUM 122 °F
MAX TEMP: TOP ____ °F BOTT ____ °F DRUM ____ °F
NORM OPER PRESS 0 psig OR ____ psia
MAX OPER PRESS ____ psig OR ____ psia
CORROSION ALLOW: SHELL 4.5mm for INTERNALS ____ in

DES TEMP 230 °F
DES PRESS 45 psig VAC ____ psia
HEADS: ELIP ____ DISHED ✓ CONE ____ FLAT ____
CODE: ASME VIII API ____ OTHER ____
STRESS RELIEVED: YES ✓ CODE ____
RADIOGRAPHED: YES ____ CODE ____
EARTHQUAKE ____ WIND ____ mph

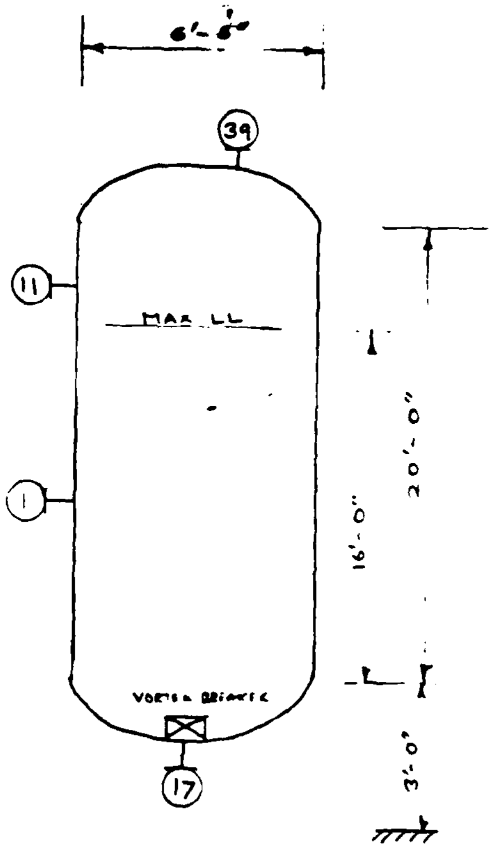
MATL: SHELL CS LINER ____ THK ____ in
INSULATION: CONSERV'N ✓ PROTECT'N ____ NONE ____
DECK MATL: ____

NOZZLES: FLG CLASS 150 COUPL CLASS ____

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

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			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	2	FEED FROM
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-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 (PSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P C)
38			PRESSURE TAP (PT)
39	1	1½	N2 BLANKETING
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T C)
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			

LIQUID SP GR = 1.03 @ operating temp



REV	ISSUE DATE	DESCRIPTION	PREL CHKD	BY
	4/14/89	FOR TANK 4		

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/BNL DEPT/LOCATION BEULAH, ND
PLAINS GASIF PLANT
JOB NO 05571

PROCESS VESSEL SKETCH

FA-806 DWG NO -

VESSEL NO FA-807 COMB WITH
VESSEL NAME CRESYLIC ACID DRUM
DIAMETER 2'-0" ft-in & ft-in
VERT HT ft-in SKIRT ft-in
HOR'L LENGTH 5'-0" ft-in
OPER TEMP: TOP °F BOTT °F DRUM 285 °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR 4.2 psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW: SHELL 2 mm in DECKS in

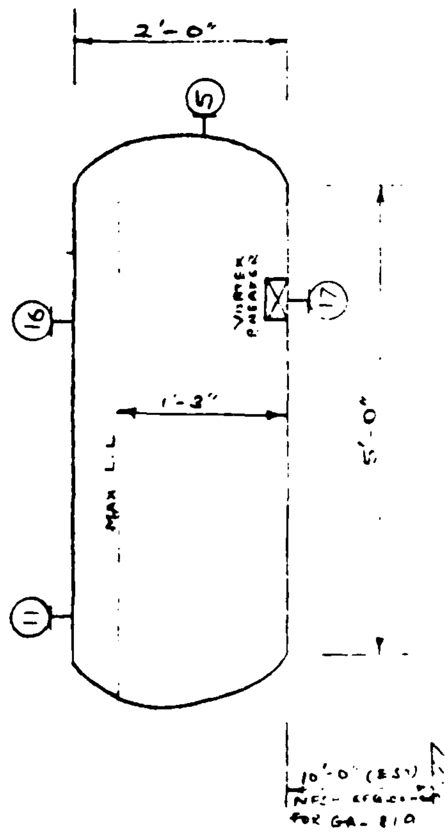
DES TEMP 320 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELIP DISHED ✓ CONE FLAT
CODE: ASME VIII ✓ API OTHER
STRESS RELIEVED: YES CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE: WIND mph

MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL.

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-801 (SIDE DRAW)
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (RES. PUMP)
15			FROM REBOILER
16	1	2	EQUALIZING LINE WITH DA-801
17	1	2	BOTTOM OUTLET TO GA-807
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 (EL 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 (GG)
46			EXTERNAL LEVEL
47	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

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



LIQUID SP. GR: 0.94 @ operating temp.

△							
△	4/14/80	FOR TASK 4					
REV	ISSUE DATE	DESCRIPTION	ORIG. BY	PROJ	APPR	APPR	

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE - GASIFICATION BEULAH, NORTH DAKOTA PLAINS GAS PLANT
PROJ NO JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FA-807 DWG SKR

VESSEL NO FA-808 COMB WITH
VESSEL NAME PHENOL DRAIN ... DRUM
DIAMETER 2'-0" ft-in & ft-in
VERT HT ft-in SKIRT ft-in
HORIZ LENGTH 4'-0" ft-in
OPER TEMP. TOP °F BOTT °F DRUM 274 °F
MAX TEMP TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR 33 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

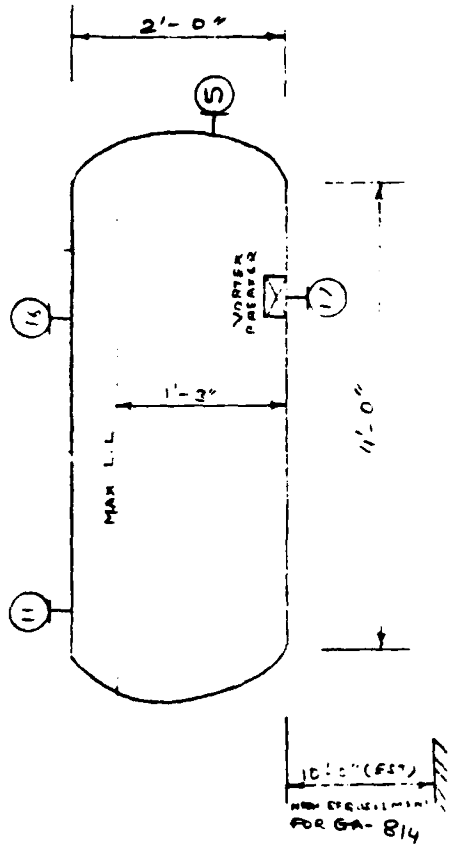
MATL SHELL CS LINER 316L SS CLAD THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL

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	1	2	FEED FROM FA-802 (... ...)
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (RES PUMP)
15			FROM REBOILER
16	1	1½	EQUALIZING LINE WITH DA-803
17	1	2	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	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

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

LIQ SP GR = 0.97 @ operating temp



LUMMUS						THE LUMMUS COMPANY
TITLE JET FUEL PROJECT						
CLIENT ANG ... LOCATION BEULAH PLAINS ... PLANT						
PROJ NO						JOB NO 05571
1						
0	4/14/83	FOR TAPE 4	...			PROCESS VESSEL SKETCH
REV	ISSUE BY TS	DESCRIPTION	PROC ENGR	PROJ ENGR	APPR	APPR	VESSEL NO FA-808	DWG SKS -

VESSEL NO FA-809 COMB WITH
VESSEL NAME LIGHT ENDS DRUM
DIAMETER 4'-0" ID
VERT HT
HORIZ LENGTH 12'-0"
OPER TEMP: TOP °F BOTT °F DRUM 135 °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW: SHELL 4.5mm in HEADS in

DES TEMP 150 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELLIP DISHED ✓ CONE FLAT
CODE ASME VIII API OTHER
STRESS RELIEVED: YES ✓ CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE WIND mph

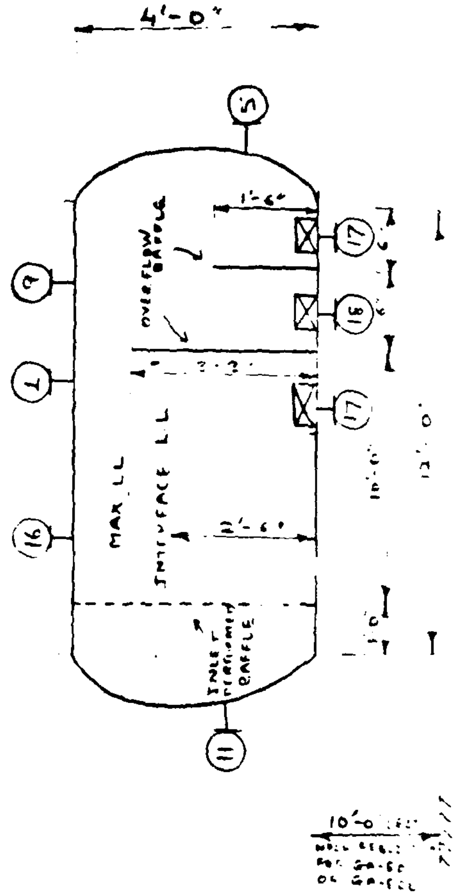
MATL: SHELL CS LINER THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL:

NOZZLES FLG CLASS 150 COUPL CLASS

ITEM NO.	NO. REQD	SIZE in	SERVICE & SYMBOL
1	1	18	MANHOLE
2			MANHOLE
3			
4			
5	1	8	HANDHOLE
6			
7			VAPOR OUTLET TO
8			VENT
9	1	2	TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11	1	1½	FEED FROM EA-804
12			FEED FROM
13			FEED FROM
14			TO REBOILER (REB. PUMP)
15			FROM REBOILER
16	1	1½	EQUALIZING LINE WITH EA-804
17	2	1½	BOTTOM OUTLET TO GA-808
18	1	1½	LIQUID OUTLET TO GA-8C?
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 (PRV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PI)
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			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	2		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE NUMBERED 1-49. FOR COUPLINGS ADD 50 TO NOZZLE NO.

LIQ. SP. GR = 0.99 (avg) @ operating temp.



REV	ISSUE DATE	DESCRIPTION	PROC ENG	PROJ	APPR	APPR
1						
0	4/19/84	FOR TASK 4	SR			

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT ANG/GREAT PLAINS GASIF. PLANT BEULAH, ND
PROJ NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FA-809 DWG NO -

VESSEL NO FB-801 COMB WITH
VESSEL NAME SULFURIC ACID TANK (66°Be 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 2.5 & DECKS in

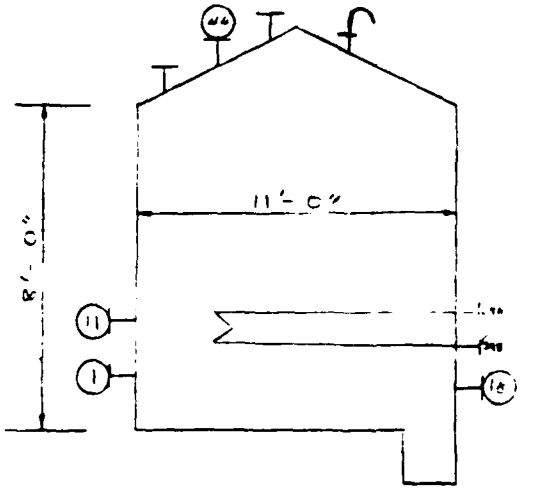
DES TEMP 220 °F
DES PRESS 8" H_2O psig VAC -2" H_2O
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API ✓ OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in
INSULATION CONSERV'N PROTECT'N NONE
DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

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

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	-	1½	LIQUID OUTLET TO GA-807
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	-	2	STEAM COIL
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			
50			



NOTES 1) SULFURIC ACID SP GR = 1.84
2) STEAM COIL TO MAINTAIN 50°F MIN

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
	4/81	FOR TANK 4				

CE LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT PACOCO/DOE GREAT PLAINS GASIF PLANT LOCATION
PROJ NO JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FB-801 DWG NO

VESSEL NO. FP-802 COMB WITH
VESSEL NAME JFL DAY TANK
DIAMETER 16'-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 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 3/16 in. DECKS in

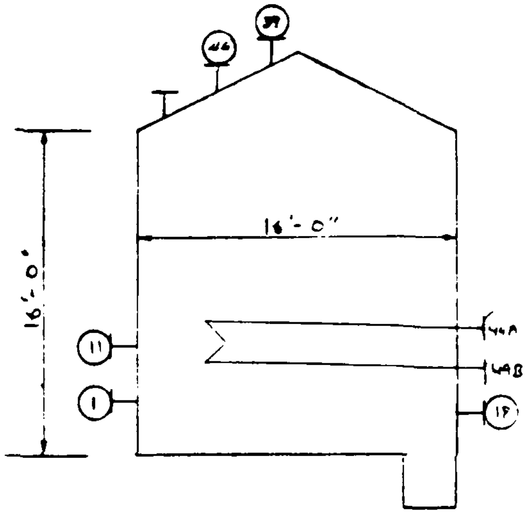
DES TEMP 230 °F
DES PRESS 8" H_2O psig VAC -2" H_2O psig
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API ✓ OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK 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	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 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	Air Blanketing
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	6	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) LIQUID SP. GR = 0.96 @ operating temp.
2) STEAM COIL TO MAINTAIN 150°F TEMP.

△						
△	10/24/79	FOR TANKS				
REV	ISSUE DATE	REVISION	PROJ ENGR	PROJ ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY
TITLE JET FUEL PROJECT
CLIENT AMOCO/GREAT PLAINS GASIFICATION, BEULAH, N.D. PLANT
PROJECT ... 05E71
PRESSURE VESSEL SKETCH
VESSEL NO. FP-802

VESSEL NO FC-802 COMB WITH

VESSEL NAME PHENOL DAY TANK

DIAMETER 13.0" ft-in & ft-in

VERT HT 16'-0" ft-in SKIRT ft-in

HORIZ LENGTH ft-in

OPER TEMP TOP °F BOTT °F DRUM 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 2mm 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 OTHER

STRESS RELIEVED YES CODE

RADIOGRAPHED YES CODE

EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in

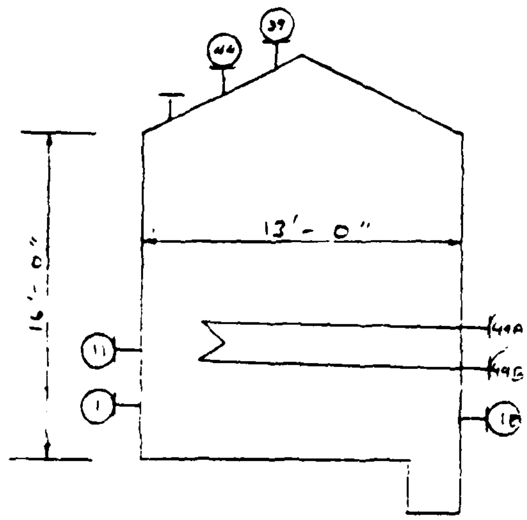
INSULATION CONSERV'N ✓ PROTECT'N NONE

DECK MAT'L

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	1½	FEED FROM GF-818
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-819
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	N_2 BLANKETING
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) LIQUID SP GR = 1.03 @ operating temp
2) STEAM COIL TO MAINTAIN 122°F TEMP.

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMGLD/DOE GREAT PLAINS PROJ. PLANT LOCATION BEULAH, ND

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1	4/14/ 79	FOR TASK 4	[illegible]			
2						

VESSEL NO FB-803 DWG SKR

VESSEL NO FR-804 A,B,C,D COMB WITH
VESSEL NAME JFK NORTH STRAGE
DIAMETER 30'-0 ft-in & ft-in
VERT HT 32'-0 ft-in SKIRT 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 3mm in DECKS in

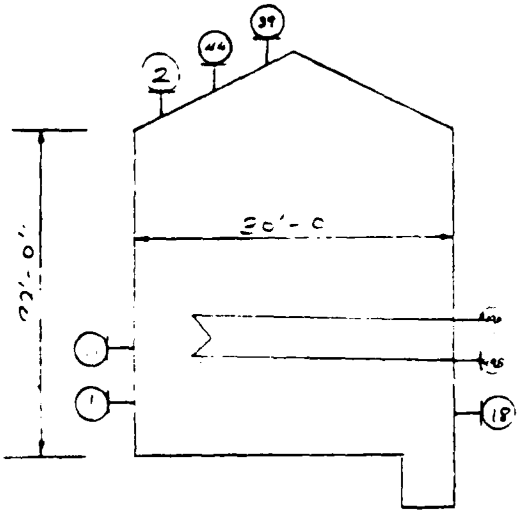
DES TEMP 230 °F
DES PRESS F+20 psig VAC -2" H_2O psia
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API ✓ OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

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	30	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 GT-825
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (REB PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17			BOTTOM OUTLET TO
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 (PVSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P C)
38			PRESSURE TAP (PT)
39	1	1½	N_2 Blanketing
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	2		INTERNAL LEVEL
48			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	4/10/80	FOR TANK 4				
REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT ANG/DOE GREAT PLAINS GASIFICATION PLANT LOCATION BEULAH ND
PROJ NO JOB NO 05871

PROCESS VESSEL SKETCH

VESSEL NO FR-804 DWG NO

VESSEL NO FR-805 A,B COMB WITH ____
VESSEL NAME PHENOL MONTH STORAGE
DIAMETER 32'-0" ft-in & ____ ft-in
VERT HT 32'-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 2 mm in DECKS ____ in

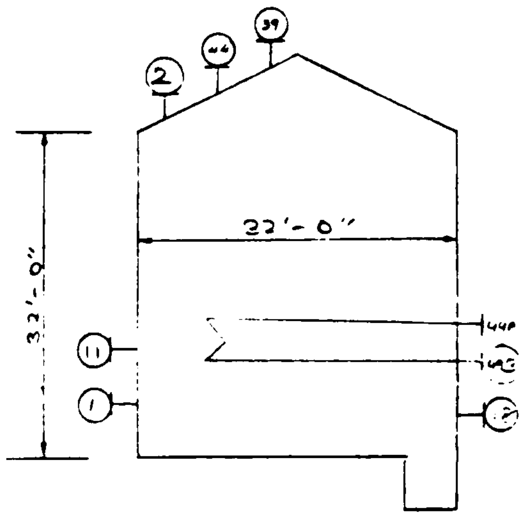
DES TEMP 230 °F
DES PRESS 5" H_2O psig VAC -2" VAC psia
HEADS ELIP ____ DISHED ____ CONE ____ FLAT ____
CODE ASME ____ API ✓ OTHER ____
STRESS RELIEVED YES ____ CODE ____
RADIOGRAPHED YES ____ CODE ____
EARTHQUAKE ____ WIND ____ mph

MATL SHELL CS LINER ____ THK ____ in
INSULATION CONSERV'N ____ PROTECT'N ____ NONE ____
DECK MATL 150

NOZZLES FLG CLASS ____ COUPL CLASS ____

FLANGED NOZZLES ARE NUMBERED 1-80
FOR COUPLING ADD 80 TO NOZZLE NO

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.819
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 (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	N_2 BLANKETING
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			



NOTES

1) LIQUID SP GR = 1.03
2) STEAM COIL TO MAINTAIN 122°F TEMP

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND GREAT PLAINS GASIF PLANT
PROJ NO ____ JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/84	FOR TASK 4	JM			

VESSEL NO FR-805 DWG SKD

ITEM NO.	SERVICE	PUMP TYPE	LIQUID	CORR./EROS. CAUSED BY	PUMPING TEMP °F NORM	PUMPING TEMP °F MAX	SP GR AT PT	VAPOR PRESS AT PT PSIA	VISC AT PT 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 801 AS	Crude Phenol Feed Pump	Centrifugal	Crude Phenol		122		1.02	1.5	0.86	25.5	31	55	-0.1		55	123	29	DI CS				Motor	
GA 802 AS	[illegible] Column Reflux Pump	Centrifugal	Water, Phenol, Toluene		194		0.99	1.9	0.47	77	95	67	-9.9		77	178	67	DI CS				Motor	
[illegible]	Flash Column Bottoms Pump	Centrifugal	Tar, Heavies		446		0.93	7.7	0.3	10	12	40	-2.3		42	95	11.5	DI [illegible]				Motor	
GA 804 AS	Acid Tar Pump	Rotary	Tar		258		0.95	1.65			1.0	39	-10		49	119	6.6	DI CS				Motor	
[illegible]	[illegible] Water Pump	Centrifugal	Water, Phenol		122		0.77	0.8	0.67		15	42	-10		52	122	8	DI CS				Motor	
[illegible]	[illegible] Column 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 807 AS	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	
[illegible]	[illegible] Acid Pump	Centrifugal	Cresylic Acid		295		0.94	4.2	0.33	15	18	33	-7.8		41	100	6.5	DI CS				Motor	
[illegible]	Light Ends Col. Reflux Pump	Centrifugal	Water, Toluene		122		0.85	1.5	0.38	10	12	41.5	-5		42	114	34	DI CS				Motor	
GA 810 AS	Light Ends Col. Bottoms Pump	Centrifugal	Phenol, O-Cresol		372		0.91	17.5	0.28	3.0	3.6	33	7.3		26	66	11.5	DI [illegible]				Motor	
GA 811 AS	Dryer Water Pump	Centrifugal	Water, Phenol		122		0.77	0.8	0.47		1	41	-10.7		50	120	67	DI CS				Motor	
GA 812 AS	Dryer Reflux Pump	Centrifugal	Water, Phenol, [illegible]		122		1.05	1.0	0.67	11	13	110	10.7		51	113	68	DI CS				Motor	
GA-813 AS	Phenol Col. Reflux Pump	Centrifugal	Toluene, Phenol		212		0.91	1.9	0.36	140	168	74	-10.3		85	215	65	DI CS				Motor	
GA-814 AS	Phenol [illegible] Pump	Centrifugal	Phenol		309		0.95	61	0.31	8	9.6	70	-5.9		76	183	6.6	DI CS				Motor	
GA-815 AS	Phenol Col. Btms. Pump	Centrifugal	Cresylic Acid		315		0.9	6.7	0.29	10	12	67	-1.5		69	176	11.4	DI CS				Motor	
GA-819 AS	[illegible] Charge Pump	Centrifugal	Phenol		122		1.04	[illegible]			18	42	-1.0		43	106	31.5	DI CS				Motor	
GA-820 AS	Dryer Col. Btms. Pump	Centrifugal	Cresylic Acid		248		0.97	0.8	0.4	16	19.2	53	-6.2		61	145	11.6	DI [illegible]				Motor	
GA 821 AS	Wash Water Pump	Centrifugal	Wash Water		122		0.99				60	25	-0.6		26	60	32	[illegible] 20				Motor	
GA 822 AS	Tar [illegible] Pump	Centrifugal	Tar		122		0.94	1.0			16	29	-1.0		20	74	[illegible]	[illegible] 20				Motor	

REV. 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/INHG ___ 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]	4/14/89

THE LUMMUS COMPANY
Bloomfield
LUMMUS
PUMP SCHEDULE

AMOCO/DOE - GPGA-F
CUSTOMER PLAINS GASIF. 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	FLANGE RATING/FACING SUCT	FLANGE RATING/FACING DISCH.	DRIVER TYPE	REMARKS
GA-823 A,B	WASH WATER RECIRCULATING PUMP	CENTRIFUGAL	WASH WATER		12[illegible]		0.9[illegible]				60	25	-0.[illegible]		26	60	3[illegible]	[illegible] 20				MOTOR	
GA-824 A,B	TAR PUMP	CENTRIFUGAL	TAR		12[illegible]		0.9[illegible]				16	21	[illegible]		30	74	[illegible]	[illegible]				MOTOR	
GA-825 A,B	TAR STORAGE PUMP	CENTRIFUGAL	TAR		122		0.9[illegible]				118	42	[illegible]		42	106	[illegible]	[illegible]				MOTOR	
GA-826 A,S	[illegible] WATER PUMP	CENTRIFUGAL	WATER, PHENOL		122		0.9[illegible]	0.8	0.49		10	42	-0.2		42	100	31	[illegible]				MOTOR	

UTILITIES

STEAM:
INLET PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
INLET TEMP., °F ____ NORM. ____ MIN. ____ MAX.
EXTRACT. PRESS., PSIG ____ NORM. ____ MIN. ____ MAX.
EXH. PRESS., PSIG ____ 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.
HEATING: ____ V ____ PHASE ____ Hz
AREA CLASS ____ GR ____ DIV ____

REV. NO.	BY	DATE
0	[illegible]	6/16/8[illegible]

LUMMUS

THE LUMMUS COMPANY
Bloomfield
PUMP SCHEDULE

CUSTOMER AMOCO/DOE-ORP? FLASH? GASIFIER? PROJECT JET FUEL
UNIT ____ AREA 800
JOB NO. 05571

VESSEL NO FD-301 ____ SAME WITH ____
VESSEL NAME 1st STAGE WATER WASH TANK
DIAMETER ____ ft-in & ____ ft-in
VERT HT ____ 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 0 ____ psig OR ____ psia
MAX OPER PRESS ____ psig OR ____ psia
CORROSION ALLOW SHELL ____ in DECKS ____ in

LENGTH = 7'-0"
WIDTH = 4'-6"
DEPTH = 5'-6"

DES TEMP 160 °F
DES PRESS 40 psig VAC ____ psia
HEADS: ELIP ____ DISHED ____ CONE ____ FLAT ____
CODE: ASME ____ API ____ OTHER ____
STRESS RELIEVED: YES ____ CODE ____
RADIOGRAPHED: YES ____ CODE ____
EARTHQUAKE ____ WIND ____ mph

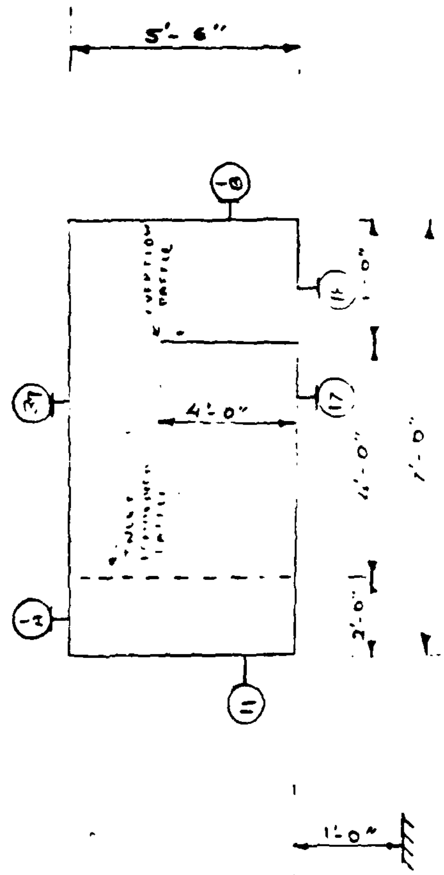
MATL: SHELL CARBON STEEL SPLINER ____ THK ____ in
INSULATION: CONSERV'N ____ PROTECT'N ____ NONE ____
DECK MATL: ____

NOZZLES: FLG CLASS ____ COUPL CLASS ____

FLANGED NOZZLES ARE NUMBERED HR. FOR COUPLING ADD (C) TO NOZZLE NO

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-117 & GA-122
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-1[illegible]
18		2	LIQUID OUTLET TO GA-1[illegible]
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	N2 BLANKETING
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T____C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	2		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

LIQUID SP GR = 0.97 (avg) @ operating temp



THE LUMMUS COMPANY

LUMMUS

TITLE JET FUEL PROJECT
CLIENT AMOCO/ANG COAL GASIFICATION BEULAH, ND PLAINS GASIF. PLANT
JOB NO 05571

PROCESS VESSEL SKETCH

REV	DATE	DESCRIPTION	PROC ENGR	PROJ ENGR	APPR	APPR
1						
0	4/1	For TASK 4	SR			

VESSEL NO FD-301 DWG NO -

VESSEL NO FD-802 COMB WITH ____
VESSEL NAME 2nd STAGE WATER WASH TANK
DIAMETER ____ ft-in & ____ ft-in
VERT HT ____ T-T BOTT ____ 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 0 psig OR ____ psia
MAX OPER PRESS ____ psig OR ____ psia
CORROSION ALLOW: SHELL ____ in DECKS ____ in

LENGTH = 7'-0"
WIDTH = 4'-6"
DEPTH = 5'-6"

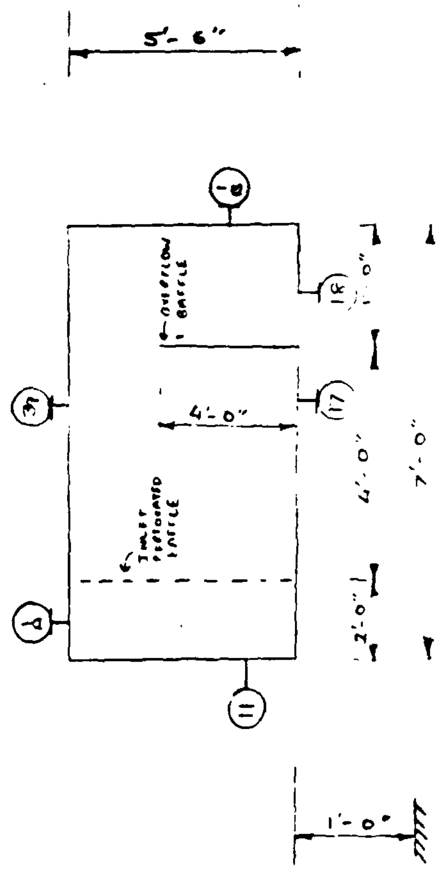
DES TEMP 160 °F
DES PRESS 60 psig VAC ____ psia
HEADS: ELIP ____ DISHED ____ CONE ____ FLAT ____
CODE: ASME ____ API ____ OTHER ____
STRESS RELIEVED: YES ____ CODE ____
RADIOGRAPHED: YES ____ CODE ____
EARTHQUAKE ____ WIND ____ mph

MATL: SHELL DOMESTIC 20 LINER ____ THK ____ in
INSULATION: CONSERV'N ____ PROTECT'N ____ 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 CONN. (S), COOLER (SC)
33			SAFETY VALVE (PSV)
34			SAFETY VALVE (PVSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PI)
37			PRESSURE CONTROLLER (P__C)
38			PRESSURE TAP (PT)
39	1	1½	N_2 BLANKETING
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T__C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44			
45			GAGE GLASS (LG)
46			EXTERNAL LEVEL
47	2		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE NUMBERED 1-49. FOR COUPLINGS ADD 50 TO NOZZLE NO.



LIQUID SP. GR = 0.97 (avg) @ operating temp.

THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT ANG/DOE CORPORATION BEULAH, ND
PLAINS GASIF PLANT
JOB NO 05571

PROCESS VESSEL SKETCH

FD-802 DWG. SAR

REV	DATE	DESCRIPTION	PROC
1			
2	4/1/8?	FOR TASK 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 ft^3

MATL : CS CORR ALLOW: 4.5mm

EA-810 STRIPPING COL CONDENSER

SURFACE AREA : 1050 ft^2

SHELL MATL : CS CORR ALLOW 4.5mm
TUBE MATL : CS 3mm

EA-814 : STRIPPING COL. SIDE REBOILER
(KETTLE TYPE)

SURFACE AREA : 450 ft^2

SHELL MATL. CS CORR ALLOW 4.5mm
TUBE MATL : CS 3mm

REV	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE	DWG. NO.	THE LUMMUS COMPANY Bloomfield, N. J.
0	4/11/83	SR							

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

0	4/14/84	FR					
REV.	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE

THE LUMMUS COMPANY
Bloomfield, N. J.

DWG. NO.

A108 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 = 1.68×10^6 Btu/hr

SURFACE AREA. 180 ft^2

MP STEAM REQ : 1900 lb/hr.

MATL. 316L SS or CS WITH 316L SS CLAD

									THE LUMMUS COMPANY Bloomfield, N. J.
0	4/14/79	SR							
REV.	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE	DWG. NO.	

A106 03 0776-1 REV.1

LUMMUS

THE LUMMUS COMPANY
Bloomfield

Always refer to this number				
	Div.	Job	PO/Req.	Sup

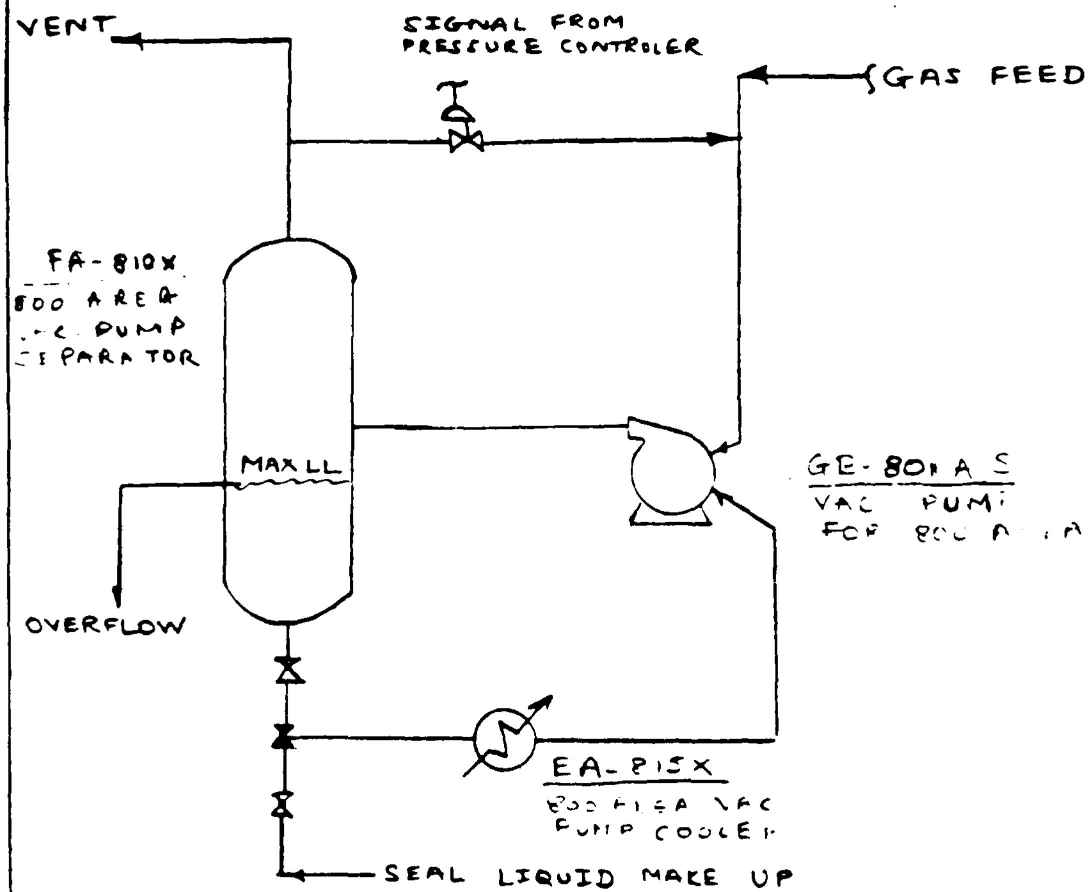
DATA SHEET · LIQUID RING VACUUM PUMP

1	APPLICABLE TO ◯ PROPOSAL ◯ PURCHASE ◯ AS BUILT			ITEM NO GR801 A&S				
2	FOR AMOCO/LOC - JET FUEL PROJECT			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)		32					
14	INLET CONDITIONS:							
15	◯ PRESSURE (psia) *		0.37					
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: 4/16/85	Rev. △	Rev. △	Rev. △		

A109 04 0783-TP2 5-1/1 REV. 4

DESIGN COMPUTATIONS FOR PA-E01 VACUUM PACKAGE FOR 800 AREA

JOB ______ ACCT. 05571



A2.801

								THE LUMMUS COMPANY Bloomfield N. J.
0	4/14/79	JR						
REV.	DATE	MADE	CHKD	APPR.	Record	REV.	ISSUE	DWG. NO.

A106 03 0778-1 REV 1

DESIGN COMPUTATIONS FOR PA-801 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	4/4/84	S/R					

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] psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP [illegible] °F

DES PRESS [illegible] psig VAC psia

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

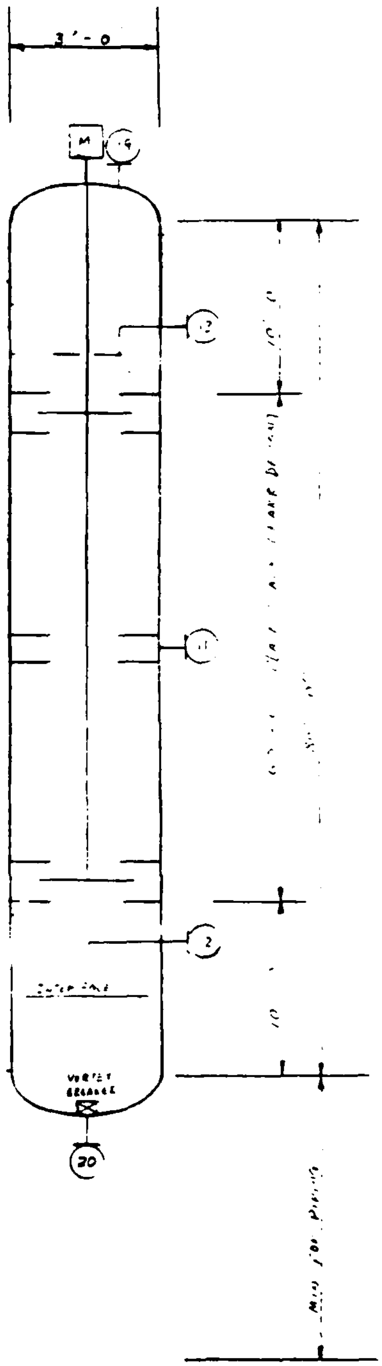
NOZZLES FLG CLASS COUPL CLASS

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		2	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	[illegible]		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

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

NOTES

[illegible]



1						
0	[illegible]	FOR TASK 4	[illegible]			
REV	ISSUE DATE	DESCRIPTION	PROC ENGR	PROJ ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY, Bloomfield

TITLE Jet Fuel Project

CLIENT [illegible] LOCATION [illegible]

PROJ NO JOB NO [illegible]

PROCESS VESSEL SKETCH

VESSEL NO [illegible] DWG SKS -

8307 0382 11

VESSEL NO DA 852 COMB WITH
VESSEL NAME [illegible]
DIAMETER [illegible] ft-in & ft-in
VERT HT [illegible] ft-in SKIRT [illegible] 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] psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW SHELL in DECKS in

DES TEMP [illegible] °F
DES PRESS [illegible] psig VAC psia
HEADS ELIP DISHED X CONE FLAT
CODE ASME API OTHER
STRESS RELIEVED YES X CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

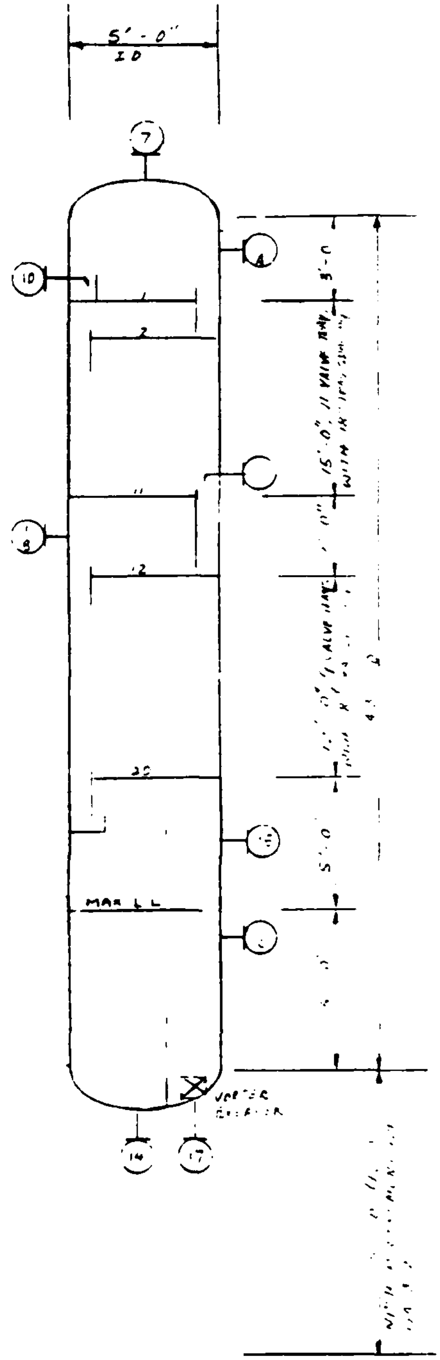
MATL SHELL CS LINER THK in
INSULATION CONSERV'N X PROTECT'N NONE
DECK MATL CS VALVES: [illegible]

NOZZLES FLG CLASS COUPL CLASS

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

ITEM NO	NO REQD	SIZE in	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7		[illegible]	VAPOR OUTLET TO EA-852
8			VENT
9			TO VACUUM EQUIPMENT
10		4	REFLUX IN FROM [illegible]
11		2	FEED FROM DA [illegible]
12			FEED FROM
13			FEED FROM
14		[illegible]	TO (REBOILER) ~~(REB PUMP)~~ [illegible]
15		[illegible]	FROM REBOILER [illegible]
16			EQUALIZING LINE WITH
17		[illegible]	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			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES [illegible]



LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT [illegible] LOCATION [illegible]
PROJ NO JOB NO [illegible]

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
	[illegible]	FOR TANK 4				

PROCESS VESSEL SKETCH

VESSEL NO DA-852 DWG SKB -

VESSEL NO DA-[illegible] COMB WITH ______
VESSEL NAME [illegible]
DIAMETER 3-0 [illegible] ft-in & ______ ft-in
VERT HT 42-0 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 ______ psia
CORROSION ALLOW SHELL ______ in DECKS ______ in

DES TEMP 25[illegible] °F
DES PRESS [illegible] psig VAC ______ psia
HEADS ELIP ______ DISHED X CONE ______ FLAT ______
CODE ASME ______ API ______ OTHER ______
STRESS RELIEVED YES ______ CODE ______
RADIOGRAPHED YES ______ CODE ______
EARTHQUAKE ______ WIND ______ mph

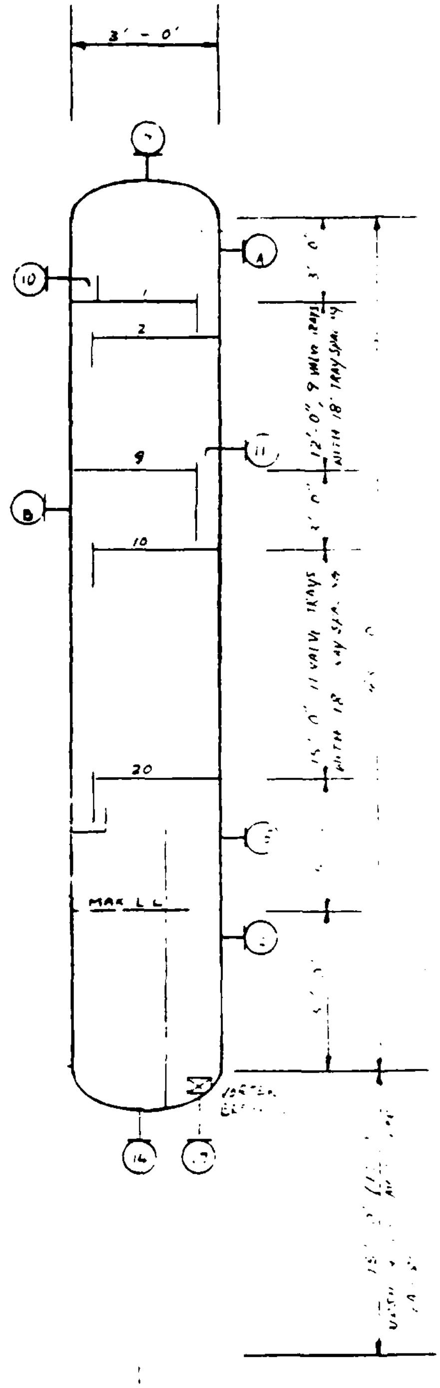
MATL SHELL CS LINER ______ THK ______ in
INSULATION CONSERV'N X PROTECT'N ______ NONE ______
DECK MATL [illegible] VALVES [illegible]

NOZZLES FLG CLASS ______ COUPL CLASS ______

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

ITEM NO	NO REQD	SIZE in	SERVICE & SYMBOL
1	[illegible]	[illegible]	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7		3	VAPOR OUTLET TO EA-[illegible]
8			VENT
9			TO VACUUM EQUIPMENT
10		2	REFLUX IN FROM GA-256
11		2	FEED FROM GA-[illegible]
12			FEED FROM
13			FEED FROM
14		4	TO (REBOILER) ([illegible]) EA-[illegible]
15		8	FROM REBOILER EA-[illegible]
16			EQUALIZING LINE WITH
17		2	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 (P)SV, (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	[illegible]		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES [illegible]



LUMMUS | THE LUMMUS COMPANY Bloomfield

TITLE [illegible] FUEL PROJECT
CLIENT [illegible] LOCATION [illegible]
PROJ NO JOB NO [illegible]

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	6/14/81	FOR TASK 4	[illegible]			

VESSEL NO DA-[illegible] DWG SKB -

8301 0382 11

VESSEL NO *DA - 854* COMB WITH

VESSEL NAME *DRYING COLUMN*

DIAMETER *2'-6" ID* ft-in & ft-in

VERT HT *38 - 6"* ft-in SKIRT *15'-0"* ft-in

HORIZ LENGTH ft-in

OPER TEMP TOP *309* °F BOTT *432* °F DRUM °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS *10 TOP* psig OR *13 BOTTM* psig

MAX OPER PRESS psig OR psig

CORROSION ALLOW SHELL in DECKS in

DES TEMP *460* °F

DES PRESS *40* psig VAC psia

HEADS ELIP DISHED *BOTTM* 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

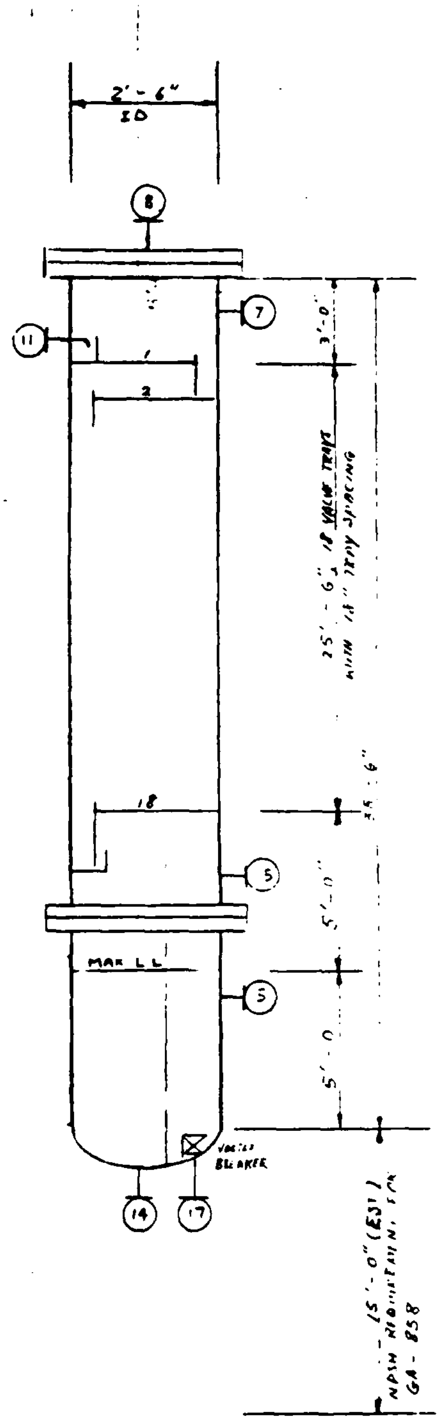
DECK MATL *304 SS* *VALVES: 304 SS*

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) ([redacted] *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			

FLANGED NOZZLES ARE NUMBERED 1-80 FOR COUPLING ADD 80 TO NOZZLE NO

NOTES *L/R SP GR = 0.89 (AVG) @ OPERATING TEMP*



THE LUMMUS COMPANY

LUMMUS

TITLE *JET FUEL PROJECT*

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

PROJ NO JOB NO *85771*

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	4/81	FOR TASK 4	MJ			

VESSEL NO *DA - 854* DWG NO -

ITEM NUMBER	SERVICE	SIDE	MATERIAL	FLOW lb/hr	SPECIFIC GRAVITY	MOLECULAR WEIGHT	VISCOSITY AT AVG TEMP cP	% VAPORIZED BY WEIGHT	% CONDENSED BY WEIGHT	TEMP. °F IN	TEMP. °F OUT	CORR. M.T.D.	DESIGN TEMP	DUTY 1000 Btu/hr	OVERALL HEAT TRANS. COEFF Btu/h ft² °F	FOUL FACTOR	TOTAL SURFACE ft²	MAX ALLOWABLE PRESS. DROP psi	PRESS. psig OPERATING	PRESS. psig DESIGN	NO UNITS AND O.D. BY LENGTH	TYPE TEMA SYMBOLS	MATERIALS SHELL	MATERIALS TUBES
EA-851	Hexane Reboiler	SHELL	HP Steam	9360					100	750	480	141	775	8560		0.0005	665		450	635		BEM	CS	CS
		TUBE	Neutral Oil	276500	0.79	100	[illegible]	20		350	350		375			0.001		12	13	45				
EA-852	Hexane Condenser	SHELL	Hexane	46700	0.617	86	[illegible]		100	[illegible]	[illegible]	71	[illegible]	8020		0.001	1320	2.5	[illegible]	40		AEM	CS	CS
		TUBE	Cooling Water	235300						82	118		150			0.001		10	60	110				
EA-853	Neutral Oil Cooler	SHELL	Neutral Oil	847	0.850		0.471			350	115	100	425	102		0.001	17	10	40	70		Double Pipe	CS	CS
		TUBE	Cooling Water	2830						82	118		150			0.002		10	60	110				
EA-854	Methanol Reboiler	SHELL	HP Steam	7340	-	-	-		100	[illegible]	[illegible]	98	[illegible]	6500		0.0005	737		100	140		BEM	CS	18-2
		TUBE	[illegible]	86730	0.980	197	[illegible]	20		[illegible]	[illegible]		[illegible]			0.001		0.15	13	45				
EA-855	Methanol Condenser	SHELL	Methanol & Water	12320	0.76	29	[illegible]		100	184	[illegible]	77	[illegible]	6300		0.001	910	2.5	10	40		AEM	CS	CS
		TUBE	Cooling Water	210000						82	118		150			0.002		10	60	110				
EA-856	Methanol Column Bottoms Cooler	SHELL	Cresylic Acid & Water	6350	0.991		0.91			217	[illegible]	51	265	536		0.001	192	10	40	70		AES	CS	CS
		TUBE	Tempered Water	53600						100	110		150			0.002		10	40	110				
EA-857	Drying Column Reboiler	SHELL	HP Steam	2350					100	710	480	55	775	2150		0.0005	434		550	635		AEM	304SS	18-2
		TUBE	Cresylic Acid	61000	0.851	105	[illegible]	20	-	412	422		460			0.001		0.5	13	45				
EA-858	Drying Column Condenser	SHELL	Cresylic Acid & Water	2030	1.05	33	[illegible]		100	308	113	115	335	1360		0.001	129	2.5	10	40		AES	304SS	304SS
		TUBE	Tempered Water	136000	-					100	110		150			0.002		10	40	110				
EA-859	Crude Cresylic Acid Cooler	SHELL	Cresylic Acid	4434	0.995	-	1.28			310	115	29	280	216		0.001	91	10	30	70		ABS	CS	CS
		TUBE	Tempered Water	21600		-	-	-	-	100	110		150			0.002		10	40	110				
EA-860	65/Methanol Cooler	SHELL	65% Methanol	6650	0.825	-	0.938			150	113	40	175	194		0.001	106	10	40	70		AES	CS	CS
		TUBE	Cooling Water	6930		-	-			82	110		150			0.002		10	40	110				
EA-861	Recov. Column Feed/Cresylic Acid Interchanger	SHELL	Cresylic Acid	4434	0.91	-	0.368			412	214	147	460	520		0.001	59	10	20	30		AES	CS	CS
		TUBE	Heavy Cresylic Acid	11100	0.878	-	0.090			[illegible]	183		205			0.001		10	40	70				

ITEM NUMBER	COMPONENT	ENTERING lb/hr VAPOR	ENTERING lb/hr LIQUID	Bubble or Dew Pt. °F	SP. GR.	MOL. WT.	LEAVING lb/hr VAPOR	LEAVING lb/hr LIQUID	Bubble or Dew Pt. °F	SP. GR.	MOL. WT.

NOTES:

REV	DESCRIPTION	BY	APP	APP	DATE
0	FOR TASK 4	[illegible]			4/14/78

LUMMUS Bloomfield

EXCHANGER SCHEDULE

UNIT AREA 850

JOB NO [illegible]

VESSEL NO FA-251 COMB WITH

VESSEL NAME Reflux Drum (handwritten; partly illegible)

DIAMETER 4'-0" ID ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HORIZ LENGTH 12'-0" ft-in

OPER TEMP TOP °F BOTT °F DRUM 118 °F

MAX TEMP TOP °F BOTT °F DRUM 187 °F

NORM OPER PRESS 20 psig OR psia

MAX OPER PRESS psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP 230 °F

DES PRESS 40 psig VAC psia

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

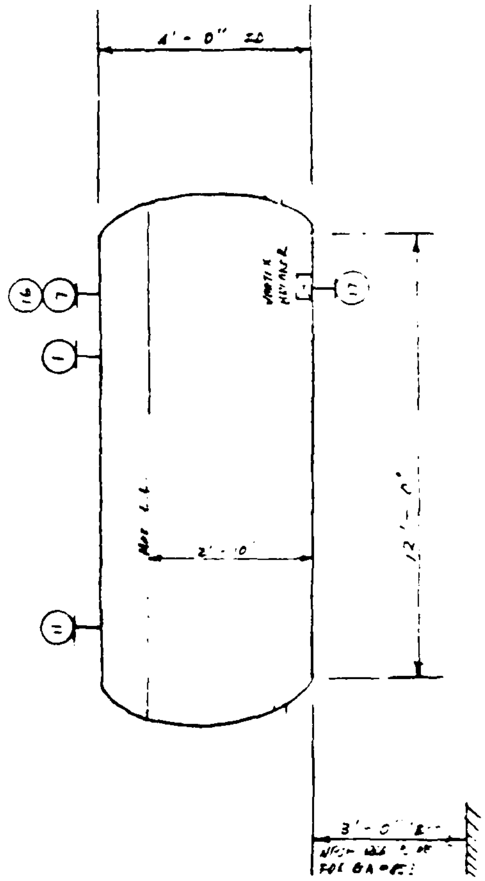
DECK MATL

NOZZLES FLG CLASS COUPL CLASS

ITEM NO	NO REQD	SIZE in	SERVICE & SYMBOL
1	1	18	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7		3	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		1½	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 80 TO NOZZLE NO

NOTES Liquid SP Gr = 0.64 @ Operating Temp



REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	11/14/79	FOR TASK 4	WJ			

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT ANG/DOE GREAT PLAINS GASIF PLANT LOCATION BEULAH, NORTH DAKOTA

PROJ NO JOB NO 06571

PROCESS VESSEL SKETCH

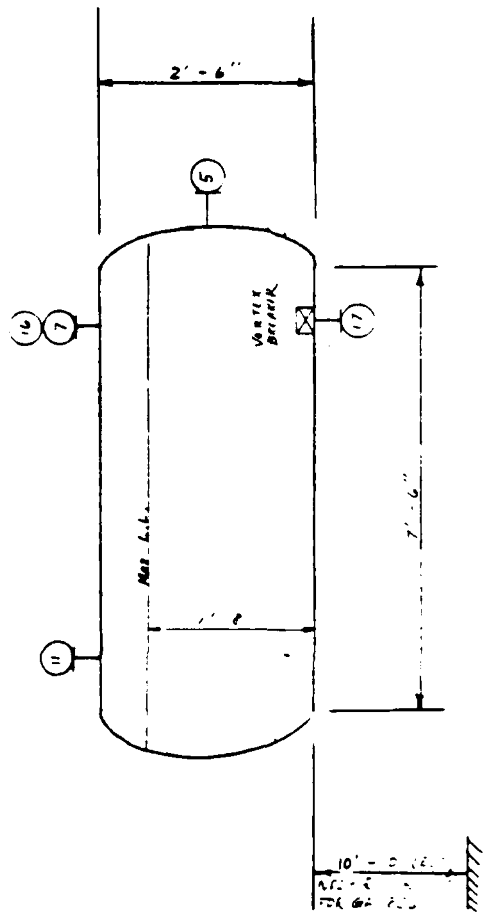
VESSEL NO FA-851 DWG SKS –

VESSEL NO	FA - 852
COMB WITH	
VESSEL NAME	[illegible] DRUM
DIAMETER	2'-6" ft-in & ___ ft-in
VERT HT	___ ft-in SKIRT ___ ft-in
HORIZ LENGTH	7'-6" 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 ___ psia
MAX OPER PRESS	___ psig OR ___ psia
CORROSION ALLOW	SHELL ___ in DECKS ___ in
DES TEMP	230 °F
DES PRESS	42 psig VAC ___ psia
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 ___

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

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	2	FEED FROM FA-855
12			FEED FROM
13			FEED FROM
14			TO (REBOILER (REB PUMP)
15			FROM REBOILER
16		[illegible]	EQUALIZING LINE WITH FA-855
17		2	BOTTOM OUTLET TO GA 85[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			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES Liquid Sp Gr = 0.76 @ Operating Temp



CE LUMMUS — THE LUMMUS COMPANY — Bloomfield

TITLE Jet Fuel Project
CLIENT ANG/DOE - GRT. PLNS. GASIF. PLANT LOCATION BEULAH, NORTH DAKOTA
PROJ NO ___ JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PREL ENGR	PROJ ENGR	APPR	APPR
1						
0	6/16/83	For TASK 4	dll			

VESSEL NO FA-852 DWG SIZE -

[illegible]

VESSEL NO _FA-853_ COMB WITH ______
VESSEL NAME _Dr. NG Coalesc Relief Drum_
DIAMETER _5'-0" ID_ 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 _305_ °F
NORM OPER PRESS _20_ 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 _X_ CONE ______ FLAT ______
CODE ASME ______ API ______ OTHER ______
STRESS RELIEVED YES ______ CODE ______
RADIOGRAPHED YES ______ CODE ______
EARTHQUAKE ______ WIND ______ mph

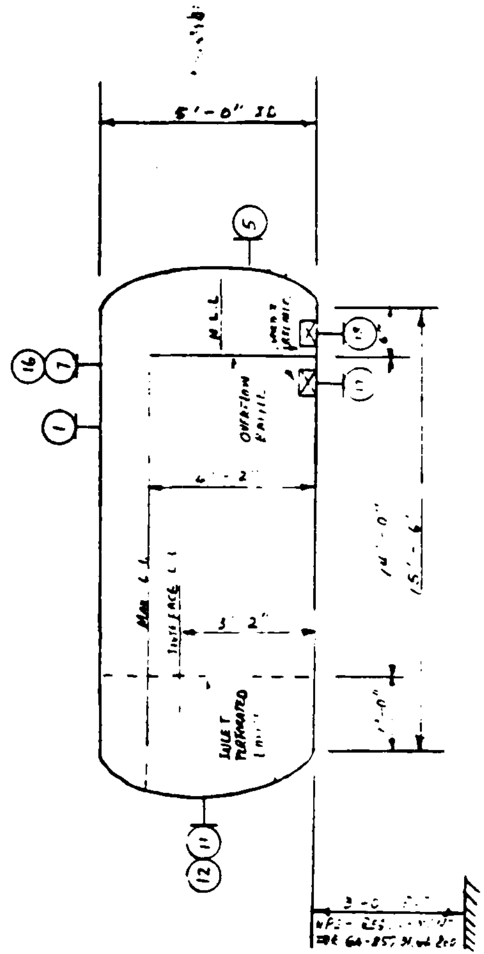
MATL SHELL _CS_ LINER ______ THK ______ in
INSULATION CONSERV'N _X_ PROTECT'N ______ NONE ______
DECK MATL ______

NOZZLES FLG CLASS ______ COUPL CLASS ______

FLANGED NOZZLES ARE NUMBERED 1-50 FOR COUPLING ADD 80 TO NOZZLE NO

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 _GA-8_
12	1	1½	FEED FROM _EA-857_
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-857_
18	1	2	LIQUID OUTLET TO _GA-860_
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 = 1.0 (AVG) @ operating temp



1						
0	4/1/79	FOR TASK 4	MJ			
REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR	PROC. ENGR	APPR	APPR

THE LUMMUS COMPANY

TITLE Jet Fuel Project
CLIENT Great Plains Gasification Plant LOCATION Beulah, North Dakota
PROJ NO ______ JOB NO 06571
PROCESS VESSEL SKETCH
VESSEL NO FA-853 DWG SKS -

VESSEL NO FA 854 COMB WITH

VESSEL NAME Metallic [illegible]

DIAMETER 3'-6" ID ft-in & 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 7K 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 CONSERV'N X PROTECT'N NONE

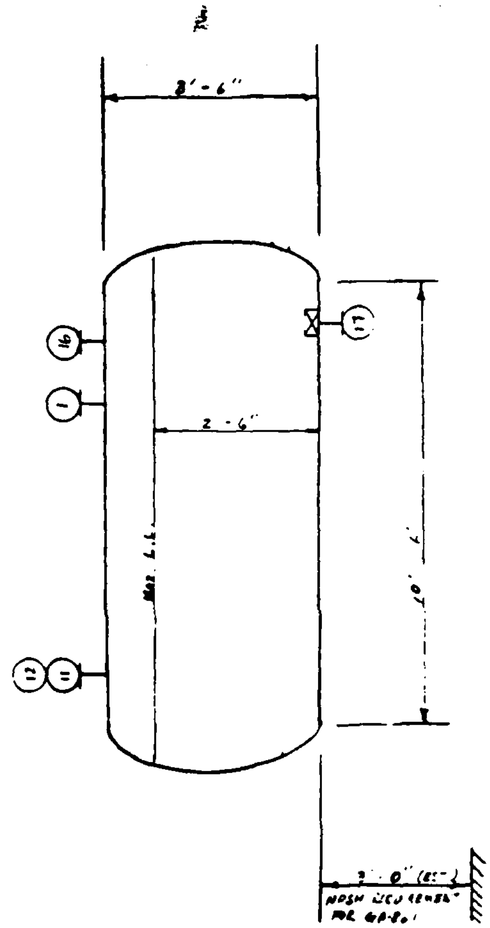
DECK MATL

NOZZLES FLG CLASS COUPL CLASS

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

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 856
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			

NOTES Liquid Sp Gr = 0.816 @ Operating Temp



	THE LUMMUS COMPANY Bloomfield
TITLE	JET FUEL PROJECT
CLIENT	Amoco / Gulf Refining [illegible] PLANT
LOCATION	Beulah, North Dakota
PROJ NO	
JOB NO	06571
	PROCESS VESSEL SKETCH
VESSEL NO	FA-854
DWG SKD -	

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROC ENGR	APPR	APPR
1						
0	4/1/80	FOR TRK 4	[illegible]			

VESSEL NO FB - 851 COMB WITH

VESSEL NAME NAPHTHA STORAGE 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 Amb °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS 6" H_2O psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP 230 °F

DES PRESS 8" 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

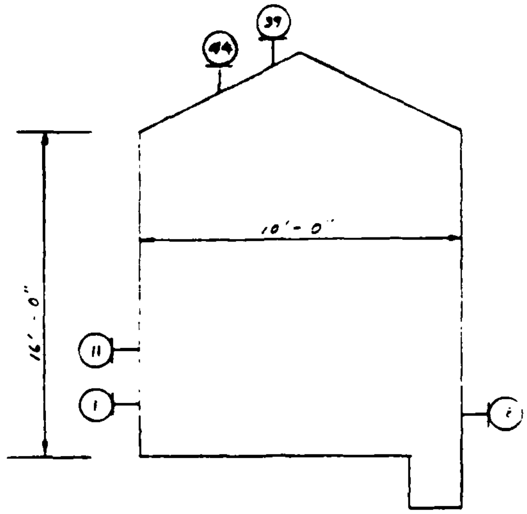
DECK MATL

NOZZLES FLG CLASS COUPL CLASS

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

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	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	4	LIQUID OUTLET TO GA-854
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	N_2 BLANKETING
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			

NOTES Liquid Sp Gr = 0.66 @ Operating Temp



LUMMUS

THE LUMMUS COMPANY

Bloomfield

TITLE JET FUEL PROJECT

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

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/16/79	FOR TASK 4	RH			

VESSEL NO FB-851 DWG SIZE -

VESSEL NO FB-852 COMB WITH

VESSEL NAME Crude Cresylic 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 113 °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 2" 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 X PROTECT'N NONE

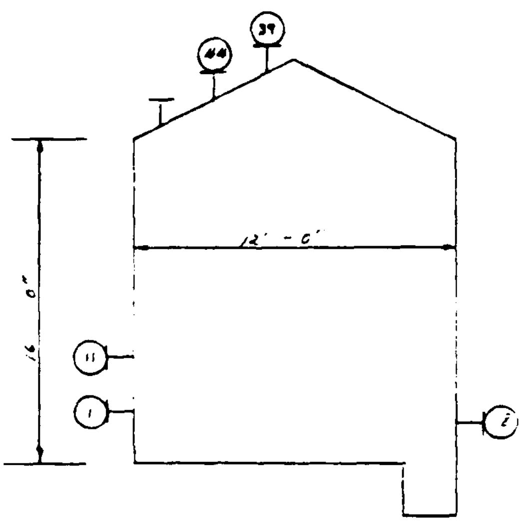
DECK MATL

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 GA-8??
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-859
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	N₂ Blanketing
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 - 54.1102 @ Operating Temp



LUMMUS THE LUMMUS COMPANY Bloomfield

TITLE Jet Fuel Project

CLIENT ANG Coal Gasification - Great Plains Gasif. Plant LOCATION Beulah, North Dakota

PROJ NO JOB NO 06571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/4/80	For Task 4	N			

VESSEL NO FB-852 DWG SIZE -

VESSEL NO FB-852 A & B COMB WITH
VESSEL NAME CRUDE CRESYLIC ACID [illegible] STORAGE TANK
DIAMETER 35'-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 113 °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS 6" W.C. psig OR psia
CORROSION ALLOW SHELL in DECKS in

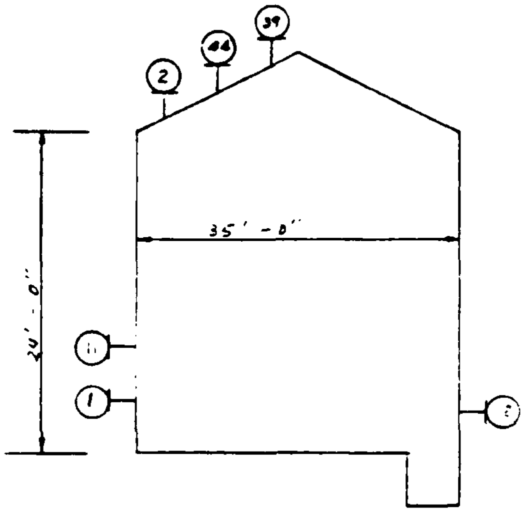
DES TEMP 230 °F
DES PRESS 8" W.C. psig VAC -2" H2O psia
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API X OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

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 (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		2	FEED FROM GA-859
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-862
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 BLANKETING
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			
50			

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



NOTES L.O.D. Sp. Gr. = 1.02 @ Operating Temp

1						
0	4/4/80	FOR TANK 4	W			
REV	ISSUE DATE	DESCRIPTION	PROC. ENGR	PROJ. ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/ANG-GREAT PLAINS GASIF PLANT LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-852 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	MAT'L CLASS	CORR ALLOW IN	FLANGE RATING/FACING SUCT	FLANGE RATING/FACING DISCH	DRIVER TYPE	REMARKS
GA-P51 A/S	Extractor Bottom Pump	Centrifugal	Methanol, Water & Cresylic Acid		113		0.84	4.0	[illegible]	21	22	63	33		32	62	140	D1 CS				Motor	
GA-P52 A/S	Methanol Bottoms Pump	Centrifugal	[illegible] Oil & Cresylic Acid		350		0.79	[illegible]	[illegible]	1.8	10	60	17		43	126	11	D1 CS				Motor	
GA-P53 A/S	Hexane Feed Pump	Centrifugal	Hexane		113		0.64	[illegible]	[illegible]	[illegible]	32	68	7		61	222	68	D1 CS				Motor	
GA-P54 A/S	Hexane Make Up Pump	Centrifugal	Hexane		77		0.65	2.7	.030		[illegible]	68	[illegible]		68.5	192	40	D1 CS				Motor	
GA-P55 A/S	Methanol Column Bottom Pump	Centrifugal	Water & Cresylic Acid		237		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18		25	61	11	D1 CS				Motor	
GA-P56 A/S	Methanol Column Reflux Pump	Centrifugal	Methanol Solution		171		[illegible]	[illegible]	[illegible]	22	[illegible]	48	7		41	126	6	D1 CS				Motor	
GA-P57 A/S	Drying Column Feed Pump	Centrifugal	Water & Cresylic Acid		113		[illegible]	3	[illegible]	11	[illegible]	[illegible]	7		46	105	[illegible]	D1 CS				Motor	
GA-P58 A/S	Drying Column Bottom Pump	Centrifugal	Crude Cresylic Acid		422		0.82	[illegible]	[illegible]	9	11	[illegible]	[illegible]		27	73	11	D1 CS				Motor	
GA-P59	Crude Cresylic Acid Pump	Centrifugal	Crude Cresylic Acid		112		[illegible]	.01	[illegible]		20	43	[illegible]		[illegible]	99	32	D1 CS				Motor	
GA-P60 A/S	Drying Column [illegible] Pump	Centrifugal	Water & Dissolved Cresylic Acid		113		0.99	1.9	[illegible]	3.3	[illegible]	32	7		[illegible]	54	47	D1 CS				Motor	
GA-P61 A/S	65% Methanol Pump	Centrifugal	65% Methanol Solution		150		[illegible]	25	[illegible]	[illegible]	[illegible]	[illegible]	7		41	126	34	D1 CS				Motor	
GA-P62 A/S	Crude Cresylic Acid Supply Pump	Centrifugal	Crude Cresylic Acid		77		[illegible]	.01	20		30	81	[illegible]		[illegible]	221	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.

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	ML	6/14/84

CE LUMMUS
THE LUMMUS COMPANY
Bloomfield
PUMP SCHEDULE

Amoco/DOE - 40781
CUSTOMER Plains Gasif Plant PROJECT Jet Fuel
UNIT ____ AREA 850
JOB NO 45:71

5109 04 05/8 1P2.4 (REV 1)

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	

EQUIPMEN 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 CGL OH.	16	CS/CS	$200.00	$3,200
EA-914	0-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

DOE JET FUEL

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

DOE JET FUEL

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

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. (Alt. Service)
DIAMETER 7'-0" ft-in & ft-in
VERT HT 172'-8" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP 262 °F BOTT 380 °F DRUM °F
MAX TEMP: TOP °F BOTT °F DRUM °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 API OTHER
STRESS RELIEVED YES ✓ CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

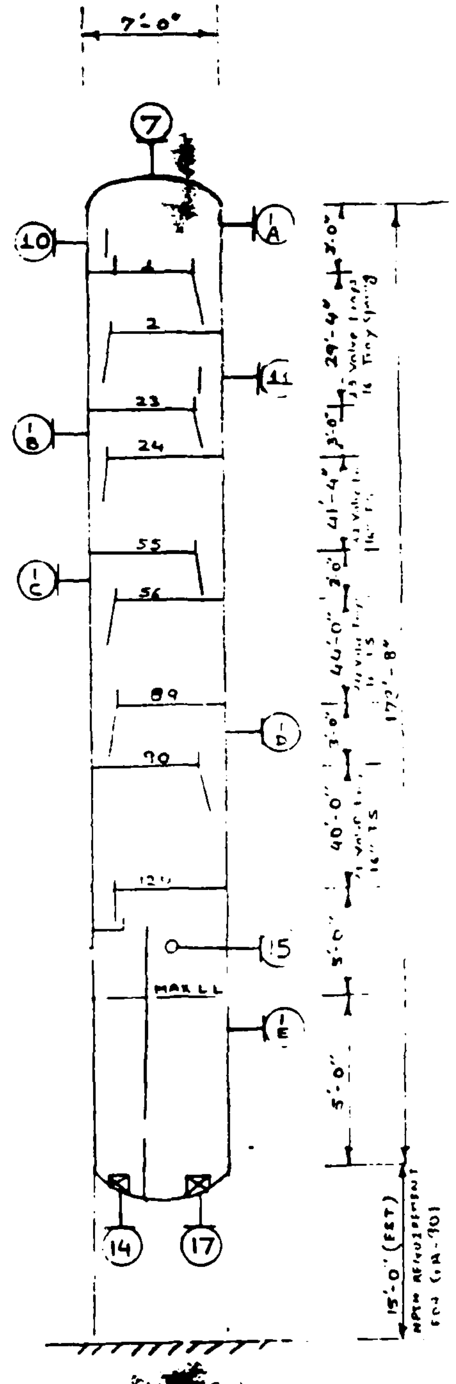
MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL CS VALVE MATL: 304 SS

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) 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___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 LIQ SP GR = 0.91 (avg) @ operating temp.



THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT AMOCO/ANL-GPSAT LOCATION BEULAH, NORTH DAKOTA
PLASMA GASIF PLANT
PROJ NO JOB NO DE57/

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/14/83	FOR TASK 4				

VESSEL NO DA-901 DWG SIZE -

CE LUM BY SUNIL COLUMN 901 CRESYLIC ACID RECOVERY

VALVE TRAY COMPUTER PROGRAM 4-9219 USED AT 10.11.07 ON 81/11/11.

BATCH
LUMMUS JOB OR ESTIMATE 5571
DEPT 302 OFFICE LTD

LAYOUT DIMENSIONS

TRAY SPACING, INCHES 15.00 [illegible] TOWER DIAMETER, INCHES 84.00
TYPE OF FLOW SXT (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
MINIMUM =	33100.00	.13300	35213.50	56.20000	19.30	.27203

(BASED ON OVERDESIGN TO 100.0 O/O OF VAPOR AND TO 100.0 O/O OF LIQUID NOMINAL RATES FOR MAXIMUM LOADED TRAY)

(BASED ON TURNDOWN TO [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 2= SLOPING
*INLET WEIR

DIMENSIONS AT TOP OF DOWNCOMER, 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)	.253
[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]		8.503
[illegible]	(NOTE 2)	43.889

[illegible] 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

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

VESSEL NO DA-902A COMB WITH
VESSEL NAME PHENOL COLUMN / O-CRESOL COLUMN (ALTERNATE CASE)
DIAMETER 5'-0" ft-in & ft-in
VERT HT 93'-9" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP 312 °F BOTT 365 °F DRUM °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS -8T(TOP) psig OR -3.5(BOTTOM) psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW: SHELL 2mm in DECKS in

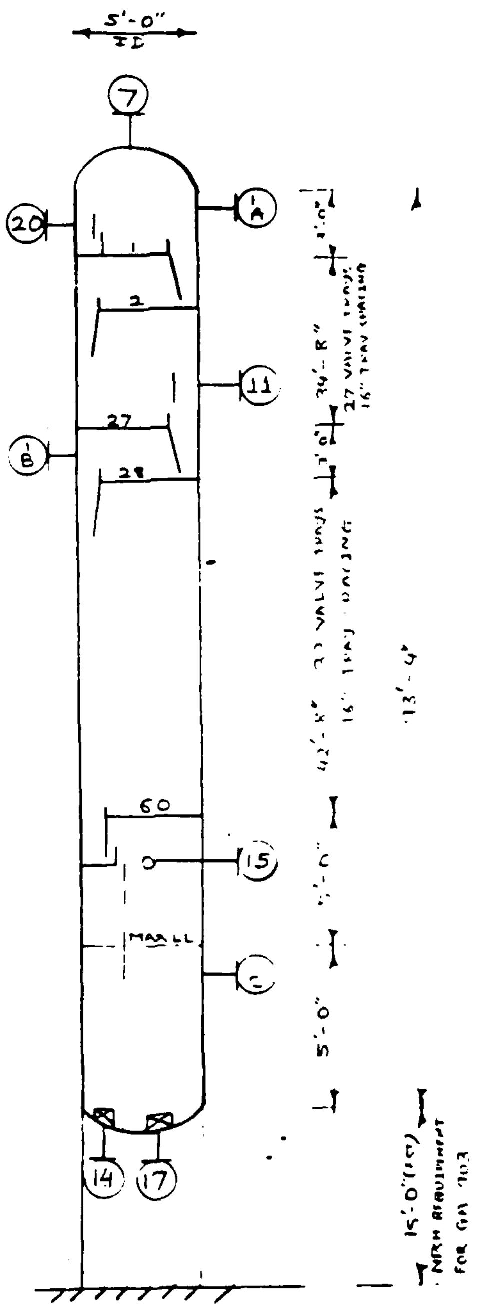
DES TEMP 380 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELIP ✓ DISHED CONE FLAT
CODE: ASME VIII API OTHER
STRESS RELIEVED: YES ✓ CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE: WIND psf

MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL: CS VALVE MAT'L-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	8	VAPOR OUTLET TO DA-902B
8			VENT
9			TO VACUUM EQUIPMENT
10			REFLUX IN FROM
11		2	FEED FROM GA-902
12			FEED FROM
13			FEED FROM
14	1	6	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-902B
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	2		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED 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 SP GR = 0.92 (avg) @ operating temp

LUMMUS	THE LUMMUS COMPANY Bloomfield

TITLE JET FUELS PROJECT
CLIENT AMOCO/DOE-GREAT PLAINS GASIF PLANT LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO 05571

REV	ISSUE DATE	DESCRIPTION	PROJ.	PROJ.	APPR	APPR
1						
0	4/16/84	FOR TASK 4				

PROCESS VESSEL SKETCH
VESSEL NO DA-902A DWG REQ.

VESSEL NO DA-902 B COMB WITH ____
VESSEL NAME PHENOL COLUMN / ... COLUMN (Alternate Service)
DIAMETER 5'-0" ft-in & ____ ft-in
VERT HT 93'-4" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ____ ft-in
OPER TEMP: TOP 256 °F BOTT 312 °F DRUM ____ °F
MAX TEMP: TOP ____ °F BOTT ____ °F DRUM ____ °F
NORM OPER PRESS -12.5 (TOP) psig OR -8 (BOTTOM) psig
MAX OPER PRESS ____ psig OR ____ psig
CORROSION ALLOW: SHELL 3 mm in. DECKS ____ in

DES TEMP 340 °F
DES PRESS 45 psi VAC FULL psig
HEADS: ELIP ✓ DISHED ____ CONE ____ FLAT ____
CODE ASME VIII API ____ OTHER ____
STRESS RELIEVED: YES ✓ CODE ____
RADIOGRAPHED: YES ____ CODE ____
EARTHQUAKE ____ WIND ____ psf

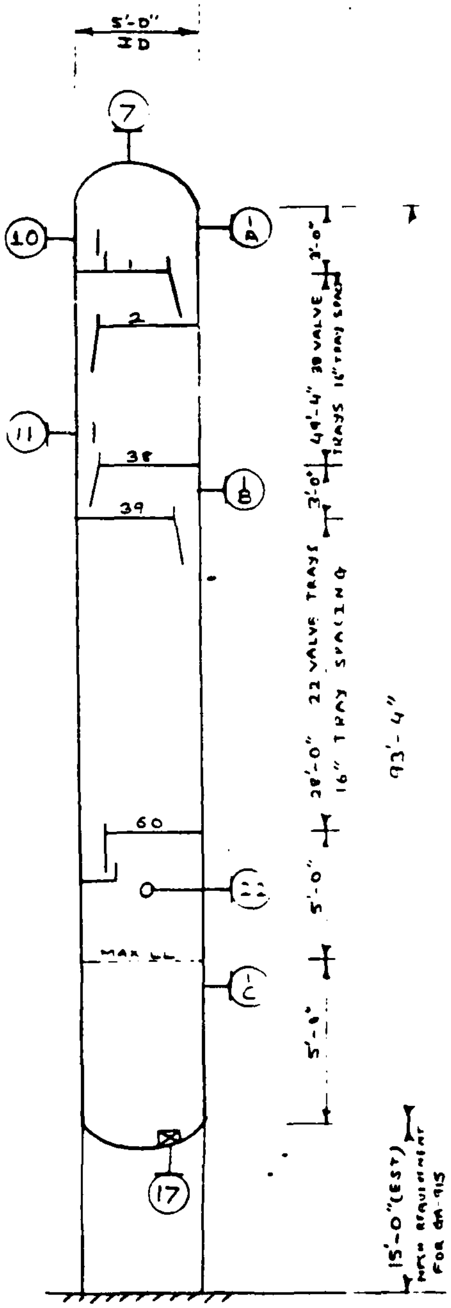
MATL: SHELL C S LINER ____ THK ____ in
INSULATION: CONSERV'N ✓ PROTECT'N ____ NONE ____
DECK MATL: C S VALVE MATL 304SS

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	1/2	REFLUX IN FROM EA-902
11	1	1/2	FEED FROM GA-901
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (REB. PUMP)
15			FROM REBOILER
16			EQUALIZING LINE WITH
17		6	BOTTOM OUTLET TO GA-915
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____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: LIQ SP GR = 0.97 (avg) @ operating temp



⚠1						
⚠	4/1/81	For TASK 4				
REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR	PROJ. DIRECTOR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY, Bloomfield

TITLE JET FUELS PROJECT
CLIENT ANG COAL GASIFICATION / DOE-GPGA LOCATION BEULAH, NORTH DAKOTA PLAINS PROJECT
PROJ NO ____ JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO DA-902B DWG SKS -

```
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 ID 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    VAPOR DENSITY      LIQUID RATE   LIQUID DENSITY  SURFACE TENSION   LIQUID VISCOSITY
                      LBS/HR         LBS/FT3            LBS/HR        LBS/FT3         DYNES/CM          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          21.48              .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  * * * * * *
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VESSEL NO DA-903 COMB WITH
VESSEL NAME M.P-C8E-D COLUMN
DIAMETER 7'-6" ft-in & ft-in
VERT HT 134'-6" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP 287 °F BOTT 370 °F DRUM °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS [illegible] psig OR [illegible] psia
MAX OPER PRESS psig OR psia
CORROSION ALLOW: SHELL 3mm in. DECKS in.

DES TEMP 395 °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 psf

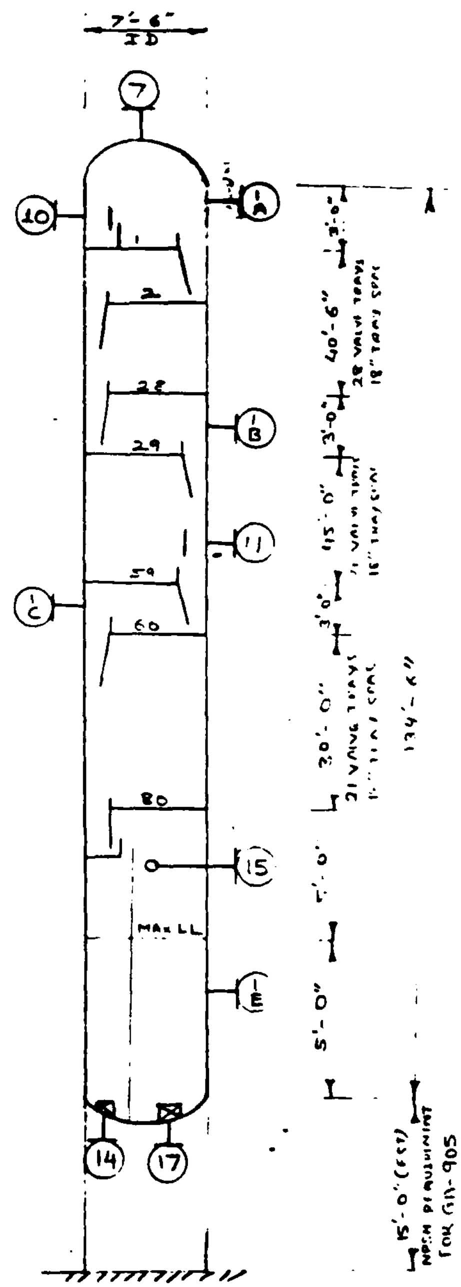
MATL: SHELL CS LINER ✓ THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL. CS VALVE MATL. 304 SS

NOZZLES: FLG CLASS 150 COUPL CLASS

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

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	1	3	REFLUX IN FROM	FA-903
11	1	1½	FEED FROM	GA-901
12			FEED FROM	
13			FEED FROM	
14	1	18	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 (& 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	2		INTERNAL LEVEL	
48			LEVEL ALARM (LA)	
49				
50				

NOTES: LIQ SP. GR = 0.89(avg) @ operating temp.



LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT [illegible] LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO

PROCESS VESSEL SKETCH

VESSEL NO DA-903 DWG NO -

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR		APPR.	
1						
2	[illegible] 84	FOR TASK 4	[illegible]			

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CE LUM                  VALVE TRAY COMPUTER PROGRAM 4-9217       RELEASE 03 DATED APR 25 1986          BATCH
BY SUNIL                USED AT 12.54.01 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    VAPOR DENSITY     LIQUID RATE   LIQUID DENSITY  SURFACE TENSION  LIQUID VISCOSITY
                       LBS/HR        LBS/FT3           LBS/HR         LBS/FT3        DYNES/CM         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           33344.50       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 * * * * * *
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VESSEL NO DA-904 COMB WITH
VESSEL NAME Xylenol Topping Column / Xylenol Column (Alternate Service)
DIAMETER 5'-6" ft-in & ft-in
VERT HT 115'-3" ft-in SKIRT 15'-0" ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP 300 °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, DECKS in

DES TEMP 415 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELLIP ✓ DISHED CONE FLAT
CODE: ASME VIII API OTHER
STRESS RELIEVED: YES CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE: WIND mph

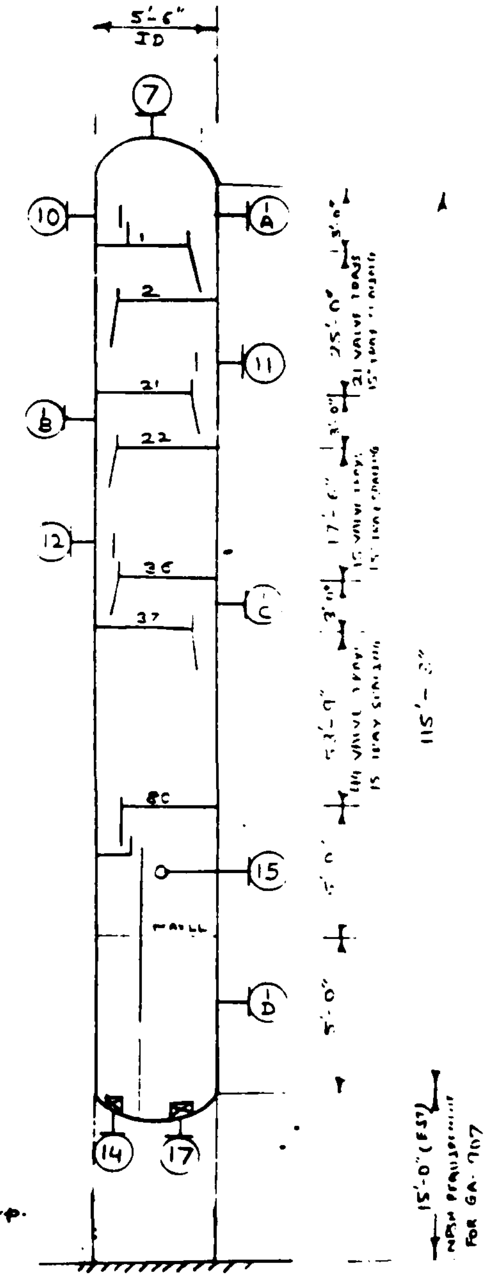
MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL: CS VALVE MATL 304SS

NOZZLES: FLG CLASS 150 COUPL CLASS

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

ITEM NO.	NO. REQD	SIZE in	SERVICE & SYMBOL
1	2	24	MANHOLE
2			MANHOLE
3			
4			
5			HANDHOLE
6			
7	1	16	VAPOR OUTLET TO EA-908
8			VENT
9			TO VACUUM EQUIPMENT
10	1	2	REFLUX IN FROM GA-914
11	1	1½	FEED FROM GA-905
12	1	1½	FEED FROM GA-916
13			FEED FROM
14	1	8"	TO REBOILER ~~(REBOILER FEED)~~ EA-907
15		12	FROM REBOILER EA 907
16			EQUALIZING LINE WITH
17	1	1½	BOTTOM OUTLET TO ~~GA~~ 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__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(S)
49			
50			

NOTES: LIQ SP. GR. ≈ 0.88 (avg) @ operating temp.



LUMMUS	THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT ANG/DOE-GPGA (GREAT PLAINS PROJECT) LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO 85571

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ		
1						
2	4/14/89	FOR TASK 4	SR			

PROCESS VESSEL SKETCH

NO DA-904 DWG SIZE -

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CE LUMMUS            VALVE TRAY COMPUTER PROGRAM 4-9212      RELEASE 03 DATED APR 25 1986          BATCH
BY SUNIL             USED AT 12.59.26 ON 88/11/11.           DESIGN - FIND ROUNDED TO SXF          LUMMUS JOB OR ESTIMATE  .571
COLUMN 904 CRESYLIC ACID RECOVERY                                                                  DEPT  302        OFFICE  LTD

LAYOUT DIMENSIONS

  TRAY SPACING,INCHES                                15.000 (50I)      INSIDE  TOWER DIAMETER,INCHES           66.00
  TYPE OF FLOW                                    SXF (1-PASS)

  DESIGN LOADS       VAPOR RATE    VAPOR DENSITY      LIQUID RATE   LIQUID DENSITY  SURFACE TENSION   LIQUID VISCOSITY
                       LBS/HR         LBS/FT3            LBS/HR         LBS/FT3        DYNES/CM          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=SID.
  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  * * * * * *
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Item Number	Service	Side	Material	Flow lb/hr	Specific Gravity	Molecular Weight	Viscosity at Avg Temp cP	% Vaporized by Weight	% Condensed by Weight	Temp In °F	Temp Out °F	Corr MTD	Design Temp	Duty 1000 Btu/hr	Overall Heat Trans Coeff Btu/hr ft² °F	Foul Factor	Total Surface ft²	Max Allowable Press Drop psi	Press Operating psig	Press Design psig	No Units and OD by Length	Type TEMA Symbols	Materials Shell	Materials Tubes
FA 901	[illegible] Col. Reboiler	Shell	HP Steam	8635					100	[illegible]	[illegible]	[illegible]	[illegible]	7900		[illegible]	710	-	550	635		[illegible]	CS	[illegible]
		Tube	[illegible]	215320	0.86	11	[illegible]	20		[illegible]	[illegible]		[illegible]			[illegible]		0.5	[illegible]	15+V				
FA 902	Phenol/[illegible] Col. Condenser	Shell	Phenol [illegible]	22820	0.97	101	0.32	-	100	[illegible]	[illegible]	47	[illegible]	6900		[illegible]	522	0.5	12.5	15+V		[illegible]	CS	CS
		Tube	Temp Water	363335						100	118		[illegible]			[illegible]		10	40	110				
FA 903	Phenol Col. Reboiler	Shell	HP Steam	4140					100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	700	-	550	635		[illegible]	[illegible]	[illegible]
		Tube	O-Cresol	109875	0.9	105	0.81	20		[illegible]	[illegible]		[illegible]			[illegible]		0.5	35	15+V				
FA 904	Phenol Col. Condenser	Shell	Phenol	15400	0.98	94	0.377	-	100	[illegible]	[illegible]	46	[illegible]	[illegible]		[illegible]	286	0.5	[illegible]	15+V		[illegible]	[illegible]	IR-2
		Tube	Temp Water	202500						100	118		[illegible]			[illegible]		10	40	110				
FA 905	M.P.-Cresol Col. Reboiler	Shell	HP Steam	8960					100	750	480	127	775	8200		[illegible]	75	-	550	635		[illegible]	[illegible]	[illegible]
		Tube	[illegible]	233230	0.85	117	0.25	20		270	270		395			[illegible]		0.5	67	15+V				
FA 906	M.P.-Cresol Col. Condenser	Shell	M.P. Cresol	39900	0.93	108	[illegible]		100	[illegible]	[illegible]	70	[illegible]	7950		[illegible]	520	0.5	12.5	15+V		[illegible]	CS	IR 2
		Tube	Temp Water	141670						100	118		[illegible]			[illegible]		10	40	110				
FA 907	Xylenol Topping Col. Reboiler	Shell	HP Steam	4015					100	[illegible]	[illegible]	[illegible]	77	2200		[illegible]	479	-	550	635		[illegible]	316L SS	316L SS
		Tube	Xylenols	102100	0.1	122		20		[illegible]	[illegible]		115			[illegible]		0.5	67	15+V				
FA 908	Xylenol Topping Col. Condenser	Shell	[illegible]	18680	0.93	109			100	259	281	174	315	3700		[illegible]	236	0.5	12.5	15+V		BEM	CS	IR 2
		Tube	Temp Water	205555						100	118		[illegible]			[illegible]		10	40	110				
FA 909	Phenol Dimo Col. Feed-Btms Interchanger	Shell	[illegible] Acid	102116	0.97	108	0.6	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		001	[illegible]	10	20	50		AEM	316L SS	316L SS
		Tube	[illegible] Xylenols	6530	0.91	112	0.34	-	-	380	[illegible]		105			001		10	20	50				
FA 910	Phenol Col. Btms Cooler	Shell	O-Cresol	2416	0.97	105	0.43			[illegible]	113	79	210	320		[illegible]	68	10	40	70		AES	[illegible]	[illegible]
		Tube	Temp Water	22000						100	110		115			[illegible]		10	40	110				
FA 911	Xylenol Topping Col. Btms Cooler	Shell	Xylenols	1260	0.96	122	0.46	-	-	381	113	84	410	170		001	35	10	40	70		AES	CS	CS
		Tube	Temp Water	17000						100	110		150			002		10	40	110				
FA 912	M.P.-Cresol Product Cooler	Shell	M.P. Cresol	5250	0.96	107	0.63	-	-	[illegible]	113	56	[illegible]	450		[illegible]	125	10	40	70		AES	[illegible]	[illegible]
		Tube	Temp Water	45000				-	-	100	110		150			002		10	40	110				
FA 913	O-Cresol Topping Col. O/H Cooler	Shell	Phenol, [illegible]	54[illegible]	0.99	105	[illegible]			[illegible]	113	56	280	55		[illegible]	16	10	40	70		Double Pipe	CS	CS
		Tube	Temp Water	5510						[illegible]	110		150			[illegible]		10	40	110				
FA 914	O-Cresol Product Cooler	Shell	O-Cresol	1945	0.99	108	0.6			260	113	54	[illegible]	150		001	46	10	40	70		AES	CS	CS
		Tube	Temp Water	15010				-	-	100	[illegible]		150			002		10	40	70				
FA 915	2,4/2,6 Xylenol Col. Feed Btms Interchanger	Shell	Xylenols	[illegible]360	0.97	122	0.76	-		113	235	110	250	130		001	18	10	20	50		Double Pipe	CS	CS
		Tube	Xylenols	1190	0.97	122	0.64			36.7	[illegible]		410			001		10	20	50				
FA 916	2,4/2,5 Xylenol Product Cooler	Shell	2,4/2,5 Xylenol	913	0.97	122	0.72			[illegible]	113	[illegible]	320	82		[illegible]	22	10	40	70		Double Pipe	CS	CS
		Tube	Temp Water	8200						[illegible]	110		150			[illegible]		10	40	110				

Item Number	Component	Entering Vapor lb/hr	Entering Liquid lb/hr	Entering Bubble or Dew Pt °F	Entering SP GR	Entering Mol Wt	Leaving Vapor lb/hr	Leaving Liquid lb/hr	Leaving Bubble or Dew Pt °F	Leaving SP GR	Leaving Mol Wt

NOTES

REV	DESCRIPTION	BY	APP	APP	DATE
0	[illegible] TASK 4	[illegible]			[illegible]

LUMMUS

EXCHANGER SCHEDULE

UNIT AREA 900

JOB NO 05571

ITEM NUMBER	ALTERNATE SERVICE FOR 700 AREA EXCHANGERS	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 hr ft² °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	SHELL	HP STEAM											2400										
	Col Reboiler	TUBE	O-CRESOL	89000																				
EA 902	O Cresol Topping	SHELL	Phenol-O-Cresol	8190										2600										
	Col Condenser	TUBE	Temp Water																					
EA 903	O-Cresol Col.	SHELL	HP STEAM											2900										
	Reboiler	TUBE	Cresylic Xylenols	78200																				
EA 904	O Cresol Col	SHELL	O-Cresol	20297										2900										
	Condenser	TUBE	Temp Water																					
EA 907	2,4/2,5 Xylenol	SHELL	HP STEAM											2400										
	Col Reboiler	TUBE	Xylenols	94850																				
EA 908	2,4/2,5 Xylenol	SHELL	2,4/2,5 Xylenol	16910										2200										
	Col Condenser	TUBE	Temp Water																					
EA 909	O-Cresol Topping Col Feed-Btms Interchanger	SHELL	O-Cresol Phenol	2416										120										
		TUBE	O-Cresol	1870																				
EA 910	O-Cresol Col	SHELL	Slop Cut	25										6										
	Btms Cooler	TUBE	Temp Water																					
EA 911	2,4/2,5 Xylenol	SHELL	Xylenol	1490										75										
	Col Btms Cooler	TUBE	Temp Water																					
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						
		SHELL																						
		TUBE																						

ITEM NUMBER	COMPONENT	ENTERING lb/hr: VAPOR	LIQUID	Bubble or Dew Pt °F	BP OR	MOL WT	LEAVING lb/hr: VAPOR	LIQUID	Bubble or Dew Pt °F	BP OR	MOL WT

NOTES

REV	DESCRIPTION	BY	APP	APP	DATE
		MH			

LUMMUS

EXCHANGER SCHEDULE

UNIT AREA 900

JOB NO 05571

VESSEL NO FA-901 COMB WITH

VESSEL NAME PHENOL-ORTHO REFLUX DRUM / ORTHO TOPPING REFLUX DRUM (Alternate Service)

DIAMETER 3'-6" ft-in & ft-in

VERT HT ft-in SKIRT ft-in

HORIZ LENGTH 6'-6" ft-in

OPER TEMP: TOP °F BOTT °F DRUM 255 °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 280 °F

DES PRESS 45 psig VAC FULL 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

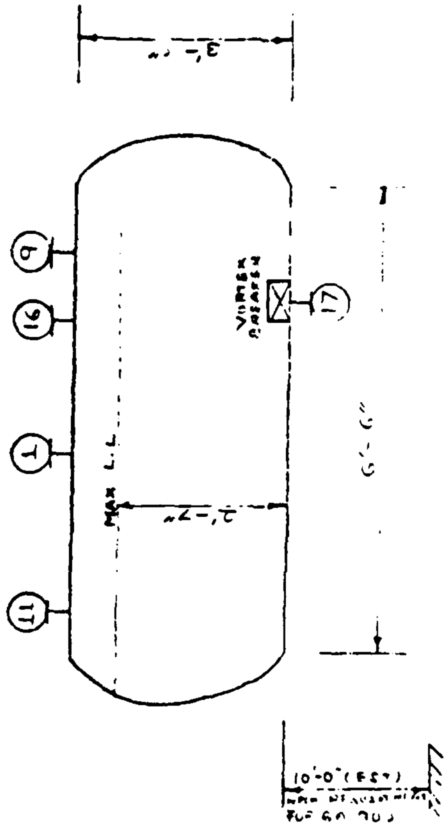
DECK MATL:

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	EQUALIZING LINE WITH EA 902
17	1	4	BOTTOM OUTLET TO GA-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 (& 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	2		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 = 0.87 @ operating temp.



E&E LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

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

PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FA-901 PART. N/A

REV	ISSUE DATE	DESCRIPTION	PROC. ENGR	PROJ ENGR	APPR	APPR
1						
0	9/14/88	FOR TASK 4	EK			

VESSEL NO FA-902 COMB WITH ______

VESSEL NAME PHENOL REFLUX DRUM/O-CRESOL REFLUX DRUM (Alternate Service)

DIAMETER 3'-0" ft-in & ______ ft-in

VERT HT ______ ft-in SKIRT ______ ft-in

HORIZ LENGTH 5'-0" ft-in

OPER TEMP TOP ______ °F BOTT ______ °F DRUM 260 °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 mm in 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

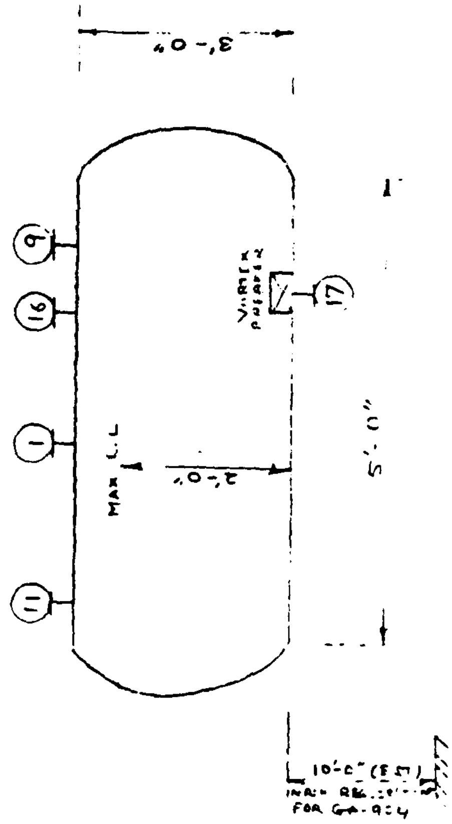
INSULATION CONSERV'N ✓ PROTECT'N ______ NONE ______

DECK MATL 150

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 (& 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 = 0.95 @ operating temp.

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT

CLIENT AMOCO/DOE-BGRT LOCATION BEULAH NORTH DAKOTA

RAINS GREAT PROJECT

PROJ NO ______ JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/4/1 '93	FOR TASK 4	[illegible]			

VESSEL NO FA-902 DWG SKS -

VESSEL NO FA-903 COMB WITH
VESSEL NAME H.P. CRESOL REFLUX DRUM
DIAMETER 3'-6" ft-in & ft-in
VERT HT ft-in SKIRT ft-in
HORIZ LENGTH 7'-6" ft-in
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
HEADS ELIP DISHED ✓ CONE FLAT
CODE ASME VIII API OTHER
STRESS RELIEVED YES ✓ CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

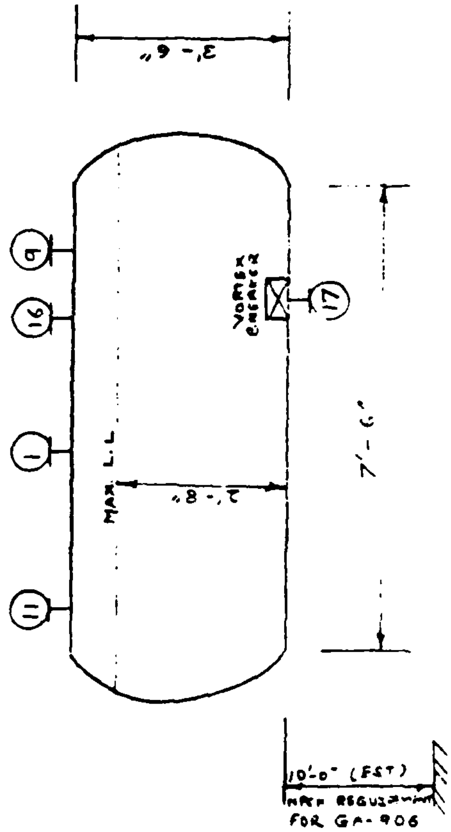
MATL SHELL CS LINER THK in
INSULATION CONSERV'N ✓ PROTECT'N NONE
DECK MATL

NOZZLES FLG CLASS 150 COUPL CLASS

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

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) (RES 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			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 = 0.93 @ operating temp.



1						
0	4/14/80	FOR TASK 4				
REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR	PROJ. ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUELS PROJECT
CLIENT AMOCO/DOE GREAT PLAINS GAS. PROJ. LOCATION BEULAH, NORTH DAKOTA
PROJ NO JOB NO 08571
PROCESS VESSEL SKETCH
VESSEL NO FA-903 DWG SIZE -

VESSEL NO FA 904 COMB WITH
VESSEL NAME XYLENOL TOPPING FILM DEJM/24-25 XYLENOL REFLUX DRUM (AIR SERVICE)
DIAMETER 3'-0" ft-in & ft-in
VERT HT ft-in SKIRT ft-in
HORIZ LENGTH 5'-0" ft-in
OPER TEMP: TOP °F BOTT °F DRUM 2?5 °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 3mm # DECKS in

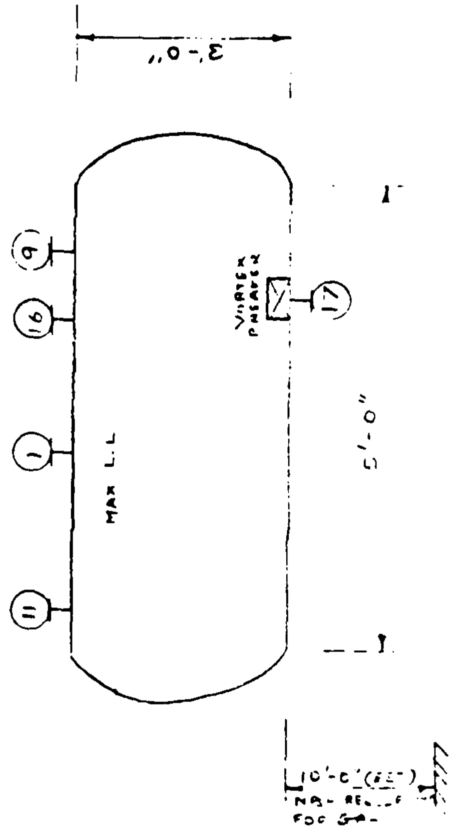
DES TEMP 320 °F
DES PRESS 45 psig VAC FULL psia
HEADS: ELIP DISHED CONE FLAT
CODE: ASME VIII API OTHER
STRESS RELIEVED: YES ✓ CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE WIND mph

MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N ✓ PROTECT'N NONE
DECK MATL

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 918
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (REB. PUMP)
15			FROM REBOILER
16	1	1 1/2	EQUALIZING LINE WITH EA-908
17	1	2	BOTTOM OUTLET TO GA-915
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			

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



NOTES: LIQUID SP GR = 0.87 @ operating temp.

1						
0	4/14/84	FOR TASK 4				
REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR

CE LUMMUS — THE LUMMUS COMPANY

TITLE: JET FUELS PROJECT
CLIENT: AMOCO/DOE GREAT PLAINS GASIF PROJ
LOCATION: BEULAH, NORTH DAKOTA
PROJ NO
JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FA 904
DWG SIZE -

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 Bottoms Pump	Centrifugal	M,P-Cresols Xylenols		380		0.86	10.5	0.27	15.2	20	45.3	0		45.3	120	12	DI-CS				Motor	
Alt Service	O-Cresol Topping Btms. Pump	Centrifugal	O-Cresol		355		0.91	10.5	0.28	42	50	43	0		43	109	12	DI-CS				"	
GA 902A/S	Phenol/Xylenol Reflux Pump	Centrifugal	Phenol O-Cresol		254		0.97	1.93	0.38	68	81	89	-10		99	236	6.6	DI-CS				Motor	
Alt Service	O Cresol Topping Reflux Pump	Centrifugal	Phenol-O-Cresol		253		0.97	1.93	0.38	17	20.5	89	-10		99	236	6.6	DI-CS				"	
GA 903A/S	Phenol Btms Pump	Centrifugal	Phenol, O-Cresol		254.4		0.90	11.2	0.27	55	65	44	1.0		43	111	11.4	DI-CS				Motor	
Alt. Service	O-Cresol Col. Btms Pump	Centrifugal	Xylenols		377		0.87	11.2	0.27	0.06	0.1	41	0.8		40	105	11.3	DI-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	DI-CS				Motor	
Alt Service	O-Cresol Col Reflux Pump	Centrifugal	O-Cresol		260		0.95	1.92	0.38	42	51	55	-10		65	158	6.6	DI-CS				"	
GA-906A/S	M,P-Cresol Btms Pump	Centrifugal	Xylenols M,P-Cresols		349.5		0.86	7.7	0.28	5.5	6.6	48.5	-2.8		51.3	138	11.3	DI-CS				Motor	
GA-907A/S	M,P-Cresol Reflux Pump	Centrifugal	M,P-Cresol		281		0.93	1.93	0.37	86	102	69.5	-10.2		79.7	198	6.5	DI-CS				Motor	
GA-908	O-Cresol Topping Pump	Centrifugal	O-Cresol/Phenol		113		1.02	0.06	0.90		22	43	-0.5		43.5	99	32	DI-CS				Motor	
GA-909	Mixed Xylenol Pump	Centrifugal	Xylenols		113		0.95	<0.01	1.09		12	38.6	-0.5		39.1	95	35	DI-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	DI-CS				Motor	
GA-911	M,P-Cresol Pump	Centrifugal	M,P-Cresol		113		1.01	0.02	0.91		45	42.5	-0.5		43	98	42.5	DI-CS				Motor	
GA-912	Xylenols Pump	Centrifugal	Xylenols		113		0.95	<0.01	1.06		14	42	-0.5		42.5	103	35	DI-CS				Motor	
GA-913	O-Cresol Pump	Centrifugal	O-Cresol		113		1.02	0.06	0.82		15	42	0.5		43.5	99	32	DI-CS				Motor	
GA-914A/S	Phenol Col. Sidestream Pump	Centrifugal	Phenol/O-Cresol		333		0.89	6.6	0.30		37	45	-3.7		51.7	134	11.4	DI-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/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 ____ GR ____ DIV ____

REV. NO.	BY	DATE
0	JA	4/11/89

LUMMUS THE LUMMUS COMPANY Bloomfield

PUMP SCHEDULE

CUSTOMER AMOCO/DOE-GREAT PLAINS GASIF. PROJECT GGP PUBLIC PROJECT
UNIT ____ AREA 900
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	FLANGE RATING/FACING SUCT	FLANGE RATING/FACING DISCH	DRIVER TYPE	REMARKS
GA 915 A/S	Xylenol Topping Btms. Pump	Centrifugal	Xylenols, P,M-Cresol		361		0.83	7.7	0.25	31	38	52.2	-1.0		52.2	120	11.2					Motor	
Alt. Service	Xylenol Col Btms. Pump	Centrifugal	Mixed Xylenol		286		0.83	7.7	0.28	36	40	42.3	-1.0		43.3	121	11.2						
GA-916 A/S	Xylenol Topping [illegible] Pump	Centrifugal	H.P. Phenolic Xylenols		281.5		0.93	19.3	0.27	39	47	61.8	10.2		72	179	6.5					Motor	
Alt. Service	Xylenol Col Reflux Pump	Centrifugal	2,4-2,5 Xylenol		292.5		0.87	19.2	0.27	38	45	60	10.4		70.4	187	6.3						
GA 917 A/S	O-Cresol Topping Col Feed Pump	Centrifugal	O-CRESOL		AMB		1.03	0.06	0.79	47	60	110	-0.5		110.5	248	32					Motor	
GA-918 A/S	Xylenol Col Feed 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.
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 ____ GR ____ DIV ____

REV. NO.	BY	DATE
0	[illegible]	4/4/8[illegible]

LUMMUS

THE LUMMUS COMPANY
Bloomfield

PUMP SCHEDULE

CUSTOMER AMOCO/DOE-GREAT PLAINS GASIF. PROJECT JET FUELS PROJECT
UNIT ____ AREA 900
JOB NO. 05571

R109 06 0576 (F2 4 389) V 1

VESSEL NO FR-701 COMB WITH ____
VESSEL NAME 2-PRES. TOPPING 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 3mm in 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 ____

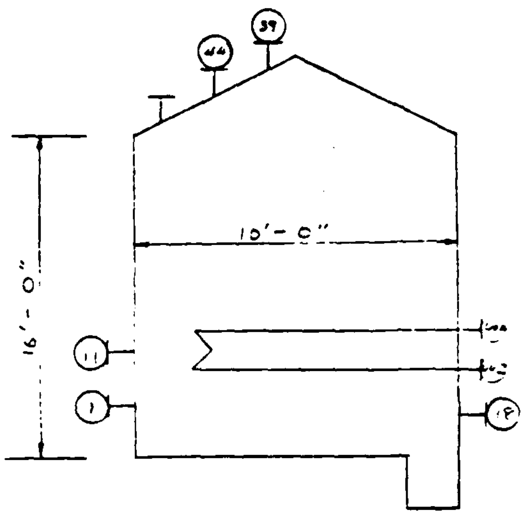
NOZZLES FLG CLASS ____ COUPL CLASS ____

ITEM NO	NO REQD	SIZE in	SERVICE & SYMBOL
1	1	24	MANHOLE (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 SR-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 GA 3-8
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	[illegible]
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	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



△1							
△0	4/14/81	FOR TANK 4					
REV	ISSUE DATE	DESCRIPT'	PROJ ENGR	PROJ ENGR	APPR	APPR	

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO ____ JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FR-901 DWG SIZ -

VESSEL NO FB-902 COMB WITH ______
VESSEL NAME XYLENOL INTERMEDIATE DAY TANK
DIAMETER 10'-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 113 °F
MAX TEMP TOP ______ °F BOTT ______ °F DRUM ______ °F
NORM OPER PRESS ______ psig OR ______ psia
MAX OPER PRESS 6" H2O ______ psia
CORROSION ALLOW SHELL ______ in DECKS ______ in

DES TEMP 230 °F
DES PRESS 8 H2O 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

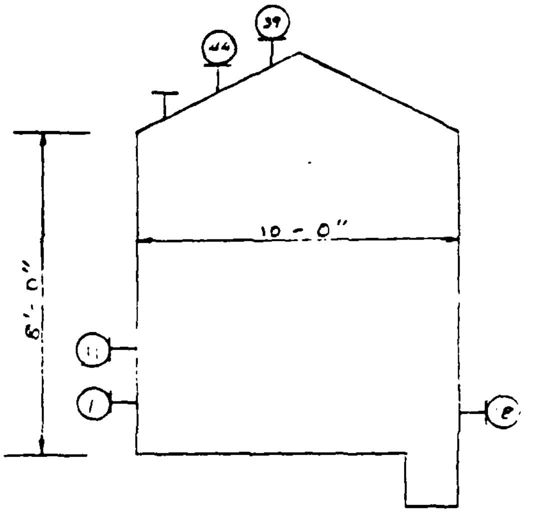
MATL SHELL CS LINER ______ THK ______ in
INSULATION CONSERV'N X PROTECT'N ______ NONE ______
DECK MATL ______

NOZZLES FLG CLASS ______ COUPL CLASS ______

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

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 GA-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 GA-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	N2 [illegible]
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T______C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	6	GAUGE - HATCH
45			GAUGE GLASS (LG)
46			EXTERNAL LEVEL
47	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES LIQUID SP GR = 0.95 at operating temp



△						
△	6/16/79	FOR TANK 4				
REV	ISSUE DATE	DESCRIPTION	PREL ENGR	PROJ ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY Bloomfield

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FB-902 DWG SIZE -

VESSEL NO FR-902 COMB WITH
VESSEL NAME O-CRESOL PRODUCT DAY TANK
DIAMETER 11'-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 113 °F
MAX TEMP: TOP °F BOTT °F DRUM °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS 6" H2O psig/psia psia
CORROSION ALLOW: SHELL 3mm in HEADS in

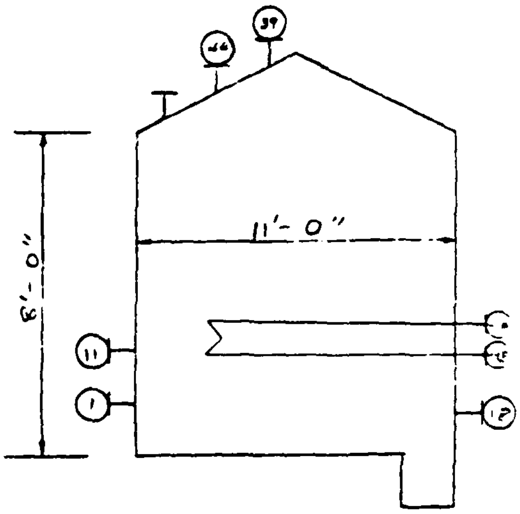
DES TEMP 230 °F
DES PRESS 8" H2O psig VAC -2" H2O
HEADS: ELIP DISHED CONE ROOF FLAT BOTTOM
CODE: ASME API X OTHER
STRESS RELIEVED: YES CODE
RADIOGRAPHED: YES CODE
EARTHQUAKE WIND mph

MATL: SHELL CS LINER THK in
INSULATION: CONSERV'N X PROTECT'N NONE
DECK MATL:

NOZZLES: FLG CLASS COUPL CLASS

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

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-924
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-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	N_2 BLANKETING
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T____C)
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	2	2	STEAM COIL
50			



NOTES: 1) LIQUID SP GR = 1.02 @ operating temp
2) STEAM COIL TO MAINTAIN 100°F

2						
1	4/1/81	FOR TASK 4	JSL			
REV	ISSUE DATE	DESCRIPTION	PREL CHECK	PROJ CHECK	APPR	APPR

LUMMUS — THE LUMMUS COMPANY
TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE GREAT PLAINS GASIF. LOCATION BEULAH, ND
PROJ NO JOB NO 05571
PROCESS VESSEL SKETCH
VESSEL NO FR-902 DWG SKS -

VESSEL NO 1E-905 COMB WITH
VESSEL NAME ... F. ... TANK
DIAMETER 14'-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 113 °F
MAX TEMP TOP ______ °F BOTT ______ °F DRUM ______ °F
NORM OPER PRESS ______ psig OR ______
MAX OPER PRESS 6" H_2O ______
CORROSION ALLOW SHELL ... in DECKS ______ in

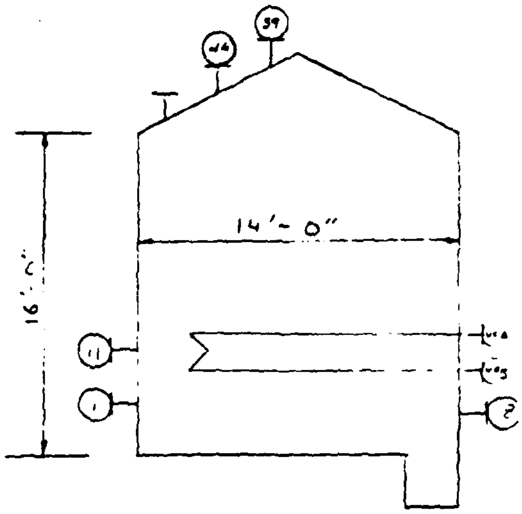
DES TEMP 230 °F
DES PRESS 8" H_2O VAC -2" H_2O
HEADS ELIP ______ DISHED ______ CONE ROOF FLAT BOTTOM
CODE ASME ______ API X OTHER ______
STRESS RELIEVED YES ______ CODE ______
RADIOGRAPHED YES ______ CODE ______
EARTHQUAKE ______ WIND ______ mph

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
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		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	N_2 Blanketing
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) ... SP GR = 1.01 @ operating temp.
2) STEAM COIL TO MAINTAIN 60°F.

1						
2	4/14 79	FOR TASK 4				
REV	ISSUE DATE	DESCRIPTION	PROC ENGR	PROJ ENGR	APPR	APPR

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 08571

PROCESS VESSEL SKETCH

VESSEL NO FB-905 DWG SKD -

VESSEL NO FB-906 CONN WITH

VESSEL NAME 24/2,5 XYLENOL DAY TANK

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 117 °F

MAX TEMP TOP °F BOTT °F DRUM °F

NORM OPER PRESS psig OR psia

MAX OPER PRESS 6 H_2O psig OR psia

CORROSION ALLOW SHELL in DECKS in

DES TEMP 220 °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 COR

RADIOGRAPHED YES DESCL

EARTHQUAKE WIND mph

MATL SHELL CS LINER THK in

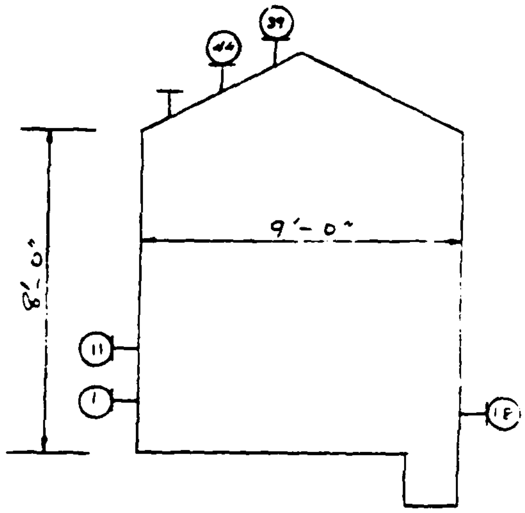
INSULATION CONSERV'N X PROTECT'N NONE

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		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	1	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 (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	N_2 BLANKETING
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			
50			

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



NOTES LIQUID SP GR = 0.955 @ operating temp

LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT

CLIENT AMOCO/DOE-ANG LOCATION BEULAH, ND
PLAINS GRASS

PRIN NO JOB NO 03571

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
2						
1	4/1/81	For Task 4	JL			

PROCESS VESSEL SKETCH

VESSEL NO FB-906 DWG NO -

VESSEL NO F.B-907 COMB WITH
VESSEL NAME MIXED [illegible] DAY TANK
DIAMETER 11'-0" ft-in & ft-in
VERT HT 8'-0" ft-in BOTT ft-in
HORIZ LENGTH ft-in
OPER TEMP: TOP °F BOTT °F DRUM 117 °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

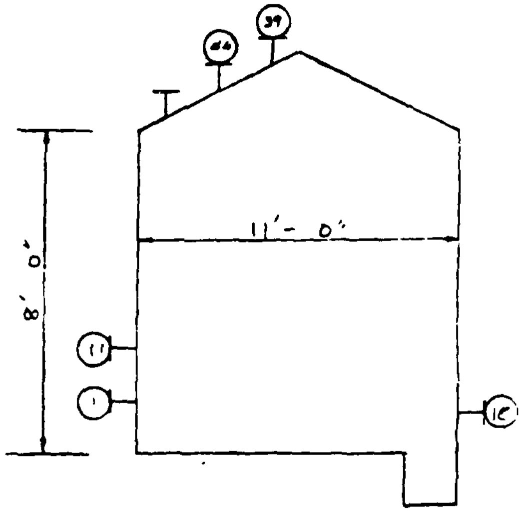
DES TEMP 220 °F
DES PRESS 6" H2O psig VAC -2" H2O psia
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API X OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

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
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-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-903
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. (& 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 BLANKETING
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			
50			

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



NOTES: SG SP GR = 0.96 @ operating temp

LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO / DOE - GREAT PLAINS GASIF PLANT LOCATION BEULAH, ND
PROJ NO JOB NO 06571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ. ENGR	PROJ. ENGR	APPR	APPR
1						
2	4/14/83	FOR TASK 4	[illegible]			

VESSEL NO FB-907 DWG SIZE -

VESSEL NO FG-926 COMB WITH
VESSEL NAME [illegible] TOPPING FEED MONTH STORAGE
DIAMETER 26'-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 113 °F
NORM OPER PRESS psig
MAX OPER PRESS 6" H_2O psig OR psia
CORROSION ALLOW SHELL 3mm in DECKS in

DES TEMP 220 °F
DES PRESS 8" 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:

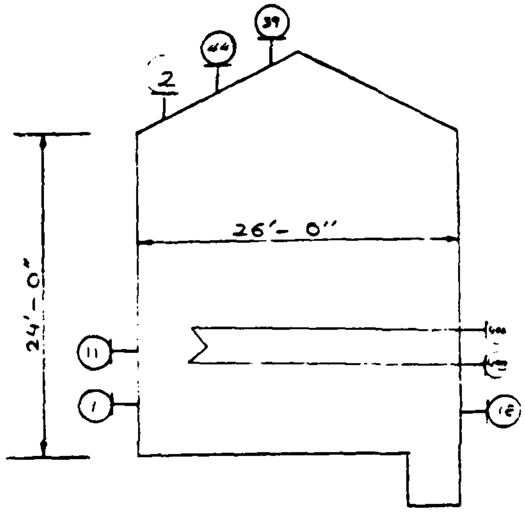
NOZZLES FLG CLASS COUPL CLASS

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

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 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	N_2 BLANKETING
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T___C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	4	OAKY- MATLN
45			GAUGE GLASS (LG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49	2	4	STEAM COIL
50			

NOTES: [illegible] SP GR = 1.04 @ operating temp.

2) STEAM COIL TO MAINTAIN 100°F TEMP



LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05371

PROCESS VESSEL SKETCH

VESSEL NO FB-908 DWG NO -

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	4/81	FOR TASK 4	[illegible]			

VESSEL NO FE 909 COMB WITH
VESSEL NAME XYLENOL INTERMEDIATE MONTH STORAGE
DIAMETER 20' 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 AMB °F
MAX TEMP TOP °F BOTT °F DRUM 113 °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS 6" H_2O psig OR psia
CORROSION ALLOW SHELL in DECKS in

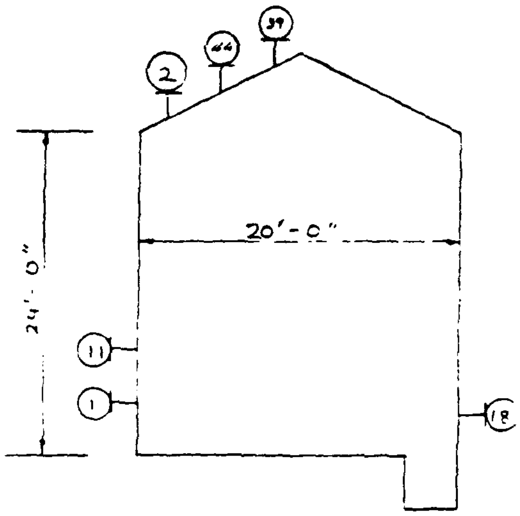
DES TEMP 230 °F
DES PRESS 8" H_2O psig VAC -2" H_2O psia
HEADS ELIP DISHED CONE ROOF FLAT BOTTOM
CODE ASME API X OTHER
STRESS RELIEVED YES CODE
RADIOGRAPHED YES CODE
EARTHQUAKE WIND mph

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 (SHELL)
2	1	20	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			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	[illegible]
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	4	[illegible]
45			GAUGE GLASS (LG)
46			EXTERNAL LEVEL
47	1		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

FLANGED NOZZLES ARE NUMBERED 1-80
FOR COUPLING ADD 80 TO NOZZLE NO



NOTES LIQUID SP GR = 0.96 @ operating temp.

CE LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-909 DWG SKS -

REV	ISSUE DATE	DESCRIPT	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	6/14/85	FOR TALK 4	[illegible]			

VESSEL NO FP-910 COMB WITH ______
VESSEL NAME [illegible] 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 8" H2O ______ psia
CORROSION ALLOW SHELL 3 mm ______ DECKS ______ in

DES TEMP 220 °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

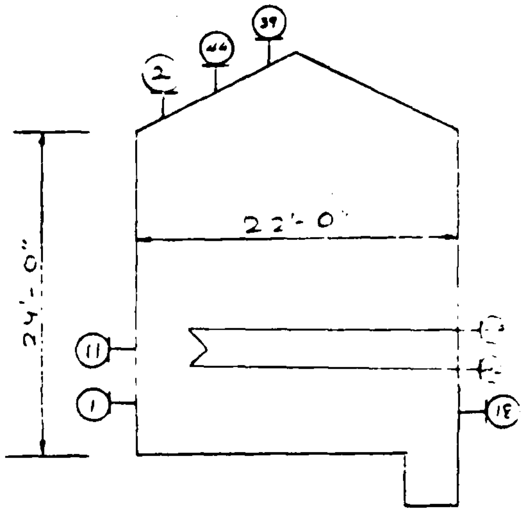
MATL SHELL CS LIN ______ HR ______ in
INSULATION CONSER.N X PROTECT ______ NONE ______
DECK MATL ______

NOZZLES FLG CLASS ______ COUPL CLASS ______

FLANGED NOZZLES ARE NUMBERED 1-80 FOR COUPLING ADD 80 TO NOZZLE NO

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	1½	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 (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	[illegible]
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T____C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	4	[illegible]
45			GAUGE GLASS (LG)
46			EXTERNAL LEVEL
47	/		INTERNAL LEVEL
48			LEVEL ALARM (LA)
49	1	4	STEAM COIL
50			

NOTES 1) LIQUID SP GR = 1.03 @ operating temp.
2) STEAM COIL TO MAINTAIN 100°F



LUMMUS — THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE - GREAT PLAINS GASIFI. LOCATION BEULAH, ND
PROJ NO ______ JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
0	4/1/83	FOR TANK	YL			

VESSEL NO FR-910 DWG BKG -

VESSEL NO FB-911 COMB WITH ____
VESSEL NAME SLOP CUT MONTH STORAGE
DIAMETER 5'-0" ft-in & ____ ft-in
VERT HT 8'-0" ft-in SKIRT ____ ft-in
HORIZ LENGTH ____ ft-in
OPER TEMP: TOP ____ °F BOTT ____ °F DESIGN AMB °F
MAX TEMP: TOP ____ °F BOTT ____ °F DESIGN 112 °F
NORM OPER PRESS ____ psig OR ____ psia
MAX OPER PRESS 6" H_2O ____ psia
CORROSION ALLOW: SHELL ____ in HEADS ____ in

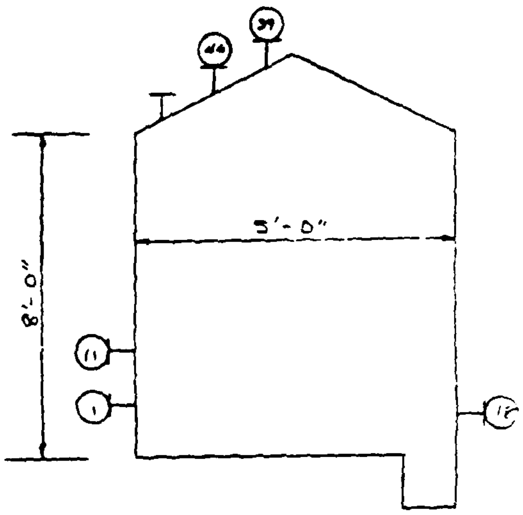
DES TEMP 230 °F
DES PRESS 8" H_2O psig VAC -2" H_2O psia
HEADS: ELIP ____ DISHED ____ CONE ECC. FLAT BOTTOM
CODE: ASME ____ API X OTHER ____
STRESS RELIEVED: YES ____ CODE ____
RADIOGRAPHED: YES ____ CODE ____
EARTHQUAKE: ____ WIND ____ mph

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 GA-903
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 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 RL FROM
27			REFLUX DRAWOFF TO
28			REFLUX RL FROM
29			PROCESS STEAM
30			STEAM OUT (SO)
31			DRAIN
32			SAMPLE CONN'L (& 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 BREATHING
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: LIQUID SP GR = 1.006 at operating temp

LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

VESSEL NO FB-911 DWG NO -

REV	DATE	DESCRIPTION			APPD	APPD
2						
1	4/14 82	FOR TANK 4				

VESSEL NO FB-912 COMB WITH ______
VESSEL NAME M/P-CRESOL PRODUCT MONTH STORAGE
DIAMETER 25'-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 60 °F
MAX TEMP: TOP ______ °F BOTT ______ °F DRUM 113 °F
NORM OPER PRESS ______ psig OR ______ psia
MAX OPER PRESS 6" H2O ______ psia
CORROSION ALLOW: SHELL 3 mm in HEADS ______ in

DES TEMP 220 °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

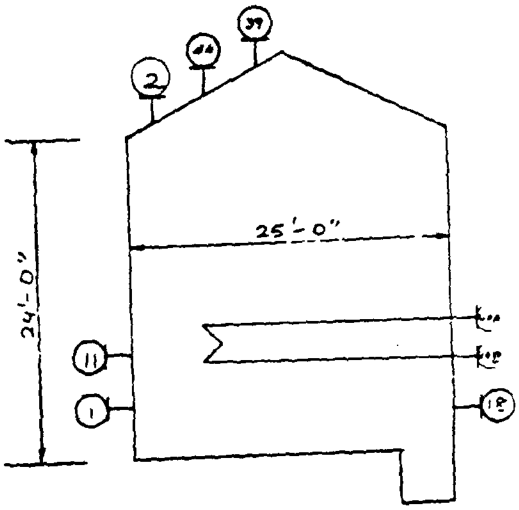
MATL: SHELL CS LINER ______ THK ______ in
INSULATION: CONSERV'N X PROTECT'N ______ NONE ______
DECK MATL: ______

NOZZLES: FLG CLASS ______ COUPL CLASS ______

ITEM NO.	NO REQD	SIZE in	SERVICE & SYMBOL
1	1	24	MANHOLE
2	2	20	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 60-911
12			FEED FROM
13			FEED FROM
14			TO (REBOILER) (RES 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 (PVSV) (VSV)
35			UTILITY CONNECTION
36			PRESSURE GAGE (PG)
37			PRESSURE CONTROLLER (P______C)
38			PRESSURE TAP (PT)
39	1	1½	No BLANKETING
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	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



LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROJ ENGR	PROJ ENGR	APPR	APPR
1						
2	4/14/83	FOR TASK 4				

VESSEL NO FB-912 DWG NO -

VESSEL NO FB-913 COMB WITH
VESSEL NAME [illegible] STORAGE
DIAMETER 14'-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 113 °F
NORM OPER PRESS psig OR psia
MAX OPER PRESS 6" H_2C psig OR psia
CORROSION ALLOW: SHELL in DECKS in

DES TEMP 230 °F
DES PRESS 8" H_2C 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

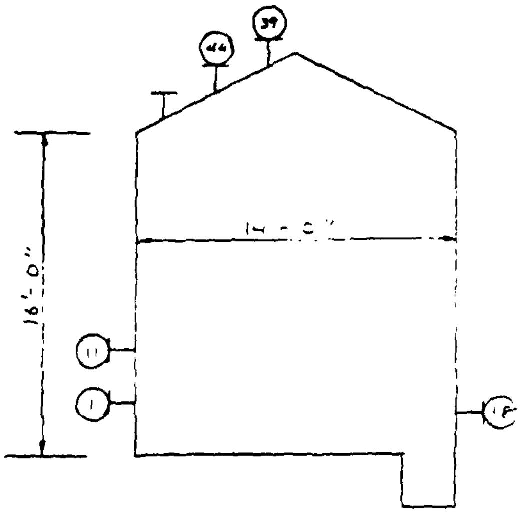
MATL: SHELL C.S. LINER THK in
INSULATION: CONSERV'N X PROTECT'N NONE
DECK MATL:

NOZZLES: FLG CLASS COUPL CLASS

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

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 GA-910
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 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	N_2 BLANKETING
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	1		EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES LIQUID SP GR = 0.96 @ operating temp.



THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571

PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION	PROC. ENGR	PROJ. ENGR	APPR	APPR
1						
2	4/14/83	FOR TASK 4	[illegible]			

VESSEL NO FB-913 DWG SKS -

VESSEL NO FC-914 COMB WITH ______
VESSEL NAME M[illegible] XYU[illegible] HD[illegible] 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 113 °F
NORM OPER PRESS ______ psig OR ______ psia
MAX OPER PRESS [illegible] psig OR ______ psia
CORROSION ALLOW SHELL ______ DECKS ______ in

DES TEMP 220 °F
DES PRESS [illegible] psig VAC -2" H_2O psia
HEADS ELIP ______ DISHED ______ CONE [illegible] FLAT BOTTOM
CODE ASME ______ API X OTHER ______
STRESS RELIEVED YES ______ CODE ______
RADIOGRAPHED YES ______ CODE ______
EARTHQUAKE ______ WIND ______ mph

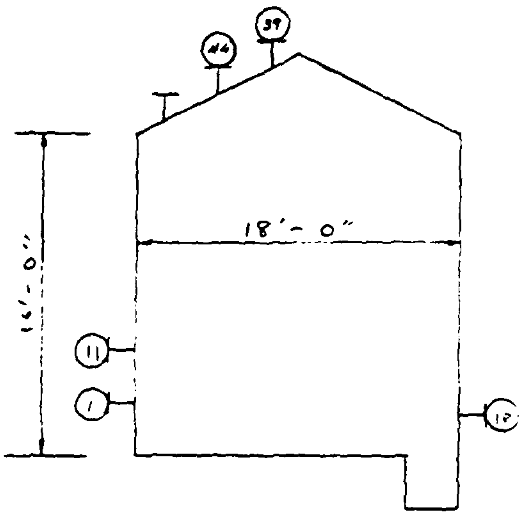
MATL SHELL CS LINER ______ THK ______ in
INSULATION CONSERV'N X PROTECT'N ______ NONE ______
DECK MATL ______

NOZZLES FLG CLASS ______ COUPL CLASS ______

FLANGED NOZZLES ARE NUMBERED 1-49 FOR COUPLING ADD 50 TO NOZZLE NO

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 GA-909
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	[illegible]
40			TEMPERATURE INDICATOR (TI)
41			TEMPERATURE CONTROLLER (T____C)
42			TEMPERATURE RECORDER (TR)
43			TEMPERATURE WELL (TW)
44	1	6	GAUG-HATCH
45			GAUGE GLASS (LG)
46			EXTERNAL LEVEL
47			INTERNAL LEVEL
48			LEVEL ALARM (LA)
49			
50			

NOTES LIQ SP GR = 0.95 @ operating temp.



LUMMUS THE LUMMUS COMPANY

TITLE JET FUEL PROJECT
CLIENT AMOCO/DOE LOCATION BEULAH, ND
PROJ NO JOB NO 05571
PROCESS VESSEL SKETCH

REV	ISSUE DATE	DESCRIPTION			APPR	APPR
1						
2	4/11/89	FOR TANK				

VESSEL NO FB-914 DWG SKD -

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 90C 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)	NORMAL	RATED	OTHER CONDITIONS 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_p (Path Exponent, PTC-10)~~ Cp/Cv		1.29				
☐ COMPRESSIBILITY (Z_1) OR (Z_{avg})		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 (Z_{avg})		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

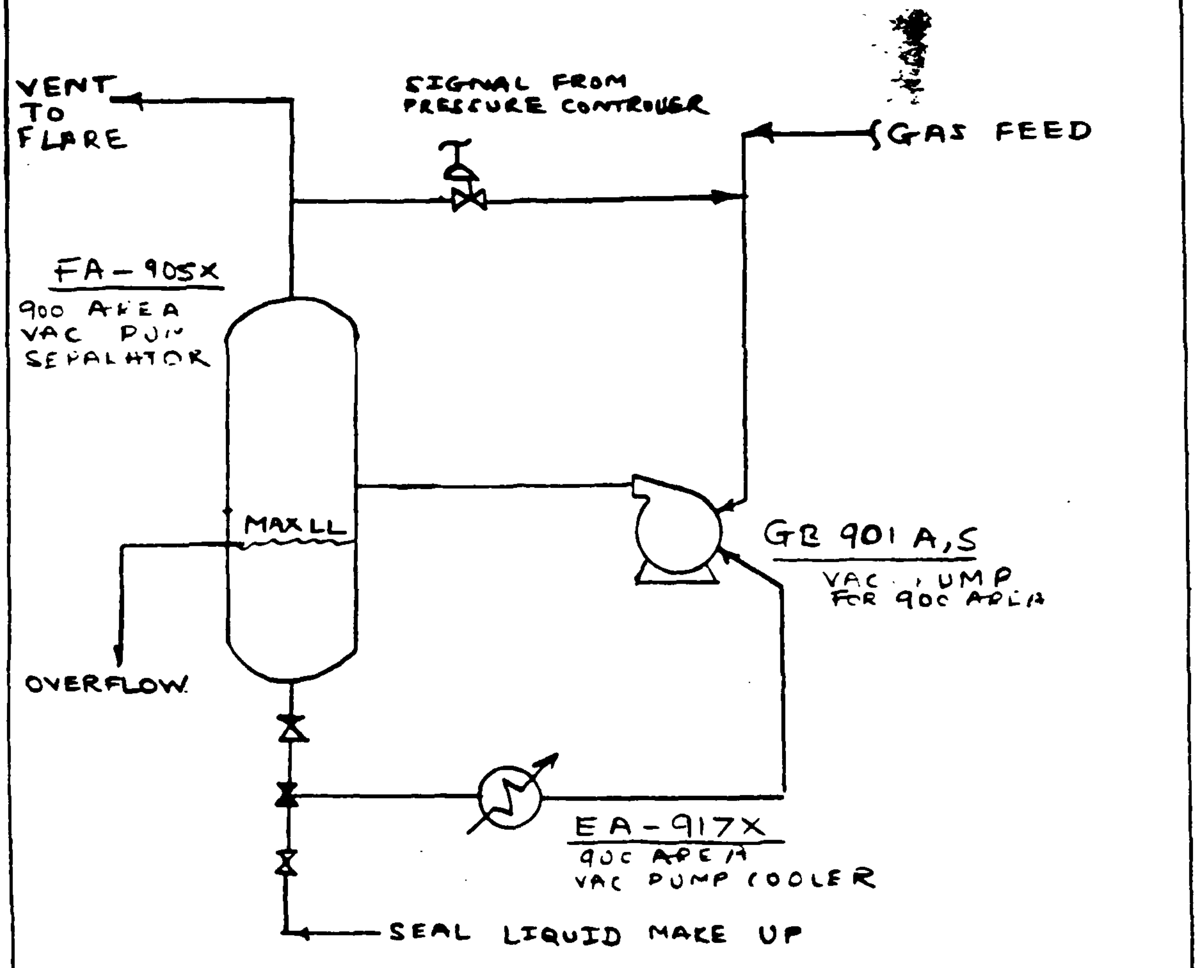
Prepared: KA	Approved:	Date: 4/14/84 △	Rev. △	Rev. △	Rev. △

A109 04 0783-TP2 5.1/1 REV 4

PA-901

DESIGN COMPUTATIONS FOR VACUUM PACKAGE FOR 900 AREA

JOB ______________ **ACCT.** 05571



									THE LUMMUS COMPANY Bloomfield N. J.
0	4/14/84	[illegible]						LUMMUS	
REV	DATE	MADE	CHKD.	APPR.	Record	REV.	ISSUE	DWG. NO.	

A2.601

A108 03 0778-1 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

PIPE ABOVE GROUND

1 ½	35000 LF	3.6 #/FT	126,000 #'S
2	11,000	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 ONLY

INSULATION	1½"	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		INSUL.	
A2A - 150# C.S.			HEX 150# GALV.
1½"	35,000 FT	7000 FT	2" - 1000 FT
2"	11,000 FT	6000 FT	3" - 1000 FT
3"	15,000 FT	3000 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 TRACING	
26"	T4S - BURIED 9'	1700 FT	1"	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 AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT		LOC. M.H.		BY MC. ES	JOB EST NO. 5571	ACCT FB
LOCATION BEULAH, NORTH DAKOTA					DATE 3/89		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE		LAB. COST		REV.		

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 CS 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 CS 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	PROD. FACT	LOC. M.H.	BY MHC. ES	JOB EST NO. 5571 — ACCT FB
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 3/89	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV.	

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 CS 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 CS 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	PROD. FACT		LOC. M.H.		BY MK. LS	JOB EST NO. 5571	ACCT FB
LOCATION BEULAH, NORTH DAKOTA					DATE 3/85	
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE		LAB. COST		REV.	

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 1/4" 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.		BY [illegible]	JOB EST NO. 5571	ACCT FB
LOCATION BEULAH, NORTH DAKOTA					DATE 3/89		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE		LAB. COST		REV.		

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-				40 000
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	PROD. FACT	LOC. M.H.	BY ME. CS	JOB EST NO. 5571	ACCT FB
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 3/85		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV.		

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 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 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]	JOB EST NO. 5571	ACCT
LOCATION BEULAH, NORTH DAKOTA			DATE 3/85		FB
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV		

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	m³/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	m³/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	m³/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						
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC. M.H.	BY MFL ES · JOB/EST NO. 5571 · ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 3/85
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.

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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	m³/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 CI / 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	m³/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				15 000			
23	m³/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 CI / 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						
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD FACT	LOC. M.H.	BY HL EJ	JOB EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA			DATE 3/89	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.	

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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 CR · 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							
13	m^3/h · SUCT kPa kg/cm² · DISCH kPa kg/cm² · TEMP °C				15000			
14	SP. GR .87 · ΔP FT 50 PSI · STGS							
15	ΔP m kPa kg/cm² · RPM							
16	MAT CASE CS · IMPELLER 12 CR · 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							
23	m^3/h · SUCT kPa kg/cm² · DISCH kPa kg/cm² · TEMP °C				15000			
24	SP GR .88 · ΔP FT 50 PSI · STGS							
25	ΔP m kPa kg/cm² · RPM							
26	MAT CASE CS · IMPELLER 12 CR · 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	6						
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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
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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	m³/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	m³/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 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	2						
22	GPM · SUCT PSIG · DISCH PSI · TEMP °F							
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 · 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					
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT		LOC. M.H.		BY HEL ES	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA					DATE 3/85		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE		LAB. COST		REV.		

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ESTIMATE SHEET

THE LUMMUS COMPANY
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	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 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 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 CR · 15 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 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 CR · 10 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						
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY [illegible]	JOB/EST NO. 5571
LOCATION BEULAH, NORTH DAKOTA	WAGE RATE	LAB. COST	DATE 3/79	ACCT GA
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS			REV.	

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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	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 Cr · 7½ 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 417/S M/P CRESOL TRANS.	2						
12	GPM 200 · SUCT PSIG · DISCH PSI · TEMP 120 °F				15000			
13	m³/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 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 418/S 2,3/2,4 CRESOL TRANSFER	2			15000			
22	GPM 50 · SUCT PSIG · DISCH PSI · TEMP 120 °F							
23	m³/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 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 · WAGE RATE · LOC. M.H. · LAB. COST

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	DESCRIPTION	QUANTITY REQ	QUANTITY EA	UNIT COST	MATERIAL COST	STD LABOR MH UNIT	STD LABOR MH TOTAL	SUBCONTRACT COST
1	GA 419/S MIXED XYLENOL TRANS.	2			15000			
2	GPM 100 · SUCT PSIG · DISCH PSI · TEMP 120 °F							
3	m³/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 12Cr · 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	m³/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	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 · 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						
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CLIENT AMOCO/DOE-GREAT PLAINS GASIF. PLANT	PROD. FACT	LOC. M.H.	BY MHG ES	JOB EST NO. 5571	ACCT GA
LOCATION BEULAH, NORTH DAKOTA			DATE 3/85		
PROJECT JET FUEL FROM COAL DERIVED LIQUIDS	WAGE RATE	LAB. COST	REV.		

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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, 2,3-Xylenol, 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, 2,3-Xylenol, 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, 2,3-Xylenol, p-Ethyl phenol	20.5
3,4-Xylenols, 3,5-Xylenols, 2,4-, 2,5-Xylenols	10.5

Markets Accessible to DGC (1992)

m-Ethyl phenol, 2,3-Xylenol, p-Ethyl phenol	10 MM lb/yr
3,4-Xylenols, 3,5-Xylenols, 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:

- o Staged deep hydrotreating
- o 2000 psig reactor pressure
- o Low space velocity (WHSV = 0.25 Overall)
- o 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:

- o 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.

- o 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.

- o Fractionation of the hydrotreated products.

- o Hydrocracking of the 550^{o}F+ material using both stages of the hydrocracker with recycle to extinction.

- o Clay treating of the jet fuel product produced.

Referring to Figure 2 and Table I, the filtration, hydrotreating and fractionation steps are as follows:

- o 15,000 Bbl of Tar Oil are hot filtered and sent to storage.

- o The hydrocracker is modified to permit by-passing of the second stage.

- o 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:

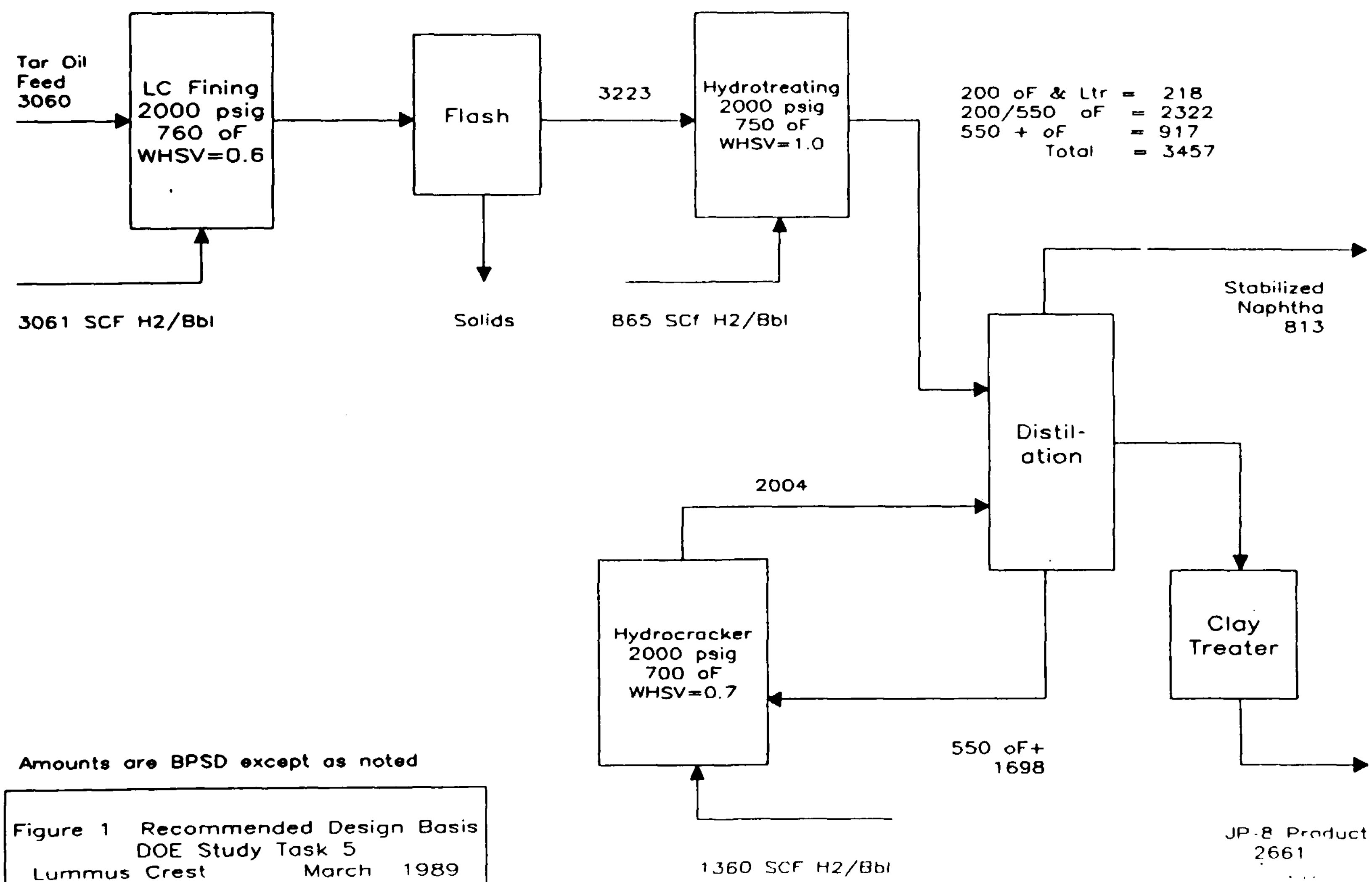
   Charles Hoertz
   President Ashland Synthetic Fuels
   2000 Ashland Drive
   Russel, Kentucky 41169
   606-329-3333

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

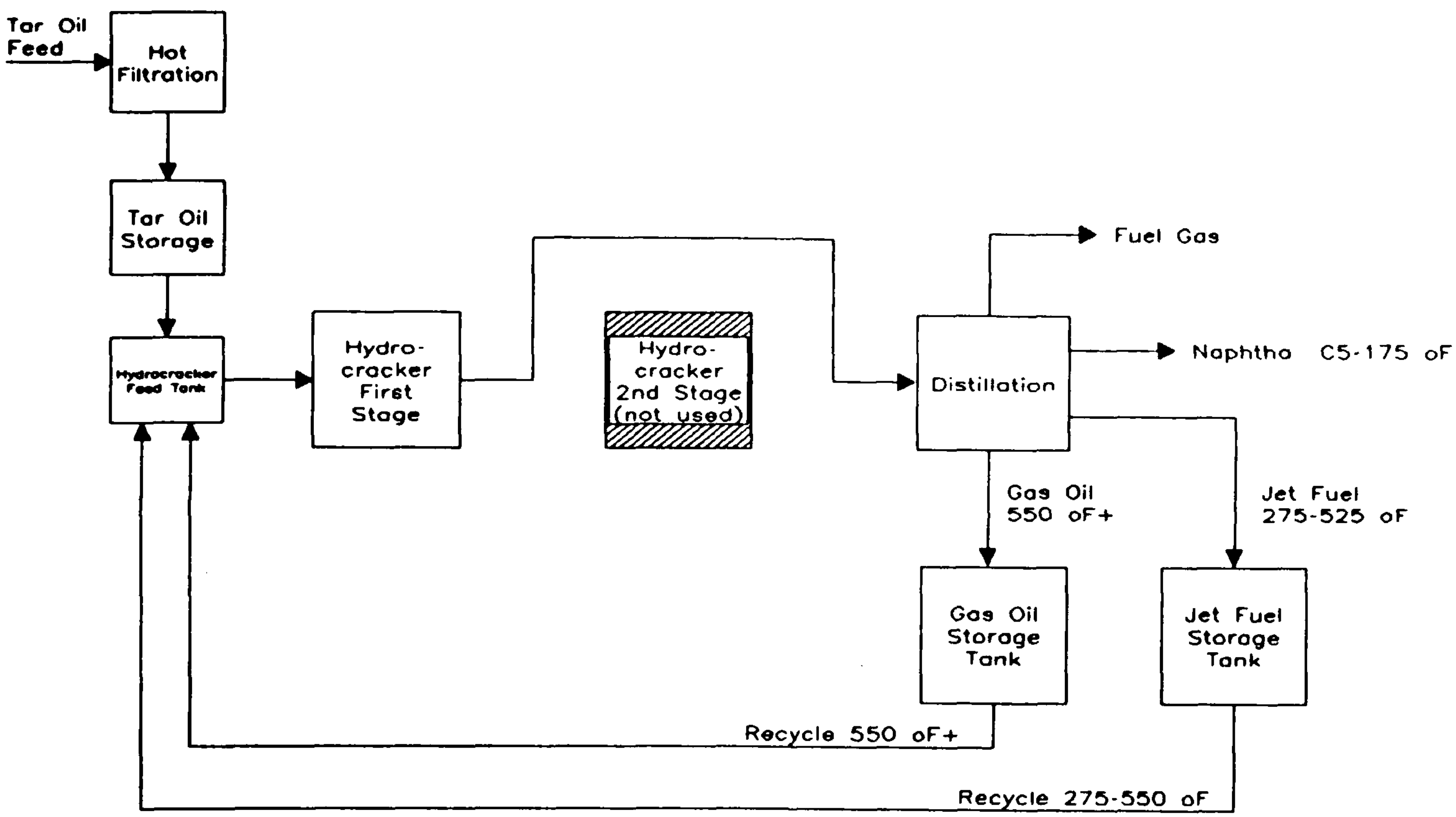


Figure 2 Hydrotreating Step
DOE Study Task 5
Lummus Crest March 1989

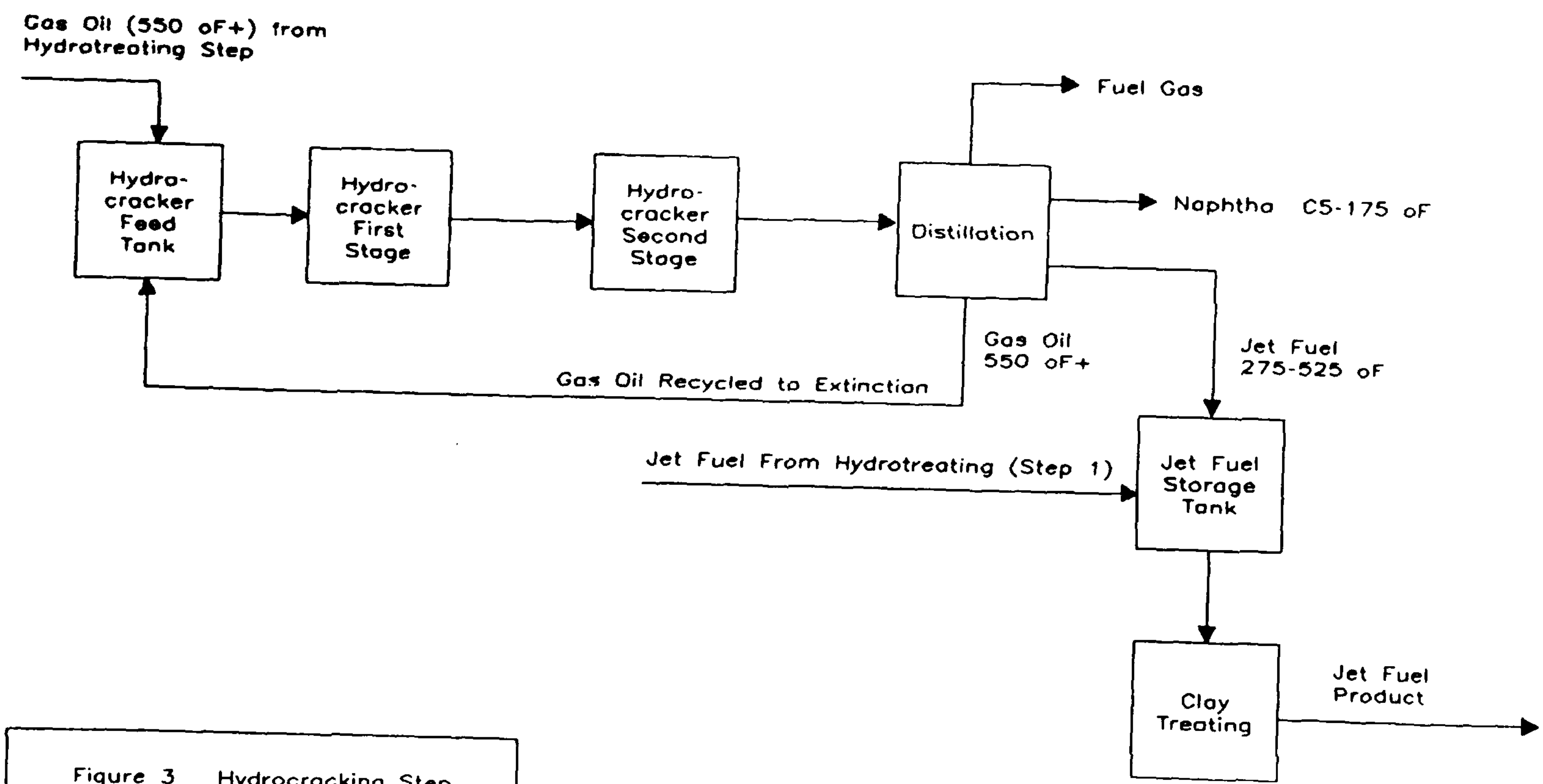


Figure 3 Hydrocracking Step
DOE Study Task 5
Lummus Crest March 1989

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

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

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