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LIQUID-PHASE METHANOL PROCESS DEVELOPMENT UNIT: INSTALLATION, OPERATION, AND SUPPORT STUDIES

Technical Progress Report No. 2

For the Period 1 January 1982 - 31 March 1982

Contractor

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and

DOE/PC/30019--T2

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Subcontractor to APCI

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Air Products

ABSTRACT

This was the second period of Contract performance. During this period approval was obtained for the unified design concept, advanced schedule for relocation of the LPM pilot plant, and advanced procurement of long lead delivery equipment items. The LaPorte LPMeOH PDU Process Flowsheet developed further and the Engineering Flowsheet evolved to the Revision OA preliminary issue. Eight cases of point-by-point heat and mass balances were released. Process equipment specifications were issued for 30 of the 33 equipment items. Mechanical specifications were issued for 16 equipment items. Quotations were received for the 2 long lead delivery items, the Feed/Recycle Compressor and the Slurry Circulation Pumps; technical evaluations of these bids are underway. Semi-final equipment arrangement and plot plan drawings were prepared. The Preliminary Hazards Review was conducted and the subsequent Design Hazards Review was initiated. A request for exemption from construction and operating permit requirements was submitted to the Texas Air Control Board. Progress was made on the specification of the Data Acquisition System. In the laboratories, APCI established the priority for compositions of new methanol powder catalysts to be prepared. Construction of the APCI Gas Phase Screening Reactor and Stirred Autoclave Reactor continued on schedule. Progress was made in evaluating the potential modification of the Deckwer liquid phase Fisher-Tropsch model to describe LPMeOH performance. In the CSI laboratories, a 550-hour liquid-fluidized run was completed successfully in the Lab PDU. Preliminary results indicate that the new catalyst tested is more attrition resistant than any prior liquid-fluidized catalyst candidate. Testing of in-situ catalyst reduction procedures continued in the Stirred Autoclave Reactor with successful results which led CSI to file a Record of Invention form for a potential invention covering this process. Specifications and quotations for major equipment items in the CSI liquid-entrained PDU were completed and received. The first of the two lab slurry pumps arrived. A preliminary plan for cold flow hydrodynamic modeling was completed. DOE approved submission of the Task 2 deliverable report on 1 June 1982 in order to increase the accuracy of the program cost estimate. The 1 June deliverable report will incorporate and take advantage of the research achievements and efforts currently underway at APCI and CSI.

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PROJECT DESCRIPTION:

On 28 September 1981, Air Products and Chemicals, Inc. (APCI) began a 42-month contract with the U.S. Department of Energy (DOE): "Liquid Phase Methanol (LPMeOH) Process Development Unit: Installation, Operation and Support Studies." This project is aimed to further develop the LPMeOH process invented by Chem Systems Inc. (CSI). Chem Systems is performing as a subcontractor to Air Products.

A DOE-owned, skid mounted pilot plant will be transferred from Chicago, refurbished, expanded for service as the LPMeOH Process Development Unit (PDU), and then relocated and commissioned at Air Products' LaPorte, Texas facility. Air Products will supply synthesis feed gas to the LPMeOH PDU and operate the unit for a planned 24-month period. Chem Systems is performing the major portion of the laboratory support R&D and is providing technical management for the project. Air Products is providing overall program management and is responsible for engineering design, construction, and operation.

The program is divided into 11 major tasks which are phased to allow progress review and approval to proceed. The 11 major tasks are:

1. Program Planning
2. Engineering and Design Specifications
3. Equipment Procurement
4. LPM Pilot Plant Relocation/Inspection
5. LaPorte LPMeOH PDU Renovation, Installation and Shakedown
6. Liquid-Fluidized Operation
7. Laboratory Support Program
8. Conversion of the LaPorte LPMeOH PDU from Liquid-Fluidized to Liquid-Entrained Mode
9. Shakedown of the Liquid-Entrained Mode of Operation
10. Liquid-Entrained Operation
11. Project Evaluation

The tasks are phased as follows:

Phase	Tasks	Schedule
I	1,2,4,7,11	28 September 1981 - 28 March 1985 (Months 1-42)
II	3,4,5	1 June 1982 - 1 April 1983 (Months 9-18)
III	6	1 March 1983 - 1 June 1984 (Months 18-32)
IV	8	1 January 1984 - 1 April 1984 (Months 28-30)
V	9,10	1 April 1984 - 1 March 1985 (Months 31-41)

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OBJECTIVES:

The overall objective of this program is to demonstrate the technical feasibility of the Liquid Phase Methanol (LPMeOH) process at the Process Development Unit (PDU) scale of operation.

On a per task basis, objectives are to:

Task 1 - Program Planning

Establish a Project Work Plan presenting in detail all activities which will be performed for the successful completion of the program.

Task 2 - Engineering and Design Specifications

a) Conduct a process engineering/design review and safety examination of the existing Liquid Phase Methanation (LPM) pilot plant at its present location in Chicago, Illinois;

b) Obtain permits to install and operate the LPMeOH PDU at LaPorte, Texas;

c) Develop detailed plans and specifications for the repair, modification, and expansion of the existing LPM unit to enable liquid-fluidized (ebullated bed) and, subsequently, liquid-entrained (slurry) methanol production; and

d) Develop a deactivation plan for the LaPorte LPMeOH PDU.

Task 3 - Equipment Procurement

Purchase, lease, or obtain from DOE inventories the equipment and systems specified in Task 2.

Task 4 - LPM Pilot Plant Relocation/Inspection

Transfer the existing LPM pilot plant from its present location in Chicago to a vendor's facility for inspection.

Task 5 - LaPorte LPMeOH PDU Renovation, Installation, and Shakedown

a) Renovate the LPM pilot plant to become the LaPorte LPMeOH PDU, according to the specifications developed in Task 2;

b) Prepare the LaPorte site;

c) Transfer and install the LPMeOH PDU at LaPorte;

d) Make interconnections and test components; and

e) Conduct an integrated run without catalyst.

Air Products

Task 6 - Liquid-Fluidized Operation

Operate in the liquid-fluidized (ebullated bed) mode to:

a) Assess the effect of reactor configuration/internals;

b) Identify catalysts which in short runs have acceptable activity and attrition characteristics;

c) Perform process variable scans to determine the effects of temperature, pressure, space velocity, catalyst loading, circulating oil flowrate, and feed gas composition; and

d) Perform a 45-day continuous run to demonstrate short-term process operability, principally at a single set of conditions.

Task 7 - Laboratory Support Program

a) Conduct literature surveys, develop a bibliography of pertinent references, and maintain liaison with others working on related liquid-entrained (slurry) systems.

b) Develop procedures for in-situ reduction of commercial powdered methanol catalysts slurried in oil, vapor phase reduction of commercial granular materials which can subsequently be slurried, and simultaneously screen commercial catalysts and develop data for modeling the liquid-entrained reaction;

c) Synthesize new liquid-entrained catalysts;

d) Screen new liquid-entrained catalysts in a gas phase fixed bed reactor, in a liquid-entrained stirred autoclave reactor, and in the Chem Systems' Fairfield laboratory PDU;

e) Construct and operate a cold flow model unit to study the hydrodynamics of the gas-slurry reactor;

f) Modify the existing Chem Systems' Fairfield laboratory PDU to allow liquid-entrained as well as liquid-fluidized operation;

g) Operate the modified CSI lab PDU to perform process variable scans; and

h) Support the LaPorte LPMeOH PDU liquid-fluidized and liquid-entrained operating modes, principally by screening catalysts.

Task 8 - Conversion of the LaPorte LPMeOH PDU from Liquid-Fluidized to Liquid-Entrained Mode

Perform necessary process adjustments, alterations, and minor operational tests to facilitate the conversion of the PDU from the liquid-fluidized (ebullated bed) to the liquid-entrained (slurry) mode.

Task 9 - Shakedown of the Liquid-Entrained Operation

Test components, conduct an integrated run with an inert powder, and conduct an integrated short run with a liquid-entrained methanol catalyst.

Task 10 - Liquid-Entrained Operation

a) Conduct short runs with promising liquid-entrained catalysts;

b) Perform process variable scans to determine the effects of various operating conditions; and

c) Perform a 45-day continuous run to demonstrate short-term process operability.

Task 11 - Project Evaluation

a) Evaluate data from the LaPorte LPMeOH PDU and the laboratories to develop models;

b) Evaluate alternative reactor designs and the two liquid phase operating modes;

c) Perform detailed process evaluations for commercial-size plants;

d) Develop plans for a larger scale demonstration of the LPMeOH process; and

e) Report on program activities.

RESULTS:

Task 1 - Program Planning

This task is complete. No activity.

Task 2 - Engineering and Design Specifications

2.1* APCI Management Activities

2.1.1 Project Management -

Specifications for dismantling the LPM pilot plant for relocation from Chicago were completed and released. Bids were received and a technical evaluation completed for this contract, and purchase approval has been requested of the DOE.

Specifications for shop inspection of the LPM pilot plant equipment in the Houston area have been completed and technically approved by the DOE. Receipt of bids is scheduled for 21 April 1982.

LaPorte commercial facility flowsheets were marked-up to illustrate the eleven piping tie-ins required for feed gases and utilities to the LPMeOH PDU. Instructions for further detailing of these tie-ins to the LPMeOH PDU battery limit were transmitted in coordination of Design Engineering activity.

DOE excess capital equipment and excess property lists for the Synthoil plant were reviewed to identify potential items for use in the Liquid Phase Methanol Program. A more detailed review and physical inspection of this equipment will be conducted on 21 April 1982.

A review of the Preliminary Hazards Review Report was conducted and a final draft is being developed. A Design Hazards Review Team was organized and assembled to conduct a detailed analysis of the plot plan, flowsheet, shutdown logic, solids handling systems, catalyst reduction and product storage.

Based on current schedules for receipt of vendor quotations for new equipment items and for inspection of the LPM equipment, a request was made to the DOE to revise the submittal date of the Phase I deliverable report that will include a revised estimate of the overall program. A revision from 1 May 1982 to 1 June 1982 was approved by the DOE, to enhance the usefulness of the estimate data.

2.1.2 Economic Evaluation - Work was started on revising an internal Project Scope Report that will consolidate the necessary data for detailed estimating by each performing group within APCI.

* Refers to Work Breakdown Structure Elements.

2.1.3 Communications - No Significant Activity.

2.1.4 Permit Fees - No Activity.

2.2 CSI

2.2.1 CSI Assistance to APCI - Chem Systems provided APCI with review and comment on preliminary flowsheets for the LaPorte LPMeOH PDU. A marked-up flowsheet showing suggested process corrections, control points and data acquisition points was transmitted to APCI. This mark-up was reviewed in a meeting at APCI on 19-20 January 1982. Plans for dismantling the LPM pilot plant were also reviewed at this meeting including procedures, equipment lists, and skid and piping break points. Chem Systems also participated in the Process Hazards Review held at APCI on 15 March 1982.

2.2.2 Data Acquisition System Specification - The LaPorte LPMeOH PDU flowsheets were reviewed to determine and verify the required data acquisition and sampling points on the unit. Calculations to reduce these data points into an operational format were outlined in order to estimate the size of the data acquisition computer. Preliminary quotations and leasing arrangements, as well as catalog information, were received from several vendors on items required in the analytical (i.e., gas chromatographs, analytical balances, interfaces, etc.) as well as the computational (computers, data loggers, printers, etc.) sections of the data acquisition unit. On the basis of this information a preliminary estimate was prepared and the buy/lease option evaluated for the data logger/microcomputer option of the data acquisition system. These results were reviewed with APCI in Allentown on 25 March 1982, where the associated costs and leasing arrangements of the minicomputer option were presented. As a result it was agreed, in principle, to specify the minicomputer system as the leading option for use in data acquisition, provided CSI can maintain complete control and responsibility for the data acquisition task at LaPorte. Final selection of this option is dependent upon confirmation of system and project criteria discussed in the 25 March meeting. In addition, the preliminary configuration and cost estimate for the analytical portion of the data acquisition system was developed. A list of acceptable vendors has been established and final specification sheets are currently being developed as a prelude to formal equipment bid solicitation.

2.3 APCI Design

2.3.1 Integration -

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Process Flowsheet

The Process Flowsheet, Revision P1, dated 5 January 1982 was attached and described in Technical Progress Report No. 1. Since that time the following change considerations have developed:

1. Elimination of Pressure Leaf Filter (22.55)

   A more detailed review of the LaPorte LPMeOH PDU shutdown and the Pressure Leaf Filter operating conditions revealed the following:

   - The solids loading is too high for a pressure leaf filter.
   - Upon shutdown, the PDU must be quickly evacuated of the catalyst/oil slurry, otherwise settled catalyst sludge will build up and cause numerous blockages. Catalyst settling in lab slurry samples implies there may be 15 minutes in which to begin evacuation, and 30 to 60 minutes available to complete the transfer. (Calculations are required to better determine these times.)
   - The oil must be cooled below 180°F (80°C) for conventional pressure leaf filtration. Standard filters use rubber gasket materials and filter aid materials contain some entrapped moisture which could cause foaming when mixed with hot oil.

   It is now recommended that the slurries be pressure transferred to the Slurry Preparation Tank (28.30) for temporary holding prior to gravity transfer t. Tote Bins for final disposal. The Tote Bins may be used to decant the slurries to yield a reuseable oil supernatent. Controlled oxidation of catalysts may be performed in the Tote Bins to permit safer handling and direct disposal to a secure landfill. The need and the methods for catalyst oxidation are under review. (A plan to evaluate the pyrophoric nature of spent catalyst/oil slurry is noted in Task 11.4.)

2. Alternative Water Addition Location

   In the Revision P1 Process Flowsheet, water addition is shown upstream of the Three Phase Separator (23.10). An alternative route has been added to allow water addition to the top of a small packed section in the vapor outlet of the Three Phase Separator. This capability allows some scrubbing of methanol from the purge/recycle gas. Low methanol content in the recycle gas is desirable in order to accurately measure net methanol production in the reactor.

3. <u>Catalyst Reduction Vessel (02.81) - (On Hold)</u>

Chem Systems continues to make significant progress in the stirred autoclave tests to optimize in-situ catalyst reduction/activation conditions (see Task 7.2.2). Evidence is mounting that the separate Catalyst Reduction Vessel is not required. Data is still needed on other catalysts to confirm more general abilities to achieve in-situ reduction.

4. <u>Potential Elimination of Spare Slurry Circulation Pump (10.50 B)</u>

The flowsheet for the LaPorte LPMeOH PDU has indicated two Slurry Circulation Pumps (10.50 A & B) since the initial proposal to the DOE for the LPMeOH Program. The proposal considered these pumps to each be 100% design capacity such that an installed spare would be available on stand-by during LaPorte PDU operation. This dual pump installation was justified originally by considering that the costs associated with a single pump failure leading to the loss of even one LaPorte PDU run would more than outweigh the cost for an additional pump.

Progressive development of the LaPorte LPMeOH PDU design has revealed that three key points of this original justification are questionable:

- Recent developmental experience with hot, high suction pressure, centrifugal, slurry pumps has lead to the commercial availability of equipment that may be considered to have acceptable reliability for the LaPorte LPMeOH PDU operating program.
- Failure of the Slurry Circulation Pump will not necessarily lead to loss of a PDU run since the Slurry Preparation Tank (28.30) will now be used to maintain the slurry in suspension and at temperature.
- Due to difficult technical problems associated with the installation of a stand-by pump in this service, the incremental costs for a dual pump installation over a single pump installation may be several times greater than originally estimated.

In the final analysis it is considered desirable to maintain the slurry circulation loop in the simplest, most direct flowing arrangement, from both operational reliability and safety standpoints. Therefore, a detailed evaluation is in progress to evaluate the suitability of a single Slurry Circulation Pump installation for the LaPorte LPMeOH PDU.

A Simplified Process Flowsheet for the LaPorte LPMeOH PDU is given in Exhibit 2.3.1-1. This simplified version complements the Revision P1 issue of the Process Flowsheet by providing a clear, smaller-size schematic of the main process lines and equipment. Heat and mass balance points are also given on this flowsheet.

Engineering Flowsheet

A Revision 0 Engineering Flowsheet for the LaPorte LPMeOH PDU was issued on 10 March 1982. This was subsequently marked up during the Design Hazards Review to produce a Revision 0A edition. A preliminary Revision 0A Engineering Flowsheet is attached as Exhibit 2.3.1-2. This preliminary flowsheet has just issued for internal APCI review and has not yet been approved and signed-off. The preliminary flowsheet does show the current state of development of the P&ID. The next level of development of the Engineering Flowsheet is the Revision 1 issue, which will be submitted in the June 1982 Phase I deliverable report to the DOE.

Heat and Mass Balances

The final design heat and mass balances for the eight (8) design cases, four (4) for the liquid-fluidized mode and four (4) for the liquid-entrained mode, were completed and released in January 1982. The operating conditions for the eight (8) design cases which include the maximum and minimum methanol production cases for both modes of operation as well as four (4) "normal" operating cases are given in Exhibits 2.3.1-3 and 2.3.1-4. The detailed point by point heat and mass balances for the design cases were developed using APCI's process simulator program and are enclosed as Exhibit 2.3.1-5. The key stream numbers for the heat and mass balance are shown in Exhibit 2.3.1-1, the Simplified Process Flowsheet for the LaPorte LPMeOH PDU.

Process Equipment Design

During this quarter, process equipment specifications were prepared and issued for 32 equipment items in the LaPorte LPMeOH PDU. One of these items (Pressure Leaf Filter 22.55) was subsequently voided, and two items are considered as one (01.10/01.20 Feed/Recycle Compressor is a multiservice machine) by Project Engineering. Therefore, 30 of 33 valid process equipment specifications are complete at this time. Of these 30 process specifications, 5 exist as revised specifications resulting from engineering feedback. The three remaining equipment items are the Reactor (27.10), the Slurry Preparation Tank (28.30), and the Catalyst Reduction Vessel (02.81). The Reactor is the existing reactor vessel (R-101) in the LPM pilot plant; the process specification is being delayed pending further analysis of the need for internals in the liquid-fluidized (ebullated bed) and liquid-entrained (slurry) modes. The Slurry Preparation Tank specification is scheduled for issue by 25 June 1982. As noted above, the Catalyst Reduction Vessel is on-hold pending additional experimental confirmation that this vessel is not required.

Some process design characteristics of key equipment items in the LaPorte LPMeOH PDU are provided in this report as follows:

1. Slurry Circulation Pumps (10.50 A & B)

   The process equipment specification is attached as Exhibit 2.3.1-6.

2. Feed/Recycle Compressor (01.10/01.20)

   The process equipment specification is attached as Exhibits 2.3.1-7A and 2.3.1-7B.

3. Slurry Heat Exchanger (21.20)

   The process equipment specification is attached as Exhibit 2.3.1-8.

4. Reactor (27.10)

   A schematic of the reactor and some key operating parameters are given in Exhibits 2.3.1-9A and 2.3.1-9B.

Hazards Review

The Preliminary Hazards Review was completed. The subsequent Design Hazards Review progressed to analyze specific hazards and to document conclusions and recommendations relevant to each item. The "What If?" method of analysis was used to review the Engineering Flowsheet, Revision 0, dated 10 March 1982. As a result of this review the following hazards were recommended for quantification by Fault Tree analysis:

	Description of Hazard		Preliminary Recommendation
1.	Potentially pyrophoric, hot, oil/catalyst slurry,	1a.	Use administrative procedures to assure

	exposed to air.		tight shutoff prior to maintenance on stand-by equipment in the slurry mode.
		1b.	Monitor errosion rates in equipment and piping.
		1c.	Use administrative controls to prevent overfill of Tote Bins for spent slurry disposal.
2.	Run-away reaction.	2a.	Provide alarms for low nitrogen flow or high H_2 concentration, specifically for reduction gas supply in liquid-fluidized catalyst preparation.
		2b.	Utilize administrative control to eliminate severe consequences of temperature rise upon loss of slurry circulation during in-situ reduction.
		2c.	Develop understanding of catalyst activity and potential for oil cracking on temperature excursions.
3.	Major release from Methanol Tank.	3a.	Provide adequate pressure relieving devices.
		3b.	Provide high liquid level alarm.

Fault trees on the above items will be completed and quantified upon release of the Revision OA Engineering Flowsheet and the preliminary shutdown logic diagrams resulting from the "What If?" review.

Environmental Permit Action

A request for exemption from construction and operating permit requirements was submitted to the Texas Air Control

Board (TACB) on 17 March 1982. It is believed that the PDU facility will not make a significant contribution of air contaminants to the atmosphere. The request to TACB included a report on the emission sources and quantities. The emission sources are the flare stack, storage tank vents, pressure leaf filter purge, and fugative hydrocarbons. The continuous process vents of hydrocarbons and CO along with emergency or relief valve vents will be sent to a single smokeless flare designed for complete combustion. Working losses from the storage tanks along with controlled fugative hydrocarbon emissions are estimated to total about 14 T/Y.

The water discharge (treated rainwater runoff from the process area) will be directed to the existing fire pond at APCI's commercial facilities at LaPorte. This water discharge increment is being included in renewal applications for APCI's overall water discharge permit at LaPorte.

Permits will not be required by APCI for handling of hazardous wastes on site. However, cradle-to-grave accounting will be required on all used catalyst/oil preparations requiring disposal.

Methanol product will be disposed of as a fuel and therefore is exempt from EPA regulation.

2.3.2 Equipment - Exhibit 2.3.2-1 summarizes engineering specification activity for the process equipment items in the LaPorte LPMeOH PDU. Process specifications have been issued for 30 of the 33 equipment items. Mechanical specifications have been issued for 16 items, including 15 of the new equipment items (18 total new items). Quotations have been received on the 2 long lead delivery items (01.10/01.20 Feed/Recycle Compressor and 10.50 A & B Slurry Circulation Pumps) and technical evaluations are underway. Requests for purchase approval for these latter items are expected to be submitted to the DOE by 30 April 1982.

2.3.3 Site/Structural - A site visit was made to LaPorte to verify conditions for tie-in pipe racks, roads and underground road crossing designs.

2.3.4 Piping -

A site visit was made to LaPorte to verify existing piping systems for tie-in. Upon return, design drawings were prepared detailing the required tie-in consturction. These drawings will be utilized for the preparation of take-off estimates to be incorporated into the 1 June 1982 deliverable report.

Semi-final equipment arrangement and plot plan drawings were prepared based on information from the Design Hazards Review. These drawings and the Revision OA Engineering Flowsheet will form a basis for the LaPorte LPMeOH PDU renovation and installation estimates to be incorporated into the 1 June 1982 deliverable report.

2.3.5 Electrical -

Specifications have been prepared for switchgear additions to the LaPorte commercial facility that would provide a source of 600 kVA service for the LPMeOH PDU.

Two alternate specifications have been prepared for motor control for the LPMeOH PDU to allow evaluation between matching and line up with the existing LPM pilot plant motor control, and total new purchase of motor control equipment.

2.3.6 Instrumentation - Support was provided in the development of control loop requirements on the Revision 0 and Revision OA Engineering Flowsheets.

Task 3 - Equipment Procurement

No Activity.

Task 4 - LPM Pilot Plant Relocation/Inspection

4.1 APCI Management Activities

4.1.1 Warehousing - No Activity.

4.1.2 Traffic Services - No Activity.

4.2 CSI Management Activities

4.2.1 On 11 February 1982, a meeting was held at IGT in Chicago, Illinois to inspect the LPM pilot plant with regard to its relocation to a fabricator shop in Texas. A Chem Systems representative was on hand for discussions with IGT personnel and to answer questions pertaining to the pilot plant. Chem Systems also reviewed the APCI specifications for dismantling the pilot plant.

4.3 Field Engineering - A site inspection was conducted by an APCI field instrument technician on the LPM pilot plant instrumentation. Several loops were energized, and pneumatic valves stroked to establish a list of reuseable instrument items for incorporation into the detailed ship inspection plans.

4.4 LPM Pilot Plant Relocation

4.4.1 Disassembly - A technical evaluation of bids was conducted and purchase approval has been sought from the DOE for award of this contract. Site activity in Chicago is expected during May 1982.

4.4.2 Inspection - No Activity.

4.4.3 Rehabilitation - No Activity.

Task 5 - LaPorte LPMeOH PDU Renovation, Installation, and Shakedown

No Activity.

Task 6 - Liquid-Fluidized Operation

No Activity.

Task 7 - Laboratory Support Program

7.1 APCI R&D

7.1.3 Catalyst Screening and Testing -

APCI Stirred Autoclave (Bench Scale Slurry) Reactor Set-Up

Major items ordered for construction of the 1000 mL Stirred Autoclave Reactor were delivered. Items which were ordered and not delivered as of this writing include:

1. Fittings and valves from Autoclave Engineers, Inc. (1 lot).
2. Pressure transducers and demodulators (3 ea.).
3. Multipoint chart recorder (1 ea.).
4. Pressure regulator (1 ea.).
5. Gas inlet flow integrators.
6. Miscellaneous solenoid valves and fittings.

The construction of the main control panel began, with cut-out holes for missing instrumentation items made from dimensions supplied by the manufacturers. The 1000 mL Stirred Autoclave Reactor was moved into the operations cell and plumbing operations will begin during April 1982. The reactor construction is proceeding on schedule; back-ordered items should not affect the schedule if promised shipping dates are met.

The operation cell area, which was newly constructed, was completed and was checked-out for proper ventillation with smoke bombs. The area is monitored with recently installed carbon monoxide alarms. The principal lab area is monitored at 4 points. The gas supply lines are located external to the lab and are monitored at 3 points for carbon monoxide. With the final check on the cell operation area ventillation and the installation of the CO monitor, the lab area is now operational.

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High-pressure piping of inlet CO and H_2 gases from the external gas supply area was completed and leak checked. The high pressure piping for inert and CO_2 gas supplies was completed; however, the gas cylinder manifold has not been installed. Work on this manifold is scheduled at a later date.

APCI Gas Phase Screening Reactor

Final specifications for this unit were given to Chemical Data Systems, Inc. and construction of this unit began at CDS's facility. Monitoring of progress continued and shipment of the completed unit is expected by 30 April 1982. Exhibit 7.1.3-1 shows a simplified schematic of the unit along with critical measurements and capacities.

7.1.4 Catalyst Preparation -

The methanol catalyst literature search to cover the program needs was initiated and is nearly complete. Discussions with APCI's Corporate Development Department and other Process Systems Group personnel have indicated that one-pound quantities of catalyst in the 45-75 micron range will be provided for testing. The first five catalysts for the program will be prepared for delivery before 30 May 1982. The catalysts will be characterized as to pore size, surface area, analytical composition, and bulk density, although only the composition and particle size distribution will be controlled in the initial preparations.

The preparation priority, from high to low, with respect to composition type is:

1. Supported CuO/ZnO, CuO/MgO, CuO/ZnO/Ceria.

2. CuO/Ceria (Ce^{+3} and Ce^{+4}), CuO/Ceria/Alumina.

3. CuO/MoO_3 or CuO/WO_3 types.

4. Raney alloys of Cu plus Zn and aluminum and copper plus cerium and aluminum.

Copper-thorium alloys have been dropped from consideration at present. This is due to the practical problems associated with handling radioactive materials. Copper-cerium and/or copper-lanthanum alloys may be recommended as substitutes after further analysis.

Mixed heterogeneous-homogeneous catalyst systems have been ruled out due to potential metal carbonyl volatility problems.

7.2 CSI R&D

7.2.1 Literature Review -

Cold Flow Hydrodynamics of Three-Phase Systems

The following paragraphs discuss some of the literature reviewed prior to scoping a system for cold flow modeling of the LPMeOH process.

The performance of a chemical reactor with respect to conversion and selectivity depends on the intrinsic kinetics of the various chemical reactions, various physical rate processes such as interphase transfer, and inter and intra particle heat and mass transfer. The effects of these physical rate processes on the reaction performance have been shown to depend on the dynamics of the various phases involved. While there are numerous publications about backmixing in liquid-gas bubble columns and in solid-fluid systems (References 1-5), much less material has been published on three-phase ebullated bed/liquid entrained systems (References 6-8).

Experimental data on Peclet numbers due to axial dispersion in chemical reactors are also very limited. Most of the work has been limited to single phase packed bed reactors. Moreover, data on such systems are only reliable when applied to systems resembling those of the experimental studies (Reference 9).

At the present time, an extensive effort is being directed toward the measurement and evaluation of backmixing in multiphase systems through residence time distribution (RTD) studies (References 10-11). One major problem encountered is that separate RTD measurements are required to evaluate the mixing characteristics of each phase. Although there are numerous methods available to obtain RTDs in complex multiphase systems, measurement problems have been encountered by all recent investigators. Flow maldistribution of the phases can especially impede evaluation of RTD data.

7.2.2 CSI Stirred Autoclave Tests -

The program for optimizing in-situ catalyst reduction techniques for catalyst powders suspended in inert hydrocarbon liquids continued during this quarterly period. To date, seven runs have been completed including five in-situ reduction conditions, one replicate run and a base case, vapor-phase reduction condition.

1. Description of Stirred Autoclave Reaction System

A process schematic of the CSI lab Stirred Autoclave System is shown in Exhibit 7.2.2-1. The heart of the system is a two-liter autoclave equipped with a top entering

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magnedrive agitator assembly and water cooled by an automatic temperature controller. The autoclave is a Model AFP-2005 from Autoclave Engineers. The agitator has a 3/8-inch diameter hollow shaft with two 3/16-inch diameter draft tube inlet holes located ten inches above the 1-1/4-inch diameter impeller. The system is set up in such a way that feed gas, reduction gas and make-up oil can be introduced under controlled pressure and flow conditions. The reactor effluent passes through a shell and tube heat exchanger before it enters the vapor-liquid separator. Auxiliary equipment on the V/L separator allow for sampling of vapor and liquid streams and measurements of flows, temperature and pressure.

2. Catalyst Reduction Test Procedures

This section contains potentially patentable material and has therefore been issued in the Supplement to the Technical Progress Report, marked "Not For Publication".

3. Run Procedures and Preliminary Results

This section contains potentially patentable material and has therefore been issued in the Supplement to the Technical Progress Report, marked "Not For Publication".

4. Calculation Methods

The feed gas contained approximately 15 mole percent of argon as an internal standard for calculation purposes. The calculated data include vapor hourly space velocity (VHSV), hydrogen and carbon oxides conversions, selectivity and methanol productivity.

The VHSV is calculated as follows:

$$VHSV = \frac{V_e}{W_C} \times \frac{Ar_e}{Ar_f} \times \frac{273.15}{273.15 + Te} \times \frac{Pe}{101.35} \qquad \text{(Eq. 1)}$$

Where:

VHSV	=	Space Velocity in $l \cdot hr^{-1} . kg^{-1}$
V_e	=	Volume flow of effluent, l/hr (at STP)
Ar_e	=	Mole percent argon in effluent
Ar_f	=	Mole percent argon in feed
W_C	=	Oxided catalyst charge, kg
Te	=	Effluent Temperature, °C
Pe	=	Effluent Pressure, kPa

The percentage conversions of feed gas components (H_2, CO and CO_2) are calculated as follows:

$$C_i = \frac{I_f - \left(I_e \times \frac{Ar_f}{Ar_e}\right)}{I_f} \times 100 \qquad \text{(Eq. 2)}$$

Where C_i = Percent conversion of component I

I_f = Mole percent of I in feed gas

I_e = Mole percent of I in effluent gas

I = H_2, CO or CO_2

If the feed gas has a low CO_2 concentration (less that three percent), then net CO_2 will be produced, and the percent selectivity to CO_2 (S_{CO_2}) can be calculated as follows:

$$S_{CO_2} = \frac{\left(D_e \times \frac{Ar_f}{Ar_e}\right) - D_f}{M_f - \left(M_e \times \frac{Ar_f}{Ar_e}\right)} \times 100 \qquad \text{(Eq. 3)}$$

Where D = Mole percent of carbon dioxide
M = Mole percent of carbon monoxide
Ar = Mole percent of argon
Subscript e refers to reactor effluent
Subscript f refers to reactor feed

The methanol productivity is calculated as follows:

$$M_p = \frac{VHSV}{22.4 \times 100} \times (M_f \times C_M + D_f \times C_D) \qquad \text{(Eq. 4)}$$

Where: M_p = calculated methanol productivity; gmol/hr/kg oxidized catalyst.

When a low CO_2 content feed gas is used, part of the CO is converted to CO_2 as well as to methanol. For this case, the selectivity to CO_2 would have to be subtracted from the term in the parenthesis in Equation (4) in order to calculate the methanol productivity.

7.2.5 Cold-Flow Model -

The initial scoping of equipment requirements and experimental techniques was conducted in order to determine costs and timing associated with cold flow hydrodynamic modeling of the LPMeOH process.

A cold flow hydrodynamic unit was designed which could be operated as either a liquid-fluidized reactor or a liquid-entrained reactor. In the liquid-fluidized mode, the process liquid velocity is controlled over a narrow range in order to fluidize a fixed quantity of catalyst particles within the confines of the reactor. For liquid-entrained operations, smaller catalyst particles are intentionally suspended in the process liquid and are circulated throughout the liquid circulation loop. The process flows and physical dimensions of the hydrodynamic unit broadly resemble that of the LaPorte LPMeOH PDU. A conceptual process flow diagram of the cold flow hydrodynamic unit is shown in Exhibit 7.2.5-1.

It is anticipated that the hydrodynamic test unit would be constructed of materials that are compatible with a range of organic solvents. The process liquids will be selected to have properties similar to those of the hot process liquids. Solvents of differing physical properties would be used in the determination of the density, viscosity and surface tension effects on the hydrodynamic character of the process fluid.

1. Process Equipment

In the liquid-entrained gas/liquid upflow configuration, gas and slurry are co-fed to the bottom of the reactor (TW-100). Gas is introduced through a suitable distribution device while the slurry is introduced below the gas distributor. Catalyst particle size and process liquid flows would be selected so as to intentionally suspend the catalyst in the process liquid and circulate the solids throughout the liquid circulation loop. By design, the catalyst solids and process liquids must remain a homogeneous mixture everywhere within the liquid circulation loop. Gas/solids/liquids are taken overhead out of the reactor to the V/L separator (VT-100) where phase separation between gas and slurry phases occurs. The separated slurry phase is recirculated to the reactor inlet through a pump (CP-100). The gas phase passes through a demister (VT-101) to de-entrain any liquid droplets. The gas can then be vented or recycled back to the compressor (GC-100). The gas compressor would be equipped with a water cooled aftercooler (HE-100). The gas then flows into a surge tank in order to damp out pressure (or flow) fluctuations prior to passing to the reactor gas distribution system.

- Reactor

  The reactor used for the hydrodynamic study would be constructed of a combination of flange-connected glass and metal sections. The column dimensions (identical to the LaPorte LPMeOH PDU reactor) will be 0.56 meters inside diameter by 4.6 meters long. The reactor piping connections at the top and bottom will be flexible. The bottom metal spool piece is designed to support the entire cold flow reactor assembly. Each metal spool piece would be constructed so as to allow for the introduction of sample probes, pressure taps, and other instrumentation as required. The sample probes would be constructed and operated so as to obtain slurry concentration data along the radial and axial direction. A Plexiglass or Lexan shield would be used to enclose the glass column for personnel protection. Sections of the plastic shield would be made removable to allow access to the various sample and pressure taps. Finally, an x-ray source and detector will be mounted so as to traverse the length of the reactor. Alternately, a series of fixed source/detector pairs may be mounted along the vertical length to obtain the density profile.

- Pumps and Compressors

  A rotary screw air compressor with a water cooled aftercooler would be used for supplying gas. The present design requires a compressor capable of up to 2.8 m^3 per minute at standard conditions and 790 kPa outlet pressure. The compressor discharges into a surge tank to damp out pressure and flow fluctuations.

  Magnetically coupled centrifugal pumps will be selected for the slurry feed and circulation loop. These pumps are magnetically coupled to their motor so as to eliminate problems of liquid or gas leakage across a dynamic seal. In addition, these pumps do not require a seal flush flow. The present design requires a pump capable of 830 liters per minute maximum flow at 23 meters total dynamic head.

- Catalyst Recovery Filter

  A plate and frame filter press is included in the design to be used in determining solids holdup within the column. Additional use would be made of the filter in recovering "used" catalyst upon completion of testing.

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- Vessels

The slurry feed tank (VT-102) was sized at 1100 liters to hold the entire contents of the cold flow hydrodynamic test unit. It is baffled at 90° and supplied with an agitator to maintain the catalyst slurry in suspension. Liquid inventory can be monitored by placing the unit on a weigh cell or by using a DP cell. If a DP cell is used, an inert purge gas must be supplied to the high side of the cell to prevent plugging by catalyst. A slurry feed pump (CP-102) is used to transfer the slurry to the main test unit circulating loop.

The slurry preparation tank (VT-103) has a capacity of 400 liters and was sized for slurry addition and makeup in multiple batches. It is also baffled at 90° and supplied with an agitator. Inventory control would be accomplished by placing the unit on a weight cell. Slurry is transferred from the vessel to the feed tank or the main circulation loop through the slurry transfer pump (CP-101).

2. Experimental Techniques

Test methods for determining hydrodynamic system characteristics can be categorized as being either external or internal monitoring techniques. External techniques are preferential in that they do not interfere with established flow patterns. Internal methods involve the insertion of devices through the test cell wall, consequently inducing flow disturbances downstream of the sample location.

- External Methods

Sonic probes and gamma-ray scan techniques have been used to obtain data on the average bulk density in multiphase systems. Gamma-ray techniques make use of differential absorption of radiation by various materials. Being an external technique, it is an excellent method for determining the average density of a multiphase system without creating a flow disturbance. A movable density gauge could traverse the length of the reactor and give point bed density measurements directly. These measurements combined with fluidized bed height measurements give a direct evaluation of the relative liquid, gas and solid phase volume fraction.

Sonic techniques are alternate external methods for determining densities of multiphase systems, using sound rather than radiation. In single-phase systems, phase-time and dual-path sonic probes (which measure sonic impedance) can be used to determine density. These devices can also be used in two-phase, liquid-solid slurry systems, provided that the sonic impedance of the two-phase mixture is a very weak function of slurry concentration. These devices cannot be used when a bulk gas phase is present because discrete gas bubbles give rise to interfering sonic reflections. It can measure vertical bubble rise velocity or slurry velocity.

- Internal Methods

Several tracer testing methods are known for determining residence time distributions, flow rates and relative phase volumes in multiphase reactors. The techniques employed involve use of a tracer component with an internal or external monitoring device. External detection systems are preferred as they will not interfere with established flow patterns.

In general, flow patterns can be studied by injecting a tracer into a vessel inlet stream and observing the subsequent concentration profile at the outlet. At steady state, methods used consist of injecting a continuous tracer into the inlet of a studied interval and measuring the upstream concentration. For large diameter columns, problems are encountered in obtaining a homogeneous dispersion of the tracer. Further, attempts to obtain an average sample profile across the column can be difficult without disturbing the original flow patterns within the column. When continuous sample withdrawal is employed, sample time effects may distort the measured response. Unsteady state methods of measuring residence time distributions consists of injecting a momentary tracer pulse at the reactor inlet and measuring the response function at the outlet. Pulse injection methods are preferred to step or frequency response methods since inputs requiring large quantities of tracer are impractical on large units. Pulse injection techniques are simple, inexpensive, and require only small quantities of tracer material.

In performing a tracer study, proper tracer selection is extremely important. The hydrodynamic response must be characteristic of the flowing phase and not a function of the tracer component. Any tracer employed should be miscible and have physical properties similar to the bulk fluid phase. The tracer must not be transferrable to the other phases of the system. All tracers under consideration should be accurately detectable in low concentrations to minimize disturbances in the established reactor flow patterns.

To enable tracer detection in fast moving streams, the data recording equipment must offer exceptional sensitivity with a minimal detection response time. For simplicity and accuracy, the response of this equipment should be linear.

Gas, liquid or solid tracers can be injected into a flow system to determine the responses for each phase. For the gas phase, a tracer gas injected into a multi-phase reactor would have its concentration measured by a thermal conductivity or infrared absorption cell. Alternately, a radioisotope is substituted. In using gas phase tracers, absorption into the liquid phase precludes an accurate determination of the gas phase mixing and holdup without an independent measurement of tracer content in other phases. The differing rise velocities of individual bubbles further complicate the detector response. Because of these inherent difficulties in using gas phase tracers, only qualitative data concerning gas phase mixing are available in the literature.

The use of liquid tracers are well accepted industrial practices. Problems associated with their use are the familiar ones of sampling induced errors when internal techniques are used. External techniques employed include the use of dyes coupled with high speed photography and radioactive tracer methods. Unfortunately, photographic techniques relying on photochromatic dyes or particle luminescence cannot be used if the color change is obsured by the catalyst particles. In larger diameter columns wall effects can also obscure the events from photographic interpretation.

For the solid phase, a magnetic tracer can sometimes be used. The concentration of a solid phase tracer may be measured by a capacitance probe if the dielectric constant of the tracer material is substantially different than that of the solid phase. In general, for solid phases, a suitable radioactive tracer is often the most convenient to use. If proper precautions are observed, a radioactive tracer has a distinct advantage over other tracers in that the tracer detection devices can be mounted externally. In this way, no disturbances in the established flow patterns resulting from the presence of probes or sampling devices are encountered. The use of a radioactive tracer permits the time distribution function of a rapidly moving phase to be accurately determined, since scintillation detectors can be interfaced with high speed recorders or with multi-channel analyzers with data storage capabilities.

7.2.6 CSI Lab PDU Modifications

The request to purchase the first of two slurry pumps was approved. Meanwhile, all responses on the RFQ for fabrication of vessels and skid equipment for the CSI lab PDU were received and evaluated. It was decided, however, at a meeting held in Fairfield on 25 February with APCI personnel not to hire a contractor to build a complete skid-mounted unit. Instead, only major equipment items, such as process vessels and heat exchangers, will be fabricated outside with the majority of engineering, skid design and assembly handled by CSI in-house. This change has been necessitated to allow more project flexibility, lower overall costs and improved scheduling. Work began on the assembly of a technical package which will serve as sufficient documentation for required purchases of equipment or services. This package will contain process flowsheets, heat and material balances and a description of the liquid-entrained CSI Lab PDU. The process flowsheets will eventually evolve into complete engineering flowsheets. This package when assembled will accompany any requests for approval sent to APCI/DOE.

7.2.7 CSI Lab PDU Experimental Program - This subtask will not be initiated until the CSI Lab PDU modifications are completed.

7.2.8 LaPorte LPMeOH PDU Support -

Overview

United Catalysts Inc. has developed under EPRI support (Reference 12) a methanol synthesis catalyst for the liquid-fluidized (ebullated bed) mode. This material represents a catalyst candidate with potentially better attrition resistance than any catalyst tested under the prior EPRI contract (Reference 13). A 10 lb sample of this catalyst (CSI Identification Number R71/OF12-02) was shipped to CSI's Fairfield Research Center for evaluation in a test in the CSI Lab PDU. The catalyst was charged to the reactor on 16 February 1982 and was reduced utilizing a vapor-phase reduction technique over a three-day period. Two days of testing concentrated on the three-phase fluidization properties of the catalyst suspended in Witco mineral oil, prior to the actual synthesis test. The catalyst was brought on-stream with a 2/1 H_2/CO feed gas, and operating conditions were maintained constant for a period of about 370 hours.

During this period, CO conversion and settled catalyst bed height were monitored. Fines generation, as determined by pressure drop buildup in the oil filters and decrease in settled bed height, was higher in the first two days on-stream time than during the later part of the run. Both factors were lower than experienced previously with another catalyst (FX2/1F15-02) tested under a previous EPRI contract (Reference 13). A measure of the attrition resistance characteristics of the catalyst will be obtained upon inspection and post-mortem analysis of the catalyst recovered from the reactor at the conclusion of the run.

During the Lab PDU operation, a process variable scan was also made to study the effect of temperature, space velocity, pressure and synthesis gas composition on catalyst activity and productivity to methanol.

CSI Liquid-Fluidized Lab PDU Description

The CSI Lab PDU reactor is 0.092 m I.D. x 2.13 m high, and the catalyst bed height can be varied from 0.6 to 1.5 meters. The detailed engineering design of the CSI Lab PDU has been presented elsewhere (Reference 14). The premixed synthesis gas feed is delivered to the laboratory in a tube trailer. A gas compressor is used to feed the gas to the reactor. In this manner, the pressure in the tube trailer can be reduced to 2170 kPa before a new supply is required. Two compressors are provided to allow flexibility in feed gas rate. Product methanol and small amounts of vaporized oil are condensed out of the product gas/vapor stream. Phase separation occurs at ambient temperature with a typical residence time in the product separator of one hour. The oil is recycled back to the process oil circulating loop. The product gases, following analysis, are sent to an incinerator. Sufficient instrumentation is provided for automatic control and monitoring from a remote control room. The system is designed for pressure up to 7000 kPa and temperatures up to 400°C. All necessary gas streams are connected to a common manifold and are constantly purged to reduce sampling time lags. The selected gas stream may be directed to each chromatograph column, in turn, to analyze for components of interest.

Preliminary Analysis of Short-Term Attrition Test

After the CSI Lab PDU was pressure tested, the reactor was loaded with fresh oxided catalyst (R71/OF12-02) and reduced over a three-day period. The system was put on-stream at conditions similar to those used in the previous EPRI-funded test made in November, 1978: 250°C reactor temperature, 7000 kPa and 3000 hr^{-1} VHSV (Reference 13). These conditions were held constant for 370 hours before process variable scans proceeded. The complete run chronology is shown in Exhibit 7.2.8-2.

At the onset of the run, CO conversion was 34 percent and then dropped linearly to the 28 percent level within 100 hours. During this time period, the settled catalyst bed height decreased to 93 percent of its initial height. For the remaining time, 270 additional hours, the CO conversion hovered at the 28 percent level while the settled catalyst bed height decreased to 81 percent of its initial height. These results are shown graphically in Exhibit 7.2.8-1.

The next 70 hours of running time were utilized in performing a process variable scan. The preliminary results of these tests are shown in Exhibit 7.2.8-3. At the termination of these scans (440 total hours on-stream time), the settled bed height had dropped to 78 percent of its initial height. Setting the system back to the initial run conditions gave a slightly lower CO conversion (27.5 percent) than the value just prior to the start of the variable scan.

With 460 hours logged on the catalyst, a short scan was performed using a low CO_2 (1.5 percent) content 2/1 H_2/CO feed gas. This synthesis gas resulted in essentially the same CO conversion as the 10 percent CO_2 gas with the exception that a small percentage of CO had apparently shifted to CO_2.

The synthesis gas used for the initial conditions was put back on-line resulting in a CO conversion of 27.5 percent. The settled catalyst bed height at this point was 75 percent of its initial height. After a total of 555 hours on-stream time, the settled catalyst bed height was 73 percent of the inital height and CO conversion was 27 percent. A short test using a 0.6/1 H_2/CO feed was then performed before the unit was shut down.

The unit will be disassembled to recover the catalyst and then cleaned up and placed in a stand-by condition. Catalyst and oil samples will be analyzed. The analysis of the non-hydrocarbon liquid products is not complete at this time but indicates a 96±1 weight percent methanol content with the remainder being Witco 40 oil, water and a small amount of higher alcohols - ethanol through hexanols.

Task 8 - Conversion of the LaPorte LPMeOH PDU from Liquid-Fluidized to Liquid-Entrained Mode

No Activity.

Task 9 - Shakedown for Liquid-Entrained Operation

No Activity.

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Task 10 - Liquid-Entrained Operation

No Activity.

Task 11 - Project Evaluation

11.1 APCI Management Activities

11.1.1 Project Management -

The Project Status Reports, Format 5 Reports, and quarterly Technical Progess Report No. 1 were coordinated.

An arrangement was made to provide closer liaison between APCI design engineers and CSI's laboratory personnel following review of CSI's requisitioning material for a skidded assembly for modification of the Laboratory PDU to permit liquid-entrained operation. The specification, design, and erection of this unit remains in CSI's subcontract scope; however, APCI will take a more active role in engineering assistance and specification review. A rough project plan was worked out to establish requirements for future purchase requests by CSI in this area.

A meeting among APCI, CSI and DOE was held in Pittsburgh on 18 March 1982 to clarify procurement and approval procedures. A brief presentation was made by APCI and CSI on the program status.

11.1.2 Economic Evaluation - No Activity.

11.1.3 Travel and Living - APCI and CSI met on several occasions in Allentown and Fairfield and once in Pittsburgh. APCI's Operations Manager from LaPorte attended meetings in Allentown and Chicago. Two trips were made to Chicago by APCI and CSI personnel to review LPM pilot plant relocation specifics.

11.2 CSI Activities

11.2.1 Data Evaluation - Information from the CSI Lab Stirred Autoclave and the CSI liquid-fluidized PDU runs was evaluated and reported under the corresponding subtasks. Thorough analysis of data from both of these units will continue into the next reporting period.

11.2.2 Design and Economics - No Activity.

11.2.3 Process Scaleup - No Activity.

11.2.4 Reporting - Monthly Project Status Reports, management reports and the first quarterly Technical Progress Report were issued. Work was completed on a paper for presentation. A meeting was held at PETC on 18 March 1982 to discuss current project status and equipment review/purchase procedures. Work began on updating the CSI Project Work Plan including schedule, manpower and costs. This will be part of the 1 June deliverable to DOE from APCI.

11.3 APCI Design

11.3.1 Integration -

APCI reviewed and technically approved CSI's first Laboratory PDU slurry pump purchase. A technical difference exists between recommendations of the International Coal Refining Co. and Lawrence Pump Co. regarding the most appropriate seal arrangement for this application. Due to the experienced position Lawrence has with various pilot plant operations in hot, high pressure, slurry service these recommendations are being given thoughtful consideration.

Technical review and approval were given by APCI on CSI specifications for pressure vessels and a slurry heat exchanger required for modification of CSI's Laboratory PDU for liquid-entrained operation.

11.4 APCI R&D Activities

11.4.1 Corporate Development Department - Input was provided to the Monthly Status Reports and Technical Progress Report No. 1. Meetings were held with the CSI Fairfield laboratory staff to strengthen the technical liaison between the research organizations.

11.4.2 Process Systems Group R&D -

Preliminary Viscosity and Density Data

In support of the LaPorte LPMeOH PDU design effort, preliminary viscosity measurements of Witco 40 oil/MC-2 catalyst slurry were carried out using a Brookfield LVT viscometer with an ultra low viscosity adapter attachment and spindle. The variables included:

Temperature	-	67°F to 482°F (19 to 250°C)
Slurry Concentration	-	0 wt%, 12 wt% and 25 wt%

Immediately before measurement for slurries, the U.L. adapter was removed and shaken vigorously to ensure a uniform solids suspension during the viscosity measurement. Preliminary results indicated that 25 wt% slurry viscosity showed a strong shear-rate dependence. These results are suspect from several points of view. The data are currently being evaluated and the full report and conclusions will be included in the next quarterly report. In addition to the viscosity data, the density, the volume % and % volume change of 12 wt% and 25 wt% slurry were measured at 71-72°F (22°C).

Pyrophoric Nature of Spent Catalyst

An experimental plan was developed to assess the pyrophoric nature of oil/catalyst slurries. Three types of experiments have been considered:

1. Qualitative observation of oil/catalyst slurries in an open air environment (hood).

2. Differential Thermal Analysis (DTA) of oil/catalyst slurries (1-5 mg) to determine quantitatively the timing and the temperature at which auto-ignition would occur.

3. Heat of combustion measurements of oil/catalyst slurries (1 g sample) to verify the theoretical calculations for the largest possible energy release.

This plan is ready for circulation within APCI for review and comment.

Fundamental Model for LPMeOH

Progress was made in exploring fundamental modeling of the LPMeOH reactor and reaction kinetics. A computer model written by Professor W. D. Deckwer of Universitat Hannover (West Germany) for Fischer-Tropsch synthesis in a slurry phase reactor was tested. (This computer program is not generally available to the public but was made available by Professor Deckwer under a private agreement with APCI. It is planned to report results from the computer model; the software programming will not be reported without prior agreement with Professor Deckwer.) The Deckwer model is well described in Reference 15. The computer program was made operational and the results of computations published in Reference 15 were duplicated. The strategy is now being developed to model the LPMeOH fluidized (ebullated bed) and entrained (slurry) reactors by modifying the rate expressions, modifying the mass balances to allow both solids and liquid to flow in and out the reactor, and by incorporating appropriate hydrodynamic parameters at high liquid velocities.

Liquid Phase Reactor Patents

A preliminary patent search on 3-phase slurry reactor designs was made regarding possible infringements of the LaPorte LPMeOH PDU reactor design on the prior patents. The search revealed that the current simple reactor designs at LaPorte probably do not infringe any prior patent because the prior 3-phase reactor patents are largely process-oriented.

Input was provided to the Monthly Status Reports and the Technical Progress Report No. 1. Meetings were organized and held with the CSI Fairfield laboratory staff to enhance technical communications.

Air Products

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Air Products

ATTACHMENTS

Exhibits 2.3.1-1
2.3.1-2
2.3.1-3
2.3.1-4
2.3.1-5
2.3.1-6
2.3.1-7A
2.3.1-7B
2.3.1-8
2.3.1-9A
2.3.1-9B
2.3.2-1
7.1.3-1
7.2.2-1
7.2.5-1
7.2.8-1
7.2.8-2
7.2.8-3

E. P. Holley
Project Manager

J. Klosek
Program Manager

ATTACHMENTS

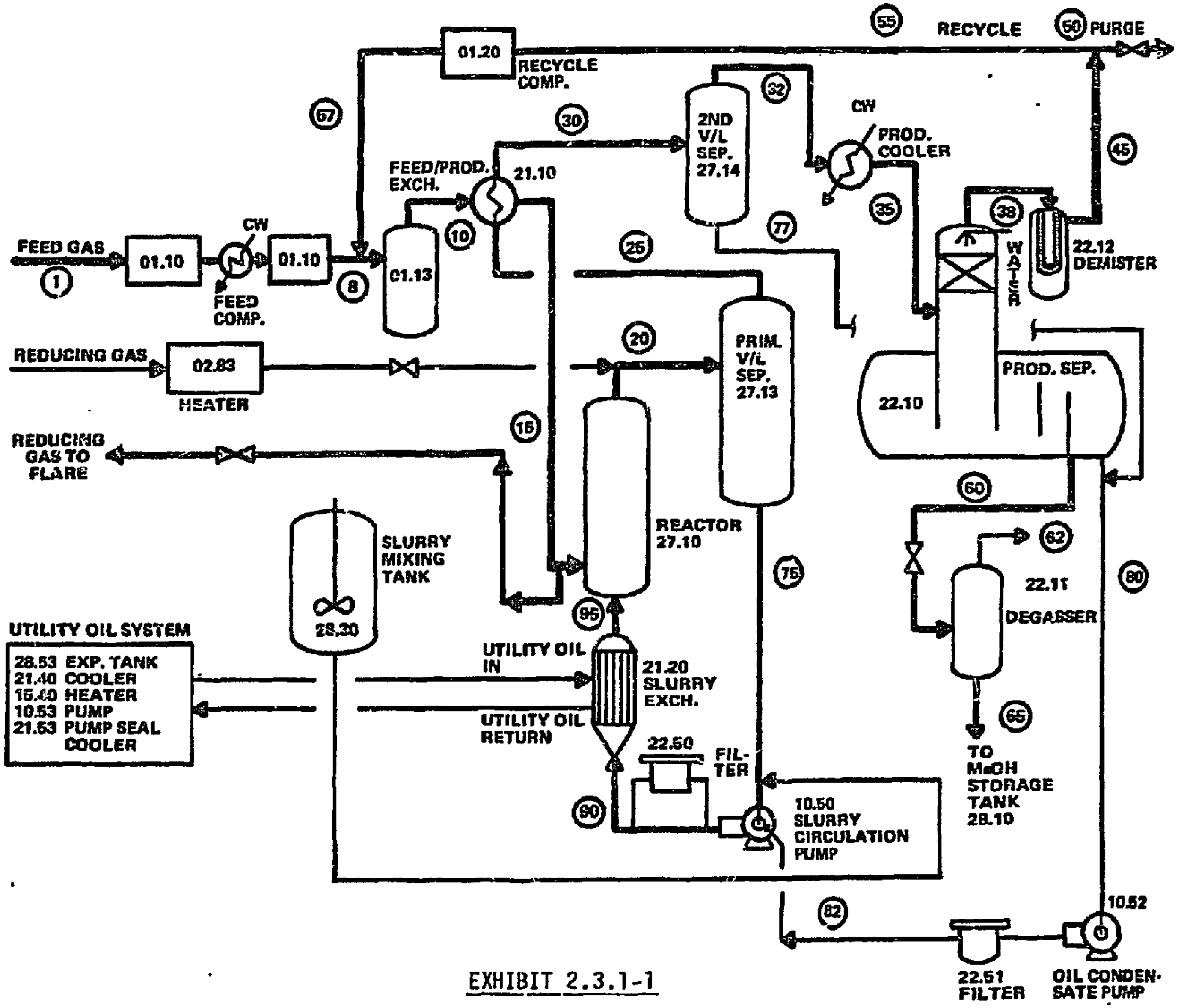


EXHIBIT 2.3.1-1

SIMPLIFIED PROCESS FLOWSHEET FOR LAPORTE LP MeOH PDU

20 April 1982

STANDARD

LINES

- PROCESS LINE
- NON-PROCESS OR UTILITY LINES
- PNEUMATIC LINE
- ELECTRICAL LINE
- INSTRUMENT CAPILLARY TUBING
- INSULATED LINE
- TEL ELECTRICAL TRACED LINE
- INSTRUMENT AIR SUPPLY
- HYDRAULIC SIGNAL LINE
- MECHANICAL LINKAGE

VALVES

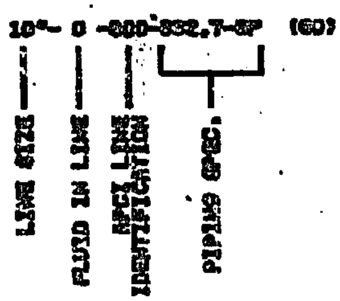
- GATE VALVE
- GLOBE VALVE
- NEEDLE VALVE
- LOCK-OUT VALVE
- CHECK VALVE
- BUTTERFLY VALVE
- THREE WAY VALVE
- FOUR WAY VALVE
- MANIFOLD VALVE
- ANGLE VALVE
- BALL VALVE
- SWITCHING CHECK VALVE
- TYPICAL AS-BUILT VALVE DESIGNATION

MISCELLANEOUS

- IN-LINE STRAINER
- STRAINER
- MATERIAL BALANCE POINT
- REDUCER
- EXPANSION JOINT OR FLEX CONNECTION
- T TRAP
- OPEN FUNNEL DRAIN
- FLEXIBLE HOSE
- UNION
- SPEC OR LIMIT BREAK
- FLANGES
- FLOW SIGHT GLASS

BOLS AND ABBREVIATIONS

LINE DESIGNATION



FLUID ABBREVIATIONS

A	AIR
AG	ACID GAS
AP	AIR PURGE
AR	AROMATICS
BFW	BOILER FEED WATER
C1	METHANOL
CW	COOLING WATER
D	DOWTHERM
DS	DIETHYL SULFIDE
EFF	EFFLUENT
FG	FEED GAS
FO	FUEL OIL
GL	GLYCOL
H	HYDROGEN
IA	INSTRUMENT AIR
INF	INFLUENT
K	CONDENSATE
L	LUBRICATING OIL
LOL	LEAN OIL
MEA	MEA
N	NITROGEN
NAP	NAPHTHA
O	OXYGEN
PG	PRODUCT GAS
PW	POTABLE WATER
R	ARGON
RG	REDUCTION GAS
ROL	RICH OIL
S	STEAM
SL	SLUDGE
SNG	SNG
SY	SLURRY
UO	UTILITY OIL
VG	VENT GAS
WAS	WASTE ACTIVATED SLUDGE
WO	WASTE OIL
WW	WASTE WATER

PIPING MATERIALS

AA	ALUMINUM ALLOY
BP	BRASS PIPE
BT	BRASS TUBE
CG	GALVANIZED
CI	CAST IRON
CP	COPPER PIPE
CS	CARBON STEEL
CSO	CARBON STEEL (OXYGEN)
CT	COPPER TUBE
IAS	INSTRUMENT AIR SUPPLY
SS	STAINLESS STEEL
TA	TUNGUM ALLOY (APL)
VC	VITRIFIED CLAY
CSG	GALVANIZED

MISC. ABBREVIATIONS

(HC)	HYDROCARBON ANALYZER
(N2)	NITROGEN ANALYZER
(O2)	OXYGEN ANALYZER
A/M	AUTO-MANUAL STATION
C.B.	COLD BOX
C.O.	CROSS OVER
F.C.	FAIL CLOSE
FLD.	FIELD
F.O.	FAIL OPEN
G.S.	GAS SAMPLE
H.PT.	HIGH POINT
I.S.	INSIDE
I/P	CURRENT TO PNEUMATIC TRANSDUCER
L.E.L.	LOWER EXPLOSIVE LIMIT
L.O.	LOCK OPEN
L.PT.	LOW POINT
L.S.	LIQUID SAMPLE
M.H.	MANHOLE
O.S.	OUTSIDE
P.T.	PRESSURE TAP
S.P.	SET POINT
T.S.	TO STACK
U.S.	UTILITY STATION
V.B.	VACUUM BREAKER
A.G.	ABOVE GROUND
U.G.	UNDER GROUND
BLDG.	BUILDING

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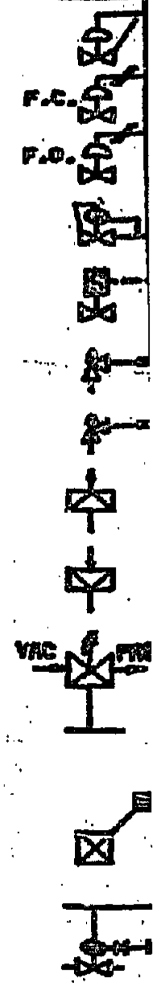

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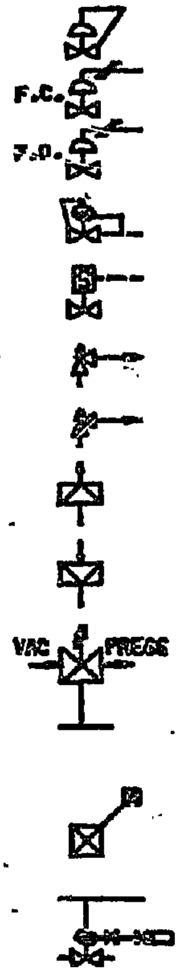
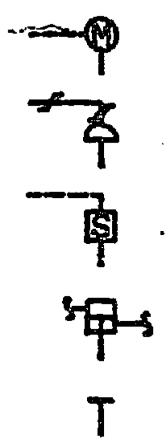
INSTRUMENT VALVES



- PRESSURE CONTROL VALVE
- TWO-WAY DIAPHRAGM VALVE (FAIL CLOSE)
- TWO-WAY DIAPHRAGM VALVE (FAIL OPEN)
- PRESSURE DIFFERENTIAL CONTROL VALVE
- SOLENOID CONTROL VALVE
- PRESSURE RELIEF VALVE
- THERMAL RELIEF VALVE
- PRESSURE RELIEF DISC
- VACUUM RELIEF DISC
- PRESSURE-VACUUM RELIEF VALVE
- SWITCHING VALVE
- REFRIGERATION

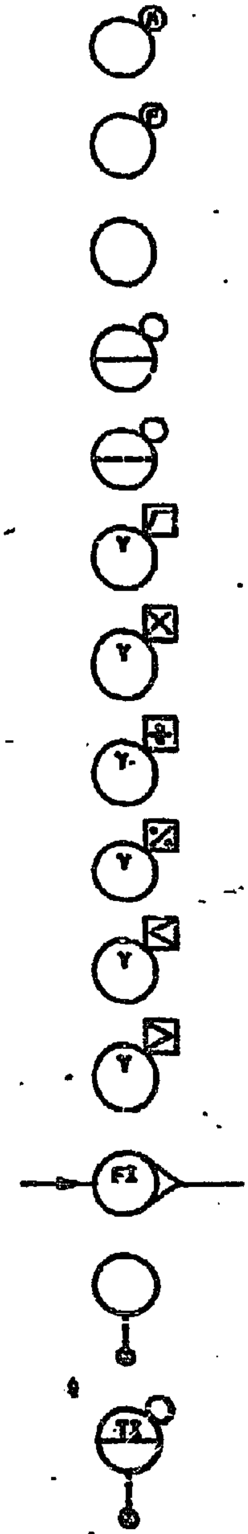
ACTUATORS



- ROTARY MOTOR ACTUATOR
- PNEUMATIC ACTUATOR
- SOLENOID ACTUATOR
- DOUBLE ACTING ACTUATOR
- HAND ACTUATOR

DUCER

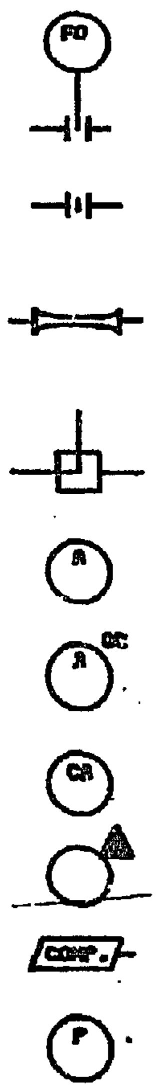
INSTRU



- FURNISHED BY APCI (VENDOR AREA ONLY)
- FURNISHED BY VENDOR (VENDOR AREA ONLY)
- LOCALLY MOUNTED INSTRUMENT
- PANEL MOUNTED INSTRUMENT
- INSTRUMENT MOUNTED ON BACK OF PANEL
- COMPUTER RELAY (SQUARE ROOT EXTRACTOR)
- COMPUTER RELAY (MULTIPLIER)
- COMPUTER RELAY (DIVIDER)
- COMPUTER RELAY (SET RATIO STATION)
- LOW SELECTOR RELAY
- HIGH SELECTOR RELAY
- ROTAMETER
- TEMPERATURE ELEMENT W/WELL (LOCAL)
- TEMPERATURE INDICATOR (TI), REMOTE PANEL MONITORING (RECORDING IF TR), THERMOCOUPLE ELEMENT (TE) THERMOWELL. PANEL LOCATION PER MINI-BUBBLE

p

TRUMENTS



- FIXED RESTRICTION ORIFICE
- ORIFICE
- VENTURI
- PITOT TUBE
- ANALYZER
- GAS CHROMATOGRAPH
- CALORIMETER
- INSTRUMENT BUBBLE DIAGRAM
- COMPUTER DATA LOGGER
- PRESS. TAP-PLUGGED

INSTRUMENT IDENTIFICATION INDEX

	FIRST LETTER			SUCCEEDING LETTERS		
	MEASURED VARIABLE	MODIFIER		PASSIVE FUNCTION	OUTPUT FUNCTION	MO[illegible]
A	ANALYSIS			ALARM		
B	BURNER					
C	CONDUCTIVITY				CONTROL	
D	DENSITY	DIFFERENTIAL				
E	VOLTAGE			ELEMENT		
F	FLOW	RATIO.				
G	GAUGING			GLASS		
H	HAND					HIGH
I	ELECTRICAL			INDICATE		
J	POWER	SCAN				
K	TIME					
L	LEVEL			LIGHT		LOW
M	HUMIDITY					MIDDL
N	EMERGENCY					
O				ORIFICE		
P	PRESSURE			POINT		
Q	QUANTITY	INTEGRATE				
R	RADIOACTIVITY			RECORD		
S	SPEED	SAFETY			SWITCH	
T	TEMPERATURE				TRANSMIT	
U	MULTIVARIABLE			MULTIFUNCTION	MULTIFUNCTION	MULTIF
V	VISCOSITY				VALVE	
W	WEIGHT			WELL		
X	SOLENOID					
Y	VIBRATION				RELAY	
Z	POSITION				DRIVE	

NOTES:

(1) FOR ANY ADDITIONAL INSTRUMENT IDENTIFICATION AND SYMBOLS, REFER TO THE ISA STANDARD, SECTION S5.1, OR THE FLOWSHEET GROUP.

(2) NEW INSTRUMENT NO.S SHOULD BE DESIGNATED FROM THE FLOWSHEET GROUP.

(3) BCV-FOR VALVE WITH INTEGRAL CONTROL
BV-FOR VALVE WITH SEPARATE CONTROLLER
B-IS THE LETTER FOR MEASURED VARIABLE

(4) ALL N2 PURGE CONNECTIONS TO FLAMMABLE GAS LINES SHALL CONFORM TO ENGR. DES. STD. S70.8

PLE

LE

PANEL LEGEND

1. MAIN CONTROL PANEL
2. 01.10 AND 01.20 PANEL (APCI)
3. 01.10 AND 01.20 PANEL (VENDOR)
5. ANALYZER PANEL

FLOWSHEET LEG

[illegible]

ODIFIER

N

DLE

IFUNCTION

EGEND

SD-1

01.10/01.20 FEED & RECYCLE COMP.

SHUTDOWN	ACTION
PSL-133 (01.10 SUCTION)	1) SHUTDOWN 01.10/01.20 COMPRESSOR 2) CLOSE HV-160 (REACTOR FEED)
TSH-138 (01.20 1ST STAGE DISC)	
TSH-144 (01.10 2ND STAGE DISC)	
PSL-322 (01.20 SUCTION)	
TSH-263 (01.10 DISC TEMP.)	
EMERGENCY STOP BUTTON	
SD-3 (10.50 SHUTDOWN ON TIME DELAY)	

ESSOR
D)

SD-2

SHUTDOWN	ACTION
EMERGENCY TRIP	1) CLOSE FV-101 (H2 FEED)
TSHH-120 (HIGH REACTOR TEMP)	2) CLOSE FV-104 (CO FEED)
	3) CLOSE FV-116 (CH4 FEED)

SD-3

SHUTDOWN	ACTION
S/D-4	1) S/D-1
10.E0 PUMP LOW AMPS CUTOUT	2) S/D 10.E0

[illegible]

SD-4

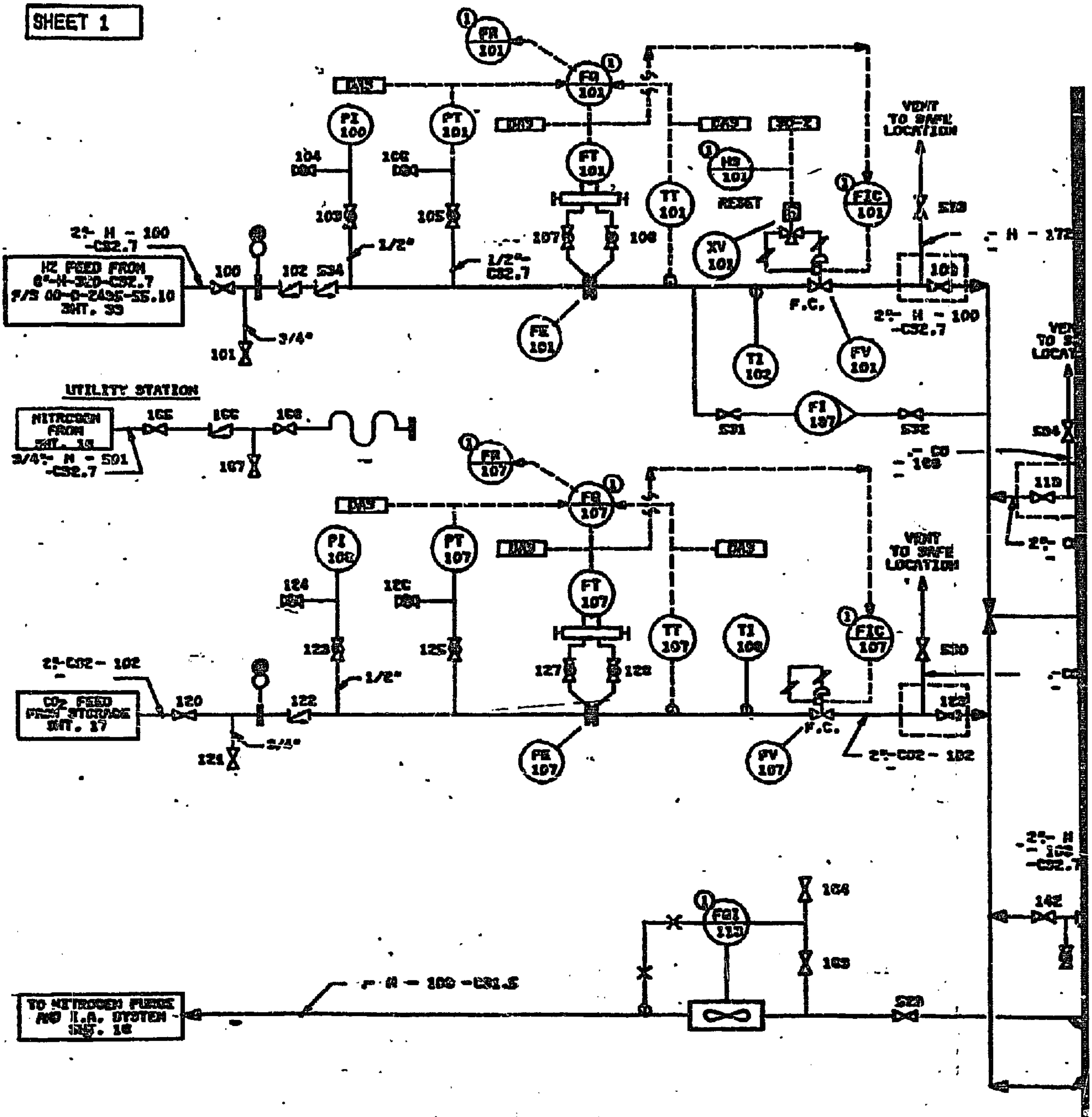
SHUTDOWN	ACTION
PSL-274 (LOW CARRIER FLUID PRESS.)	1) CLOSE PV-181 2) S/D-3
PDSL-173 (PUMP DIFF. PRESS.)	

SD-5

SHUTDOWN	ACTION
LSLL-315 (T2.11 LOW LEVEL)	1) CLOSE XV-242

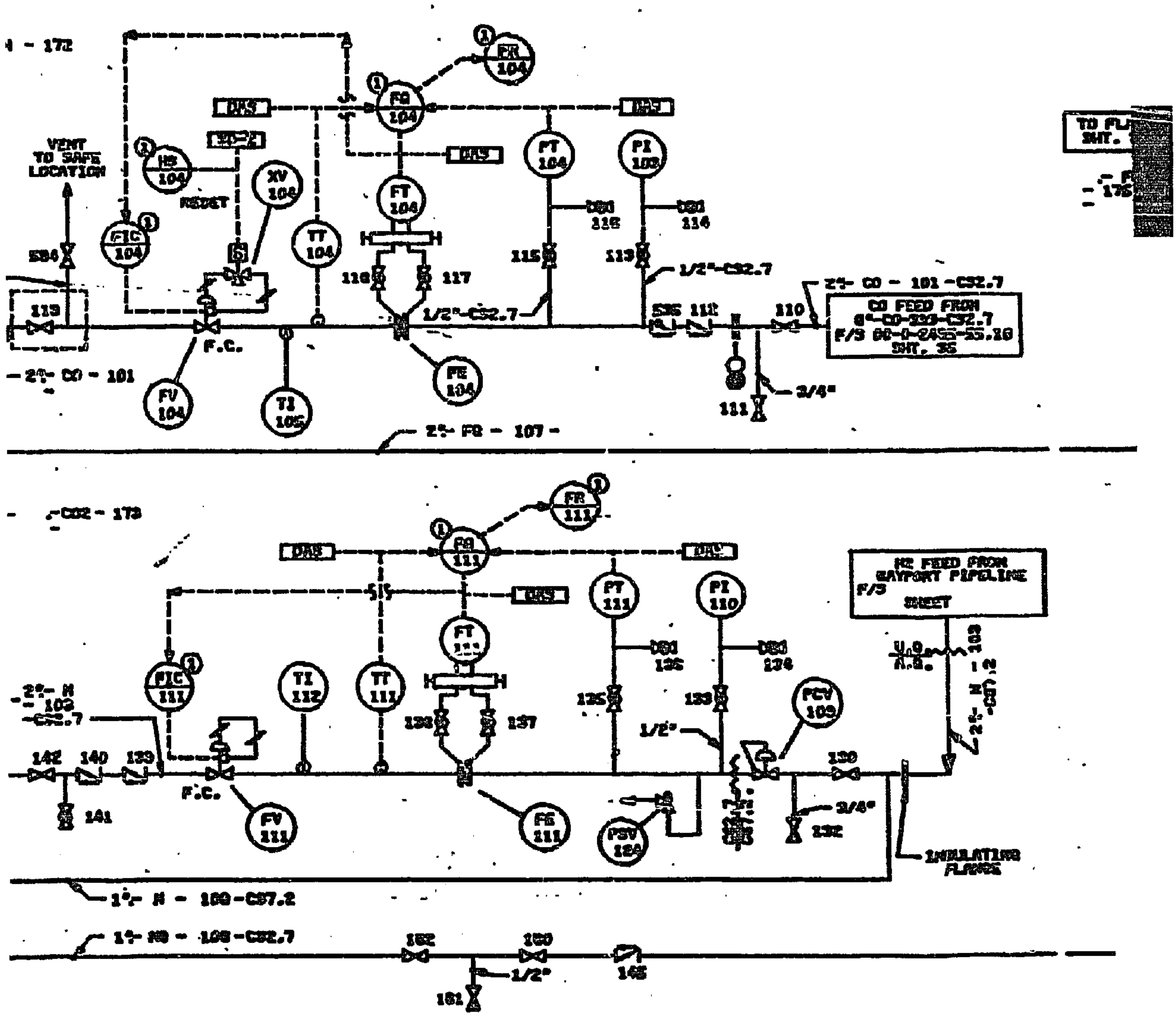
[illegible]

SHEET 1

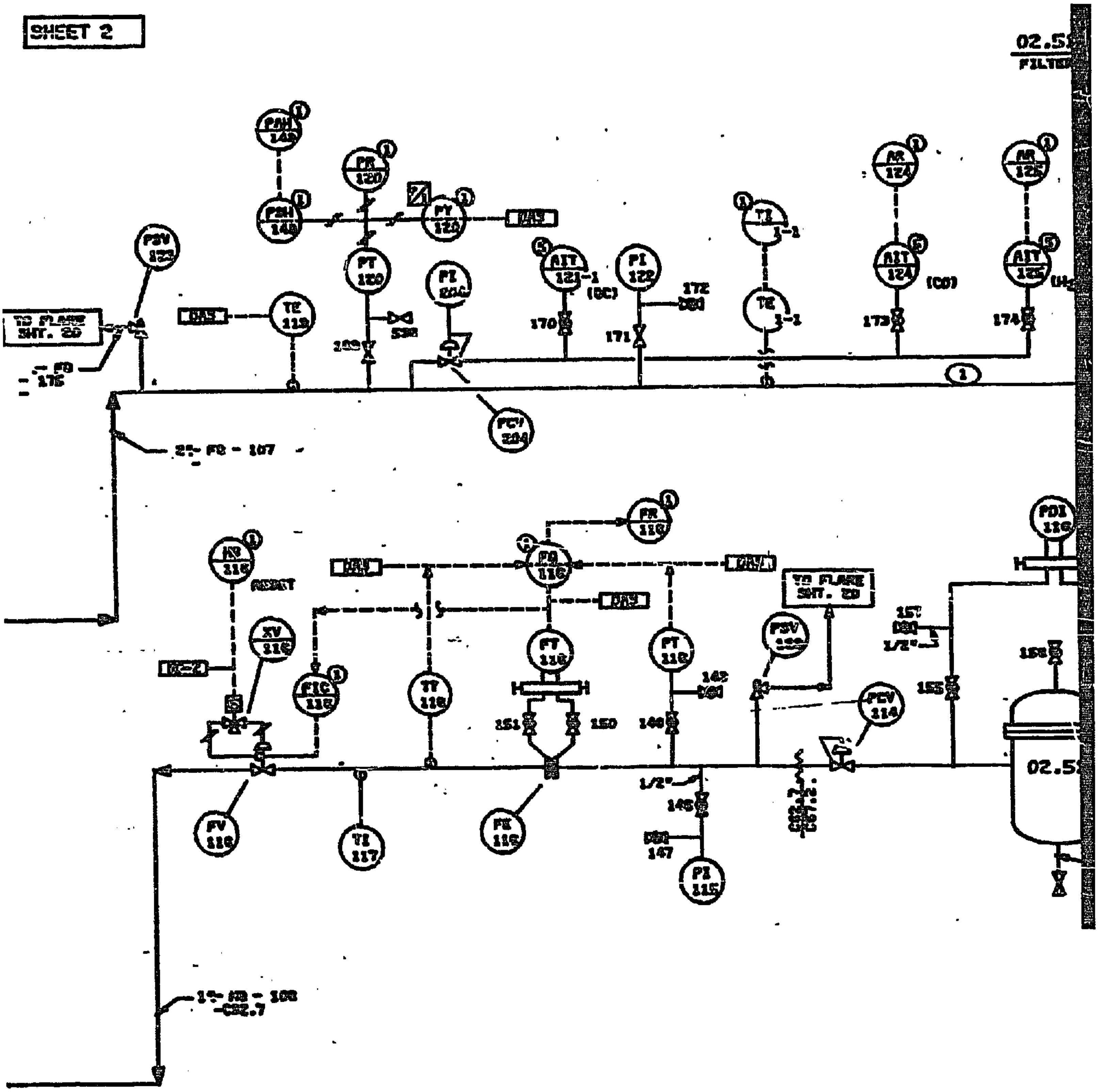


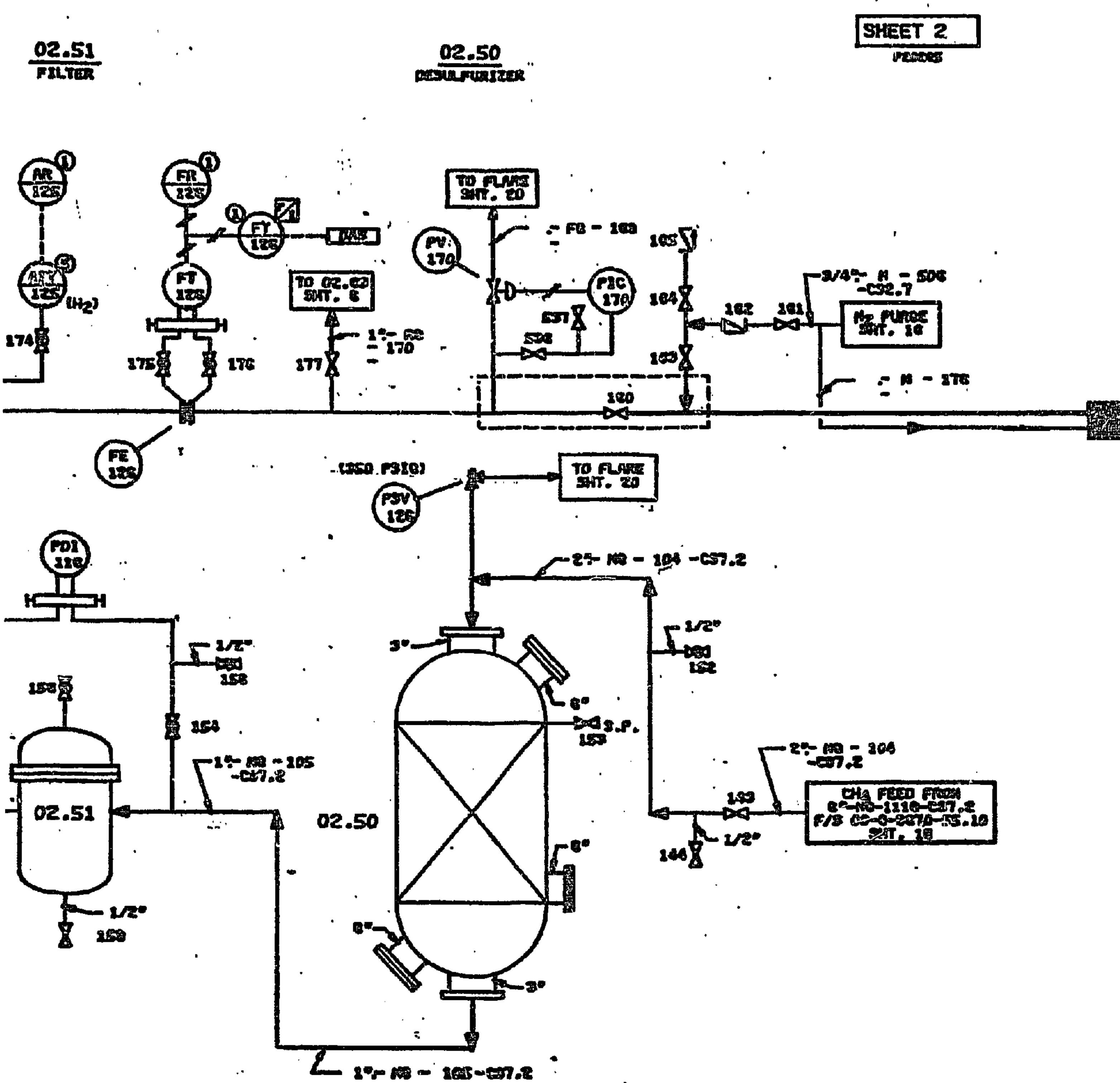
FR 101
FQ 101
PI 100
PT 101
FT 101
TT 101
HS 101
RESET
FIC 101
XV 101
VENT TO SAFE LOCATION
H2 FEED FROM
3HT. 33
F.C.
FE 101
TI 102
FV 101
UTILITY STATION
NITROGEN FROM
FI 107
FR 107
FQ 107
PI 108
PT 107
FT 107
TT 107
TI 108
FIC 107
VENT TO SAFE LOCATION
CO2 FEED FROM STORAGE SHT. 17
FE 107
FV 107
FQI 113
TO NITROGEN PURGE AND I.A. SYSTEM SHT. 18
1/2"
3/4"

SHEET 1

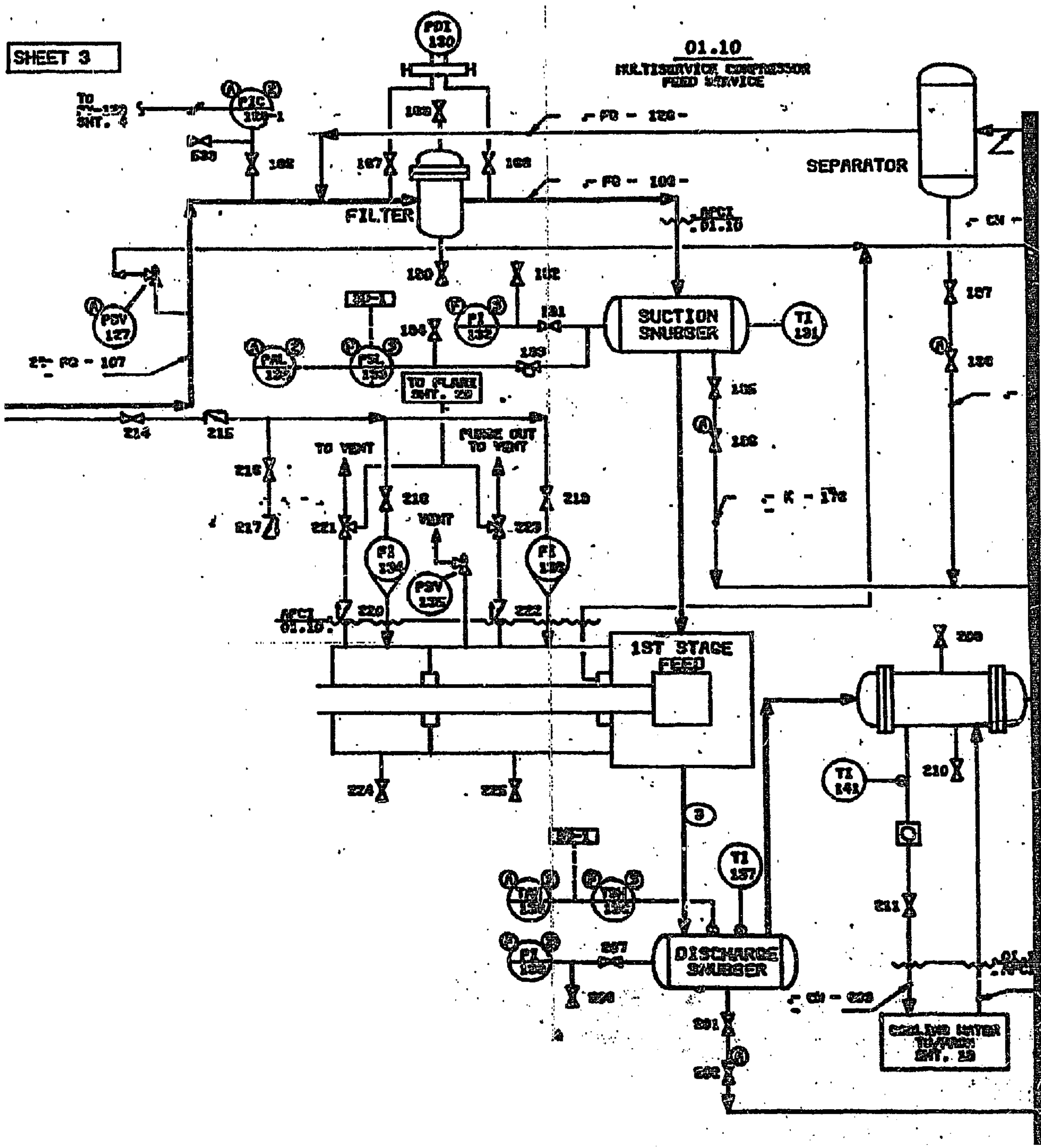

VENT TO SAFE LOCATION
RESET
F.C.
2" CO - 101
2" FG - 107
CO FEED FROM
SHT. 35
2" CO - 101 - CS2.7
1/2"-CS2.7
3/4"
FIC 104
HS 104
XV 104
TT 104
FQ 104
FR 104
FT 104
FE 104
FV 104
TI 105
PT 104
PI 103
DAS
H2 FEED FROM BAYPORT PIPELINE
SHEET
FIC 111
TI 112
TT 111
FQ 111
FR 111
FT
FE 111
FV 111
PT 111
PI 110
PCV 109
PSV 128
1/2"
INSULATING FLANGE
1/2"

p

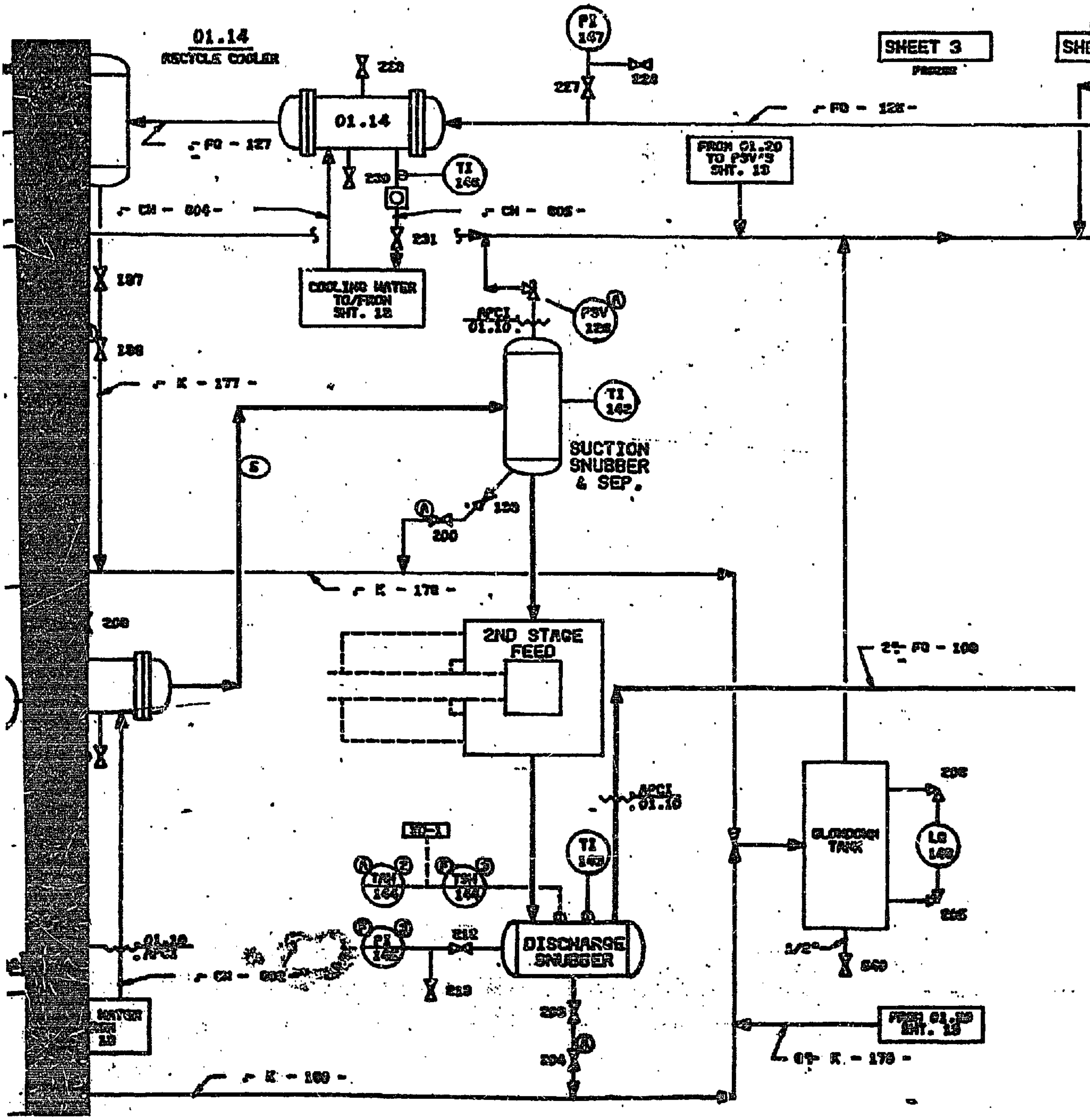

SHEET 2
02.5
FILTE
TO FLARE SHT. 2D
PSV 123
PAH 140
PSH 140
PR 120
PY 120
PT 120
TE 119
PI 204
FCV 204
AIT 121-1
(GC)
PI 122
TI
TE
AR 124
AIT 124
(CO)
AR 125
AIT 125
170
171
172
173
174
2"- FG - 107
HS 118
RESET
XV 118
FIC 118
TT 118
FQ 118
FR 118
FT 118
PT 118
PSV
PCV 114
PDI 118
FV 118
TI 117
FE 118
PI 115
151
150
148
146
147
155
156
157
1/2"
1"- HG - 108
-CS2.7


SHEET 2
02.51
FILTER
02.50
DESULFURIZER
AR
FR
FT
FE
PV
PIC
PSV
PDI
TO FLARE SHT. 20
TO FLARE SHT. 20
CH4 FEED FROM
02.51
02.50
3"
8"
8"
8"
3"
1/2"
1/2"
1/2"
1/2"
S.P.

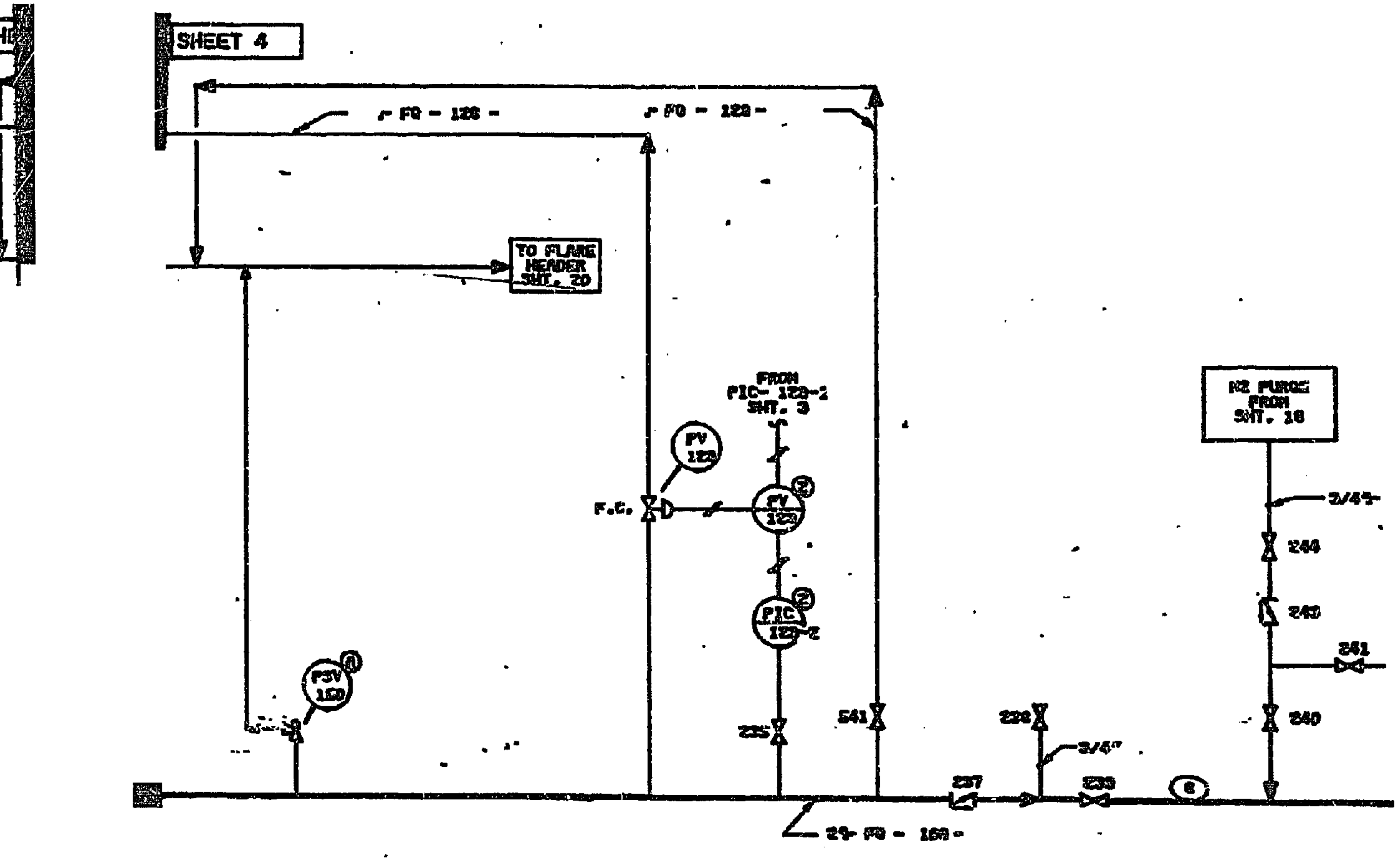
p

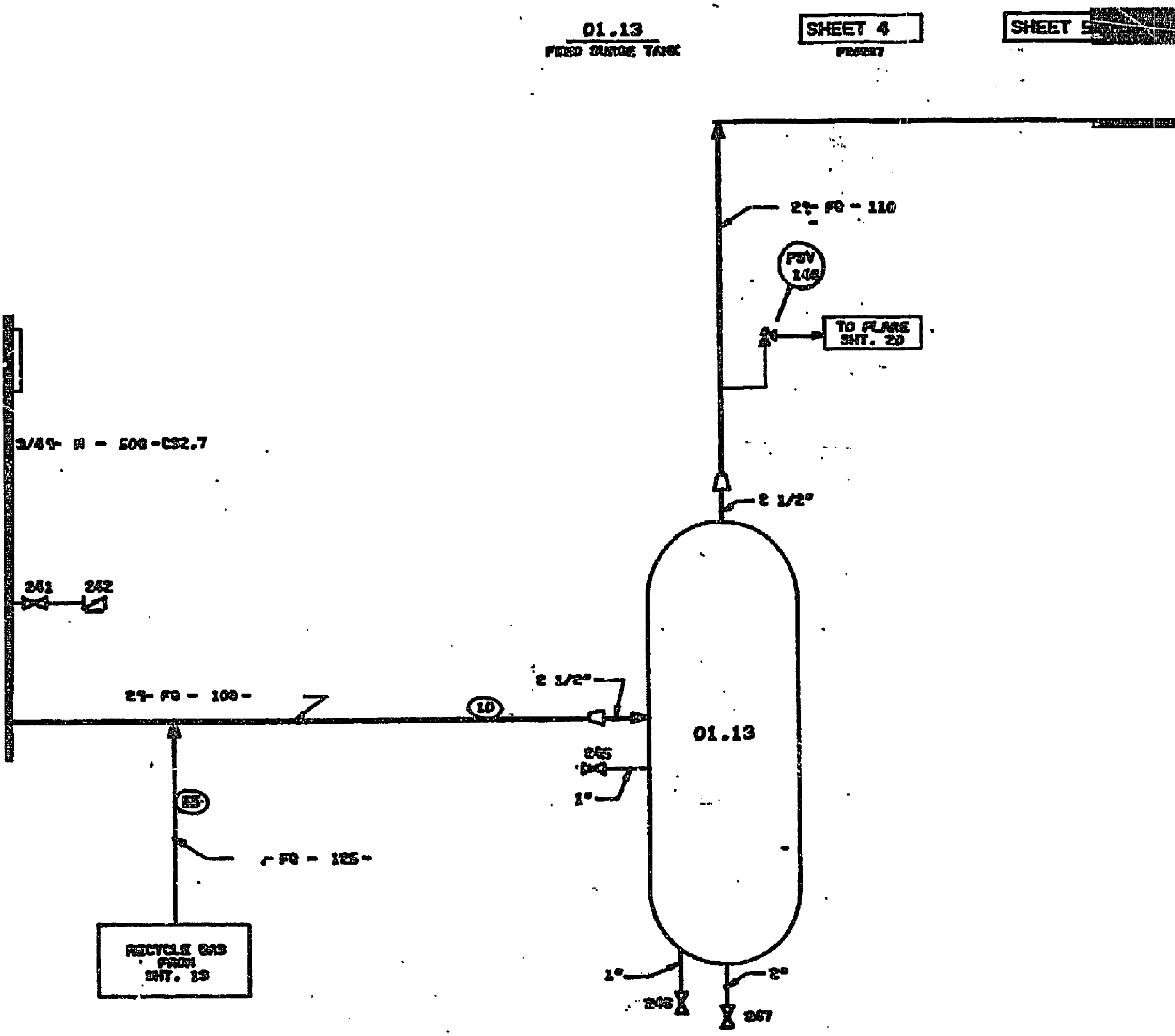


SHEET 3
01.10
SEPARATOR
FILTER
SUCTION SNUBBER
1ST STAGE FEED
DISCHARGE SNUBBER
TO VENT
PURGE OUT TO VENT
VENT
PDI 130
PSV 127
PI 132
TI 131
PI 134
PSV 135
TI 141
TI 137

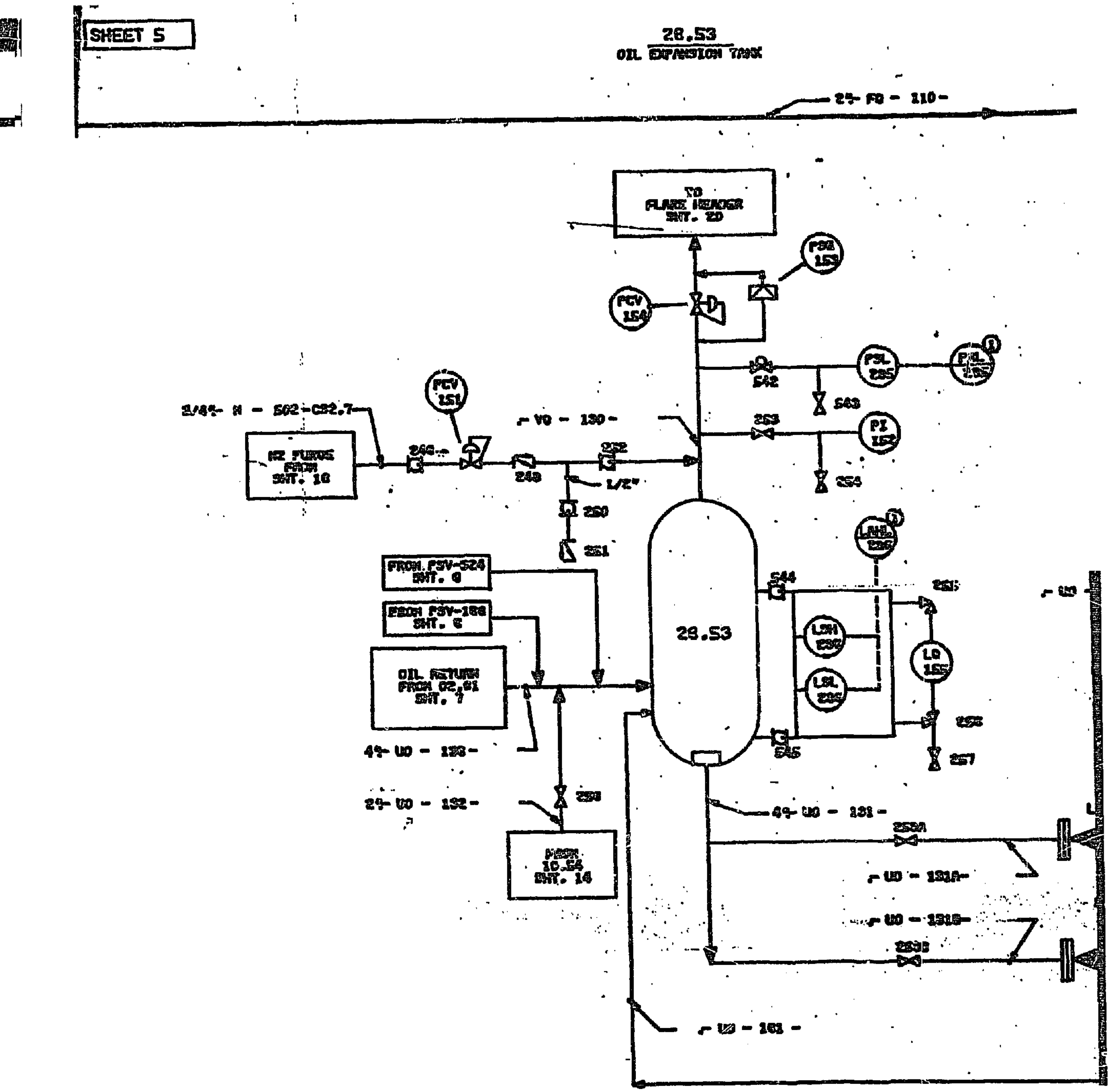


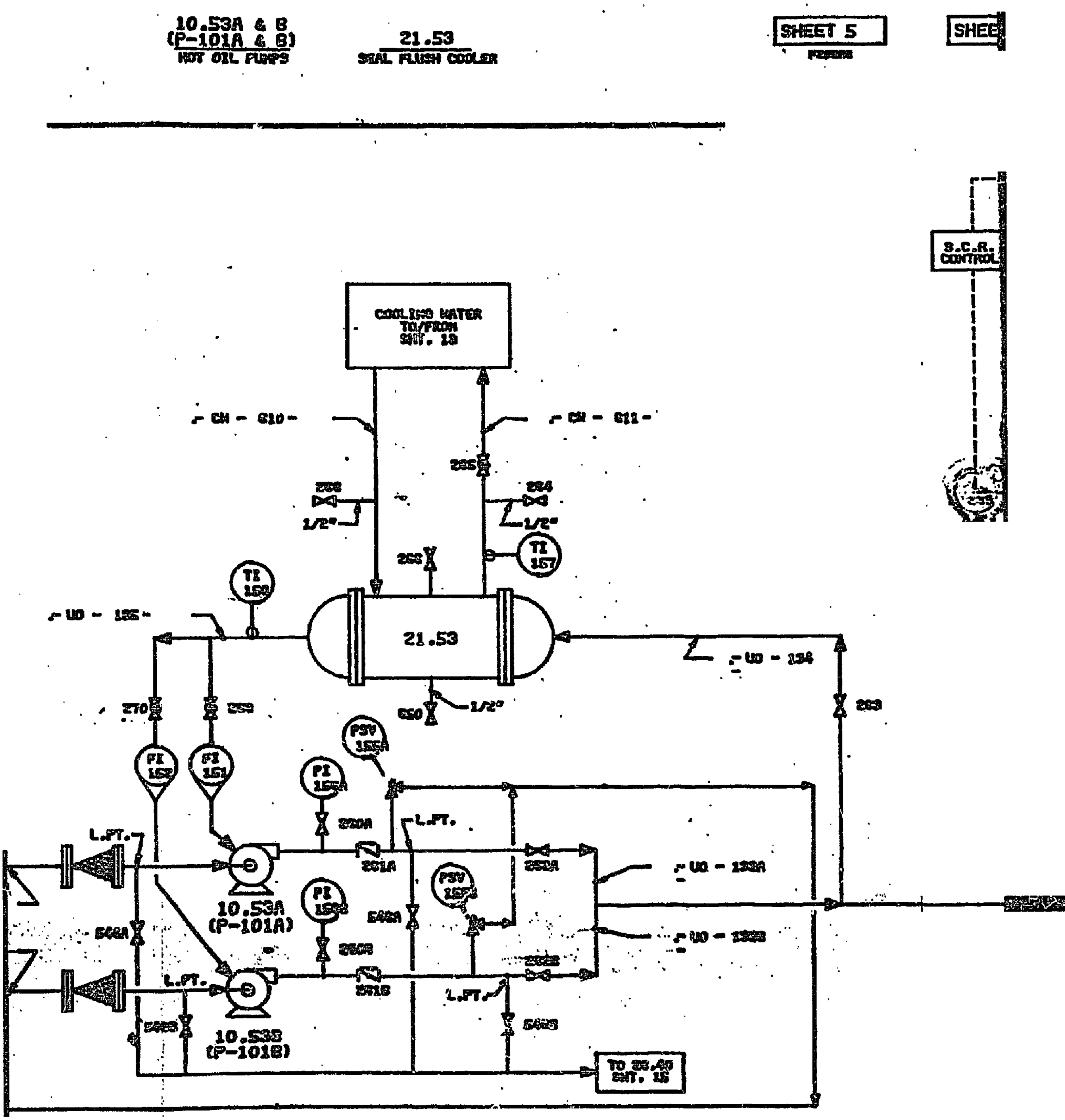
01.14
RECYCLE COOLER
01.14
SHEET 3
PI 147
TI 166
COOLING WATER TO/FROM SHT. 12
FROM 01.20 TO PSV'S SHT. 13
PSV 122
APCI 01.10
TI 142
SUCTION SNUBBER & SEP.
2ND STAGE FEED
APCI 01.10
TI 143
TSV 164
TSV 164
PI 145
DISCHARGE SNUBBER
BLOWDOWN TANK
LG 168


SHEET 4
TO FLARE HEADER SHT. 20
FROM
SHT. 3
F.C.
N2 PURGE FROM
3/4"
244
241
240
541
237


01.13
FEED SURGE TANK
SHEET 4
SHEET 5
PSV
TO FLARE
SHT. 20
2 1/2"
01.13
1"
2"
247
RECYCLE GAS
FROM
SHT. 13
241
242

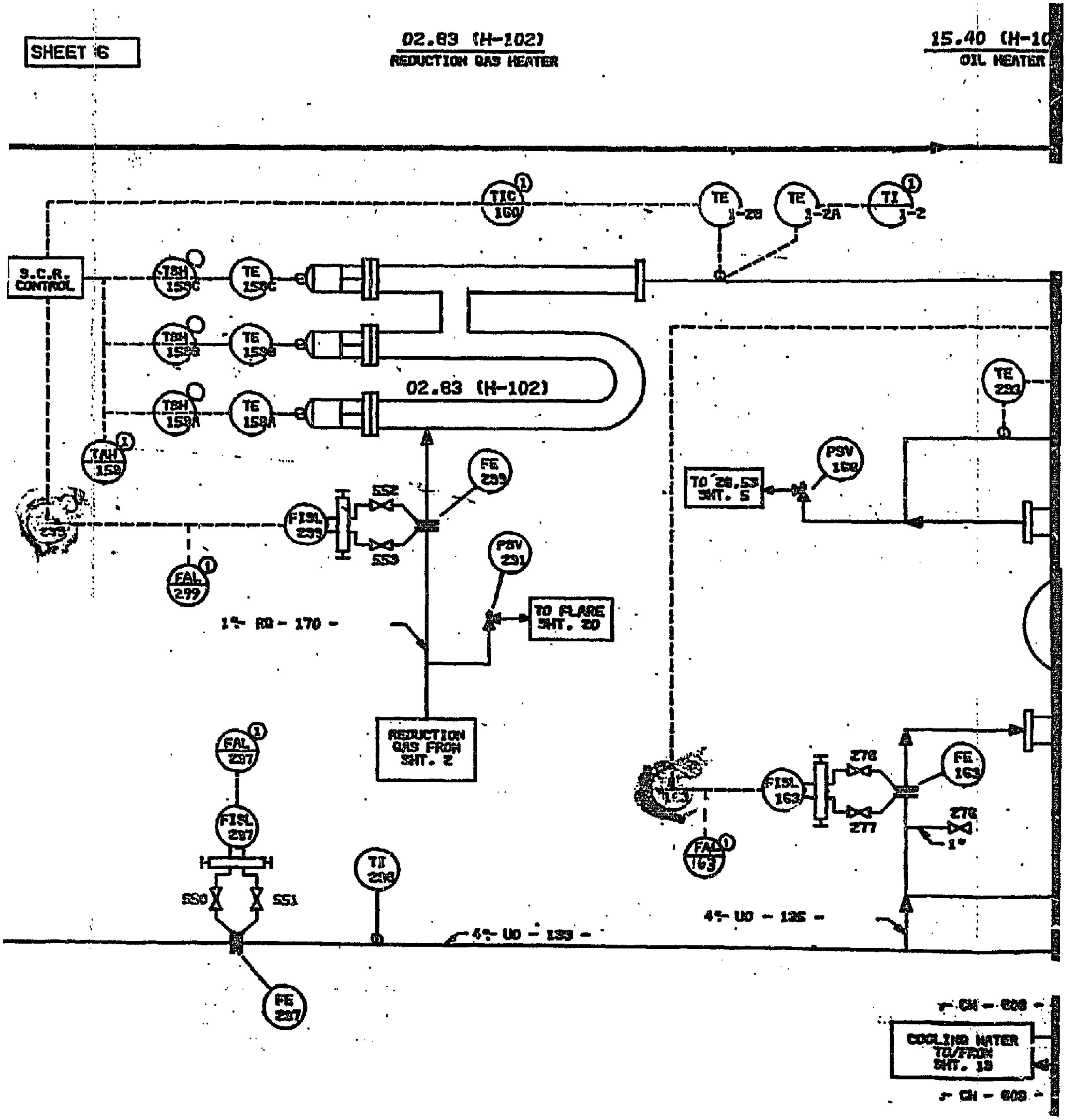
p


SHEET 5
28.53
OIL EXPANSION TANK
TO FLARE HEADER
PCV 154
PCV 151
PSL
PI
LSH
LSL
LG
OIL RETURN
28.53

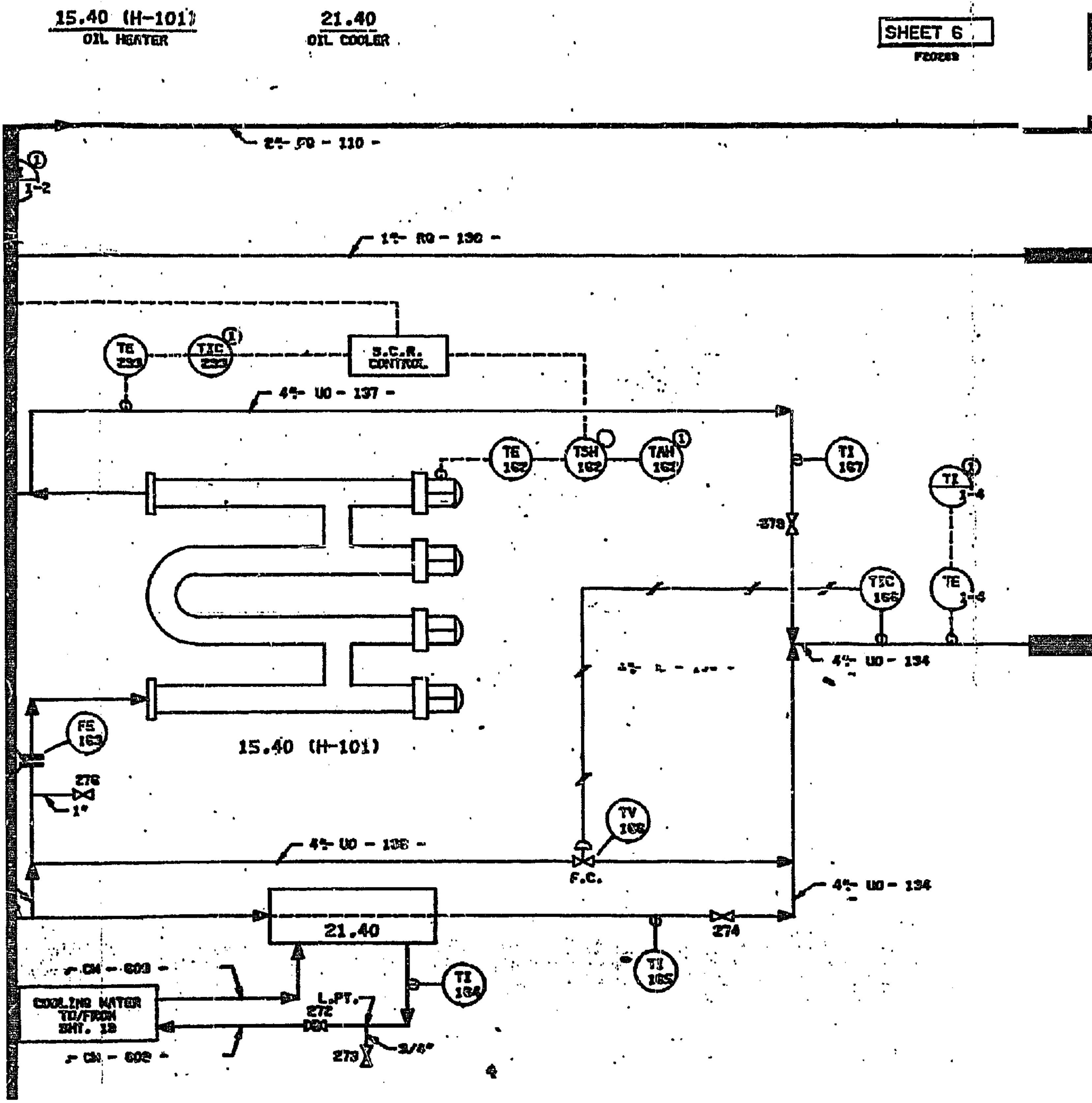


10.53A & B
(P-101A & B)
HOT OIL PUMPS
21.53
SEAL FLUSH COOLER
SHEET 5
PIPING
SHEE
S.C.R.
CONTROL
COOLING WATER
TO/FROM
SHT. 13
CW - 610
CW - 611
1/2"
TI 157
TI 158
UO - 135
21.53
UO - 134
1/2"
650
270
PI 152
PI 151
PSV 155A
PI 155A
L.PT.
10.53A
(P-101A)
10.53B
(P-101B)
PSV
UO - 133A
UO - 133B
TO 25.45
SHT. 15

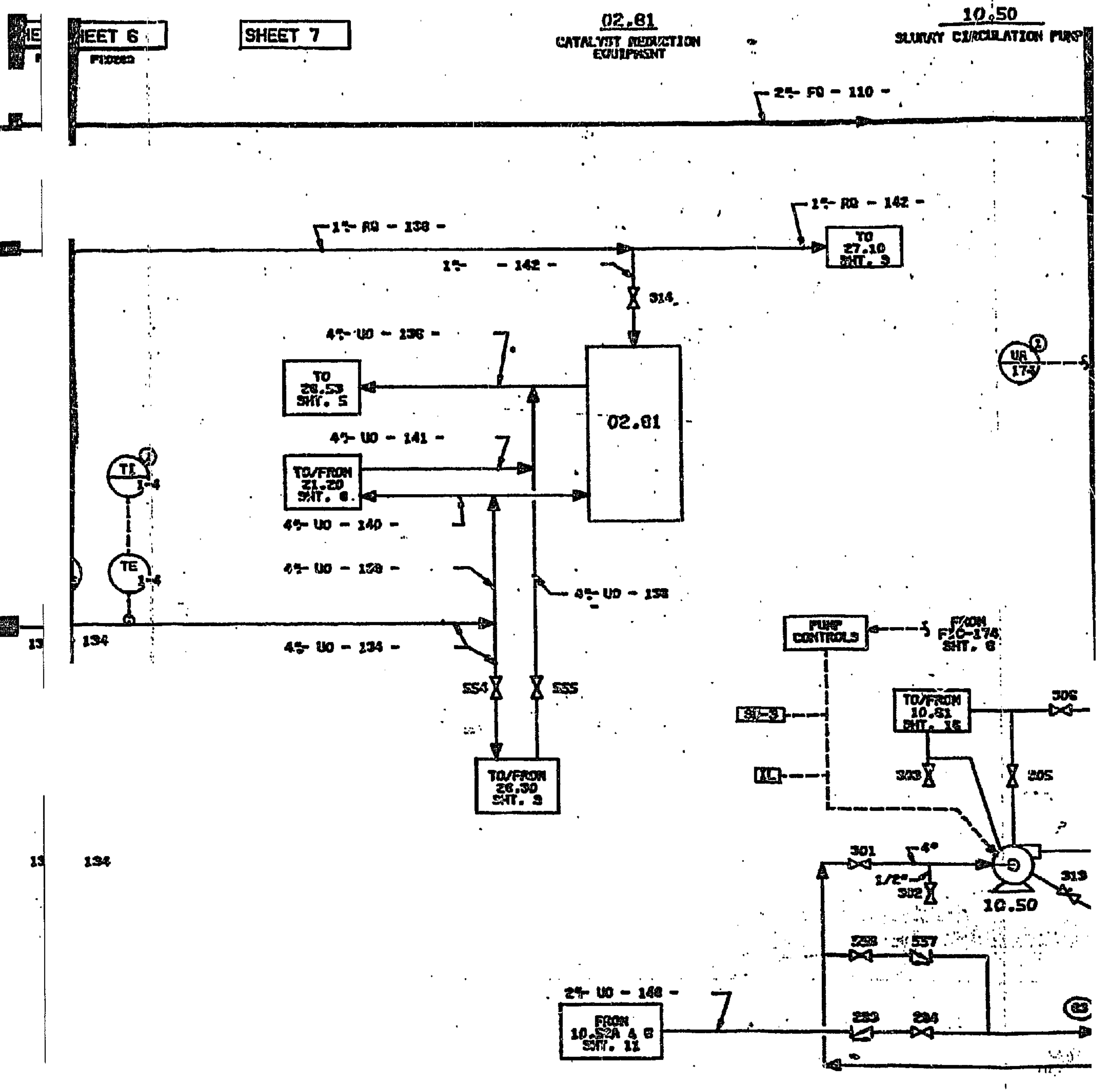
p

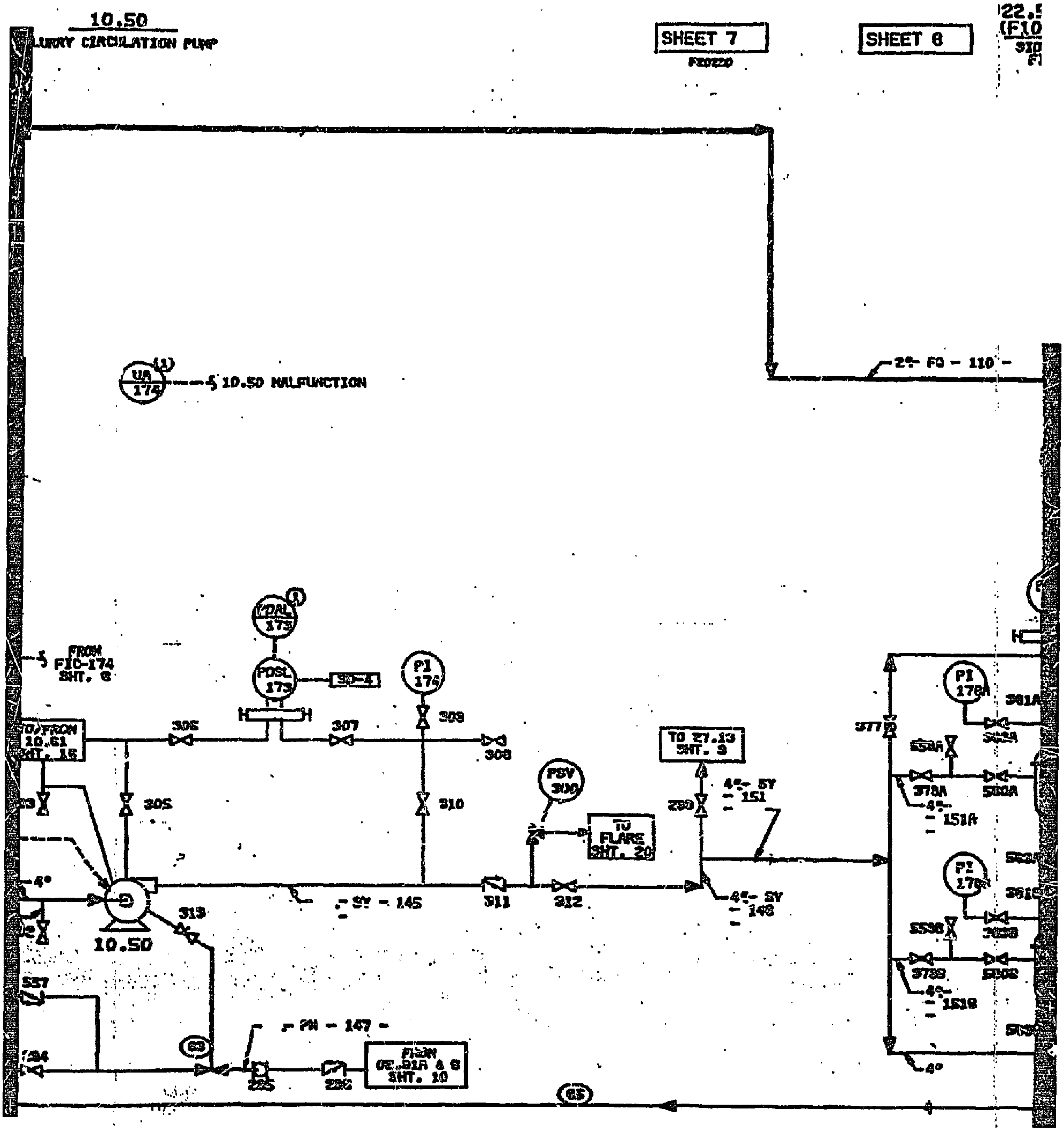

SHEET 6
02.83 (H-102)
REDUCTION GAS HEATER
15.40 (H-10
OIL HEATER
TIC 160
TE 1-2B
TE 1-2A
TI 1-2
S.C.R. CONTROL
TSH 159C
TE 159C
TSH 159B
TE 159B
TSH 159A
TE 159A
02.83 (H-102)
TAH 159
FE 299
552
553
FISL 299
FAL 299
PSV 291
TO FLARE SHT. 20
1"- RG - 170 -
REDUCTION GAS FROM SHT. 2
TE 293
PSV 160
TO 28.53 SHT. 5
FAL 297
FISL 297
550
551
TI 298
FE 297
4"- UO - 139 -
4"- UO - 135 -
276
277
278
1"
FISL 163
FE 163
FAL 163
CH - 608
COOLING WATER TO/FROM SHT. 19
CH - 609

p

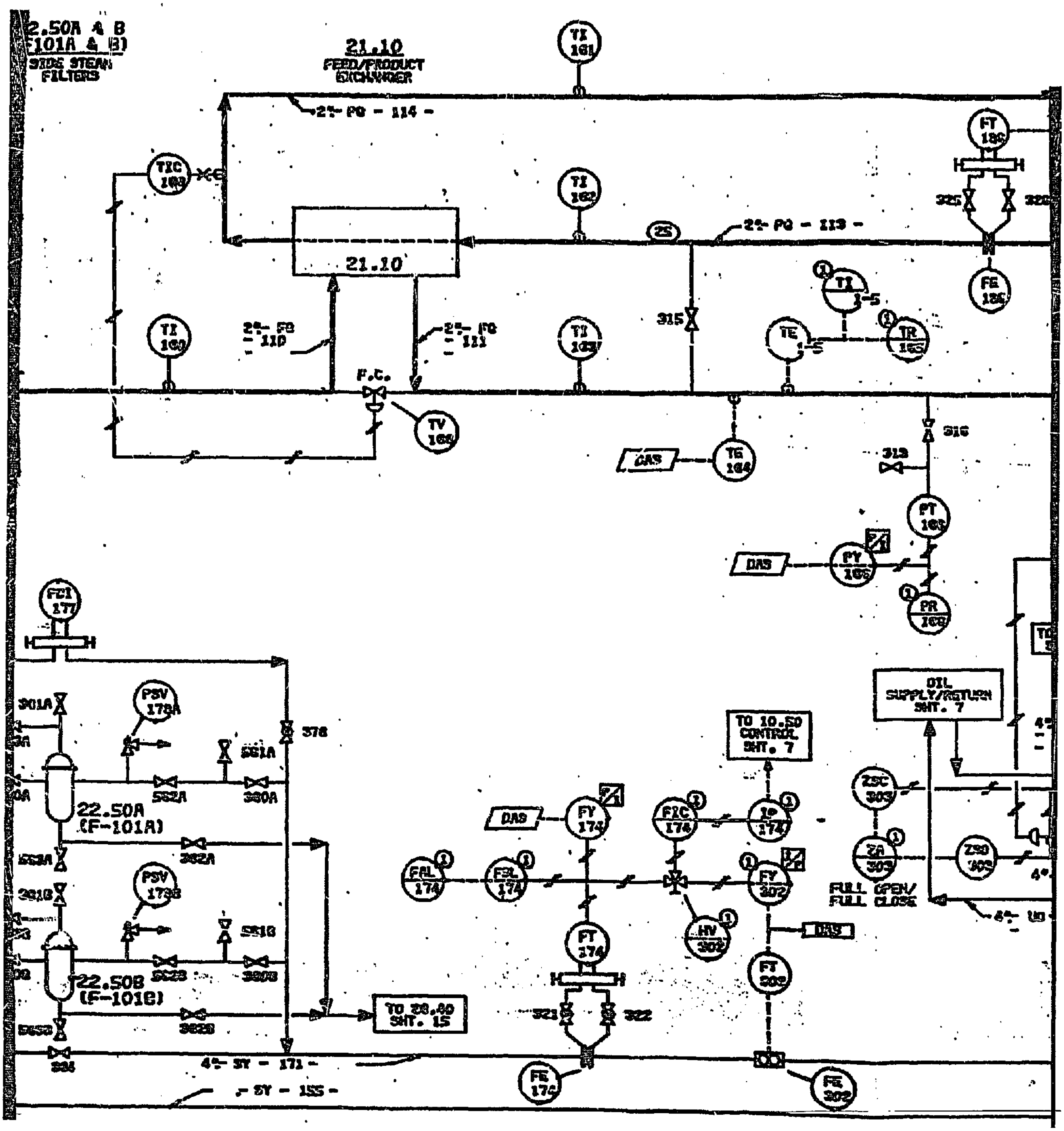

15.40 (H-101)
OIL HEATER
21.40
OIL COOLER
2"- FO - 110 -
1"- RO - 130 -
S.C.R. CONTROL
TE 233
TIC 233
4"- UO - 137 -
TE 162
TSH 162
TAH 162
TI 167
TI 1-4
TE 1-4
TIC 166
4"- UO - 134
15.40 (H-101)
FS 163
276
1"
TV 168
4"- UO - 136 -
F.C.
4"- UO - 134
21.40
274
TI 165
TI 164
COOLING WATER TO/FROM SHT. 18
- CW - 603 -
- CW - 602 -
L.PT.
272
DRN
273
3/4"

4

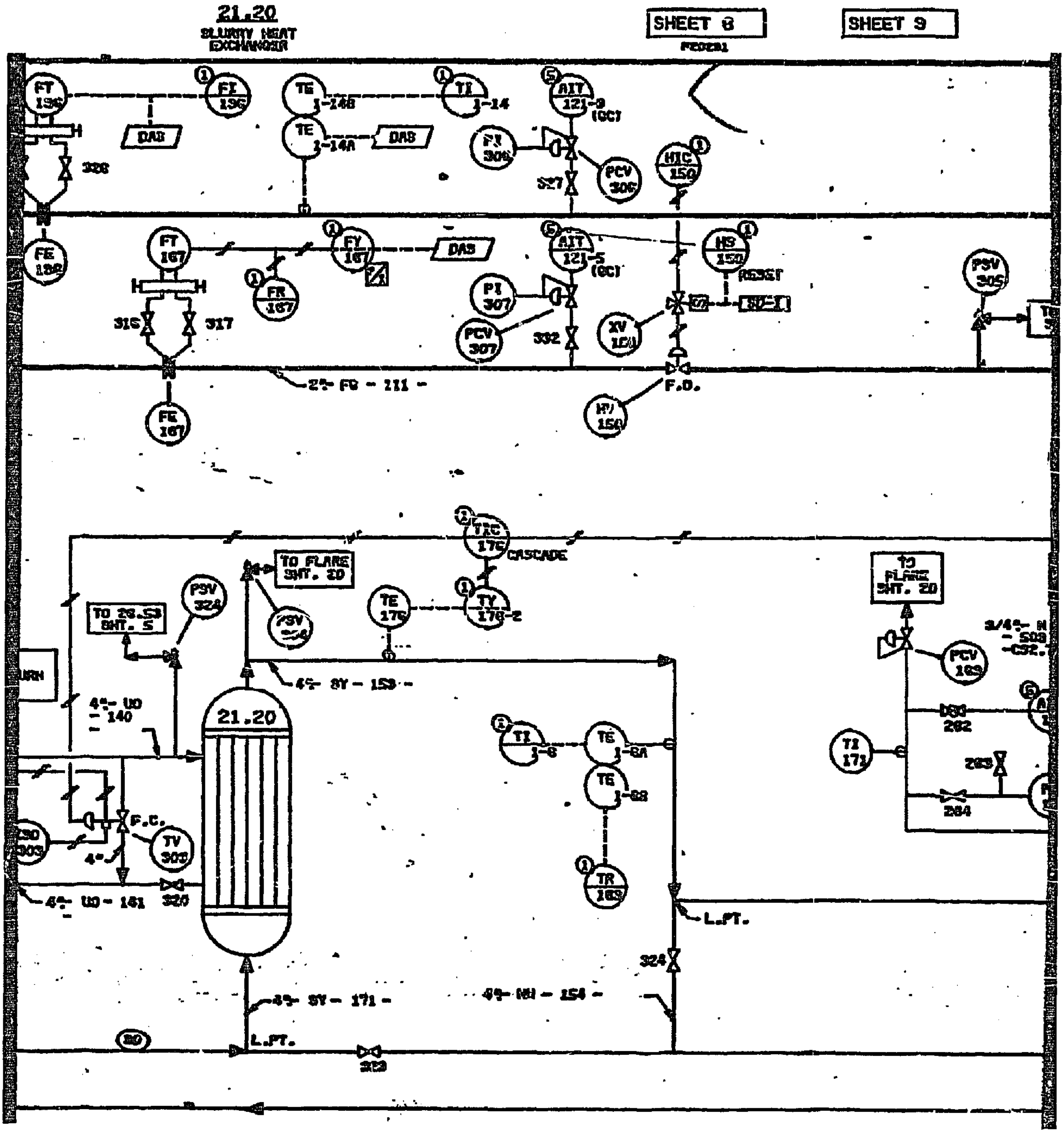

SHEET 6
SHEET 7
02.81
CATALYST REDUCTION EQUIPMENT
10.50
SLURRY CIRCULATION PUMP
2"- FO - 110 -
1"- RO - 142 -
1"- RO - 138 -
TO 27.10 SHT. 9
1" - 142 -
314
4"- UO - 136 -
TO 26.53 SHT. 5
02.81
4"- UO - 141 -
TO/FROM 21.20 SHT. 6
4"- UO - 140 -
4"- UO - 138 -
4"- UO - 139
134
4"- UO - 134 -
554
555
TO/FROM 26.30 SHT. 9
PUMP CONTROLS
FROM FIC-174 SHT. 6
TO/FROM 10.51 SHT. 16
306
303
305
301
4"
1/2"
302
10.50
319
558
557
2"- UO - 148 -
FROM 10.52A & B SHT. 11
293
294
134


10.50
LURRY CIRCULATION PUMP
SHEET 7
SHEET 8
2"- FO - 110 -
10.50 MALFUNCTION
FROM
FIC-174
SHT. 8
PI
174
PI
178A
PI
178B
TO/FROM
10.61
SHT. 16
306
307
309
308
305
310
PSV
TO
FLARE
SHT. 20
TO 27.13
SHT. 9
4"- SY
- 151
311
312
313
- SY - 145
4"- SY
- 148
10.50
- PH - 147 -
FROM
02.31A & B
SHT. 10
377
373A
373B
4"-
- 151A
4"-
- 151B
4"

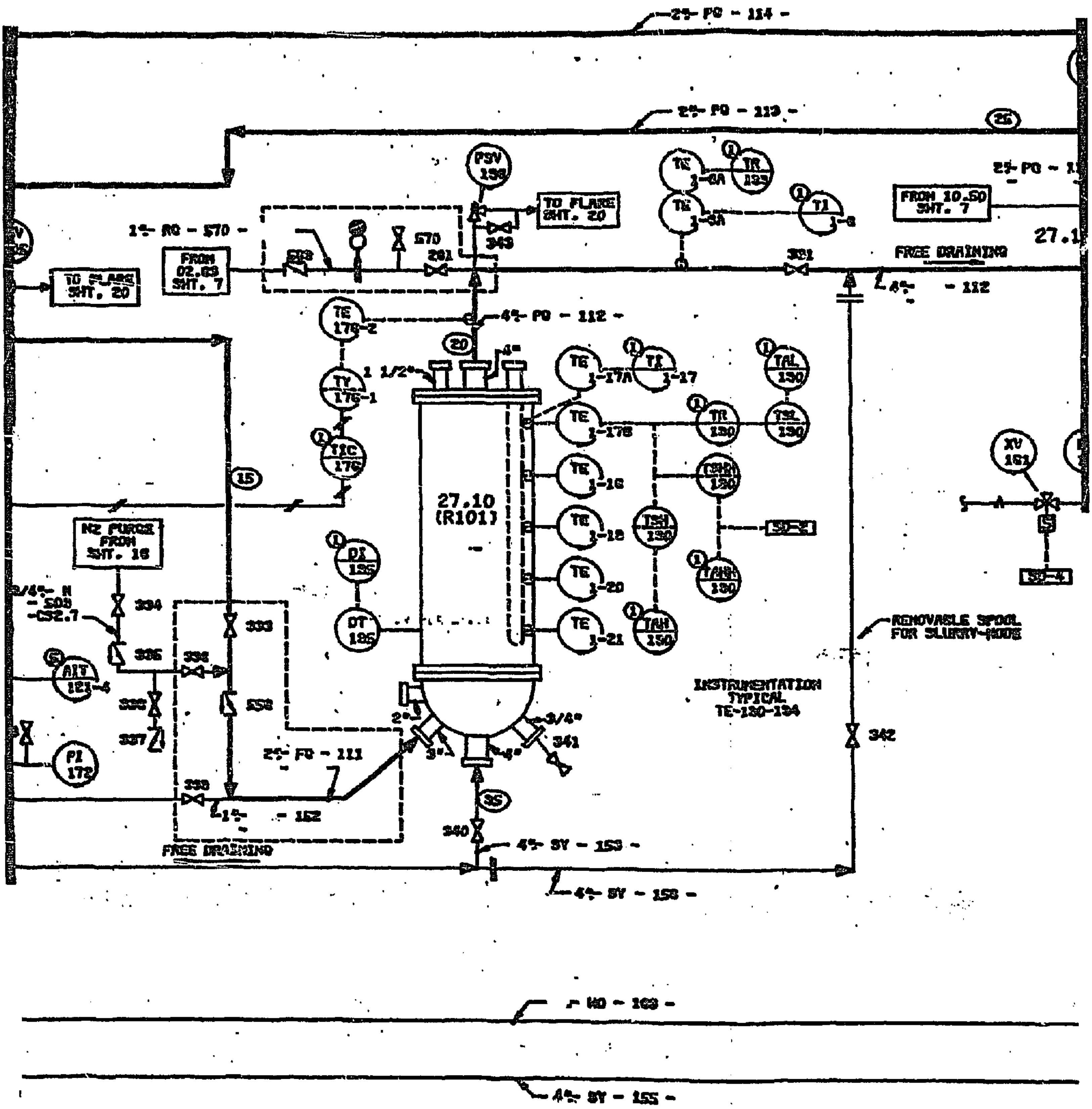
p



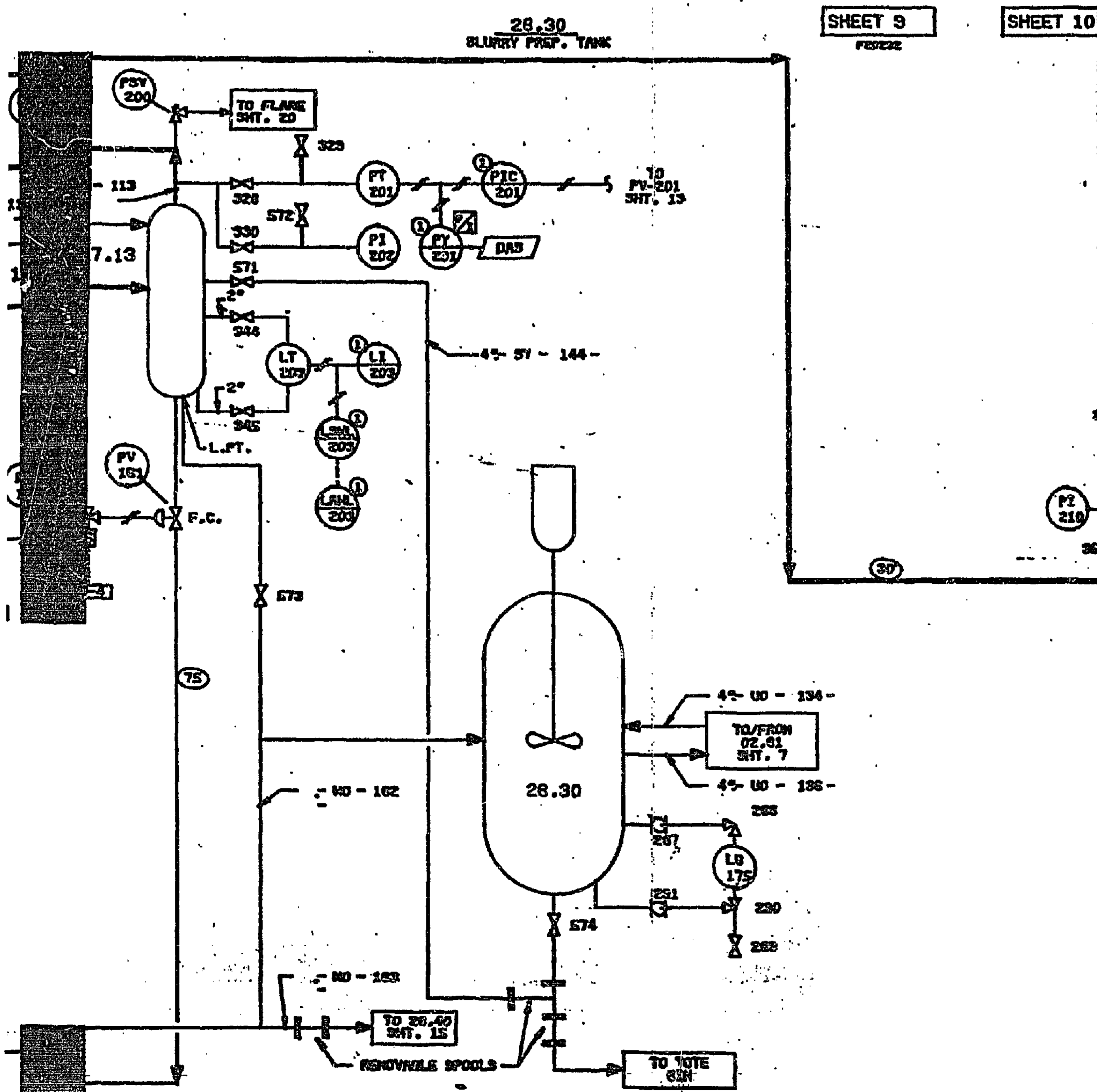
2.50A & B
F101A & B)
SIDE STEAM FILTERS
21.10
FEED/PRODUCT EXCHANGER
TI 161
2"- PG - 114 -
FT 186
TIC 160
TI 162
25
2"- PG - 113 -
325
326
21.10
FE 186
TI 1-5
315
TI 160
2"- PG - 110
2"- PG - 111
F.C.
TI 163
TE 1-5
TR 165
TV 160
DAS
TE 164
316
313
PT 166
DAS
PY 166
PR 166
FQI 177
301A
PSV 178A
378
561A
562A
380A
22.50A
(F-101A)
563A
382A
301B
PSV 178B
561B
562B
380B
22.50B
(F-101B)
565B
382B
TO 28.60 SHT. 15
384
4"- SY - 171 -
- SY - 155 -
OIL SUPPLY/RETURN SHT. 7
TO 10.50 CONTROL SHT. 7
DAS
FY 174
FIC 174
IP 174
ZSC 303
ZA 303
ZSO 303
FAL 174
FSL 174
FY 302
FULL OPEN/ FULL CLOSE
HV 302
DAS
FT 174
FT 302
321
322
FE 174
FE 302



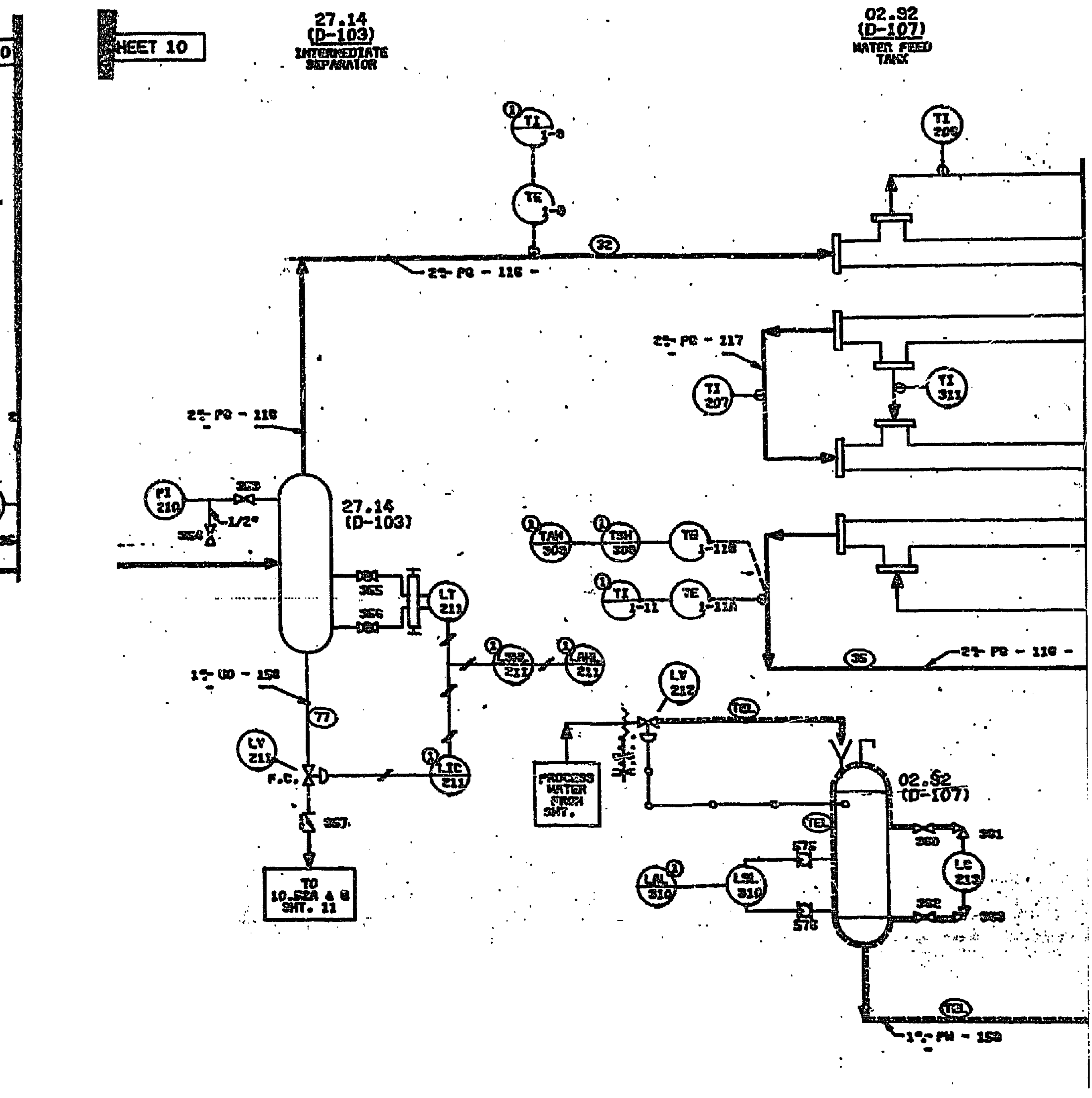
21.20
SLURRY HEAT EXCHANGER
SHEET 8
SHEET 9
FT 196
FI 196
DAS
TE 1-14B
TE 1-14A
TI 1-14
AIT 121-9 (GC)
PI 306
PCV 306
HIC 150
FE 182
FT 167
FY 167
FR 167
AIT 121-5 (GC)
HS 150
RESET
PI 307
PCV 307
XV 150
PSV 305
316
317
332
2"- FG - 211 -
F.O.
HY 150
FE 167
TIC 176
CASCADE
TO FLARE SHT. 20
TE 176
TY 176-2
PSV 324
TO 26.53 SHT. 5
4"- SY - 153 -
4"- UO - 140
21.20
F.C.
TV 303
4"- UO - 161
320
TI 1-8
TE 1-8A
TE 1-8B
TR 183
L.PT.
324
4"- SY - 171 -
4"- NH - 154 -
L.PT.
323
TI 171
PCV 183
282
283
284
3/4"- N



2" - PG - 114 -
2" - PG - 113 -
2" - PG - 1
1" - RG - 570 -
TO FLARE SHT. 20
FROM 02.03 SHT. 7
TO FLARE SHT. 20
FROM 10.50 SHT. 7
PSV 156
343
570
281
301
FREE DRAINING
4" - 112
4" - PG - 112 -
27.1
TE 176-2
TY 176-1
TIC 176
1 1/2"
4"
27.10 (R101)
TE 1-17A
TI 1-17
TAL 130
TE 1-17B
TR 130
TSL 130
TE 1-18
TE 1-19
TE 1-20
TE 1-21
TSH 130
TAHH 130
TAH 130
XV 161
N2 PURGE FROM SHT. 16
DI 135
DT 135
AIT 121-4
PI 172
334
333
336
335
338
337
339
2" - PG - 111
- 152
FREE DRAINING
2"
3"
4"
3/4"
341
340
4" - SY - 153 -
4" - SY - 158 -
342
REMOVABLE SPOOL FOR SLURRY-MODE
INSTRUMENTATION TYPICAL TE-130-134
- WO - 103 -
4" - SY - 155 -

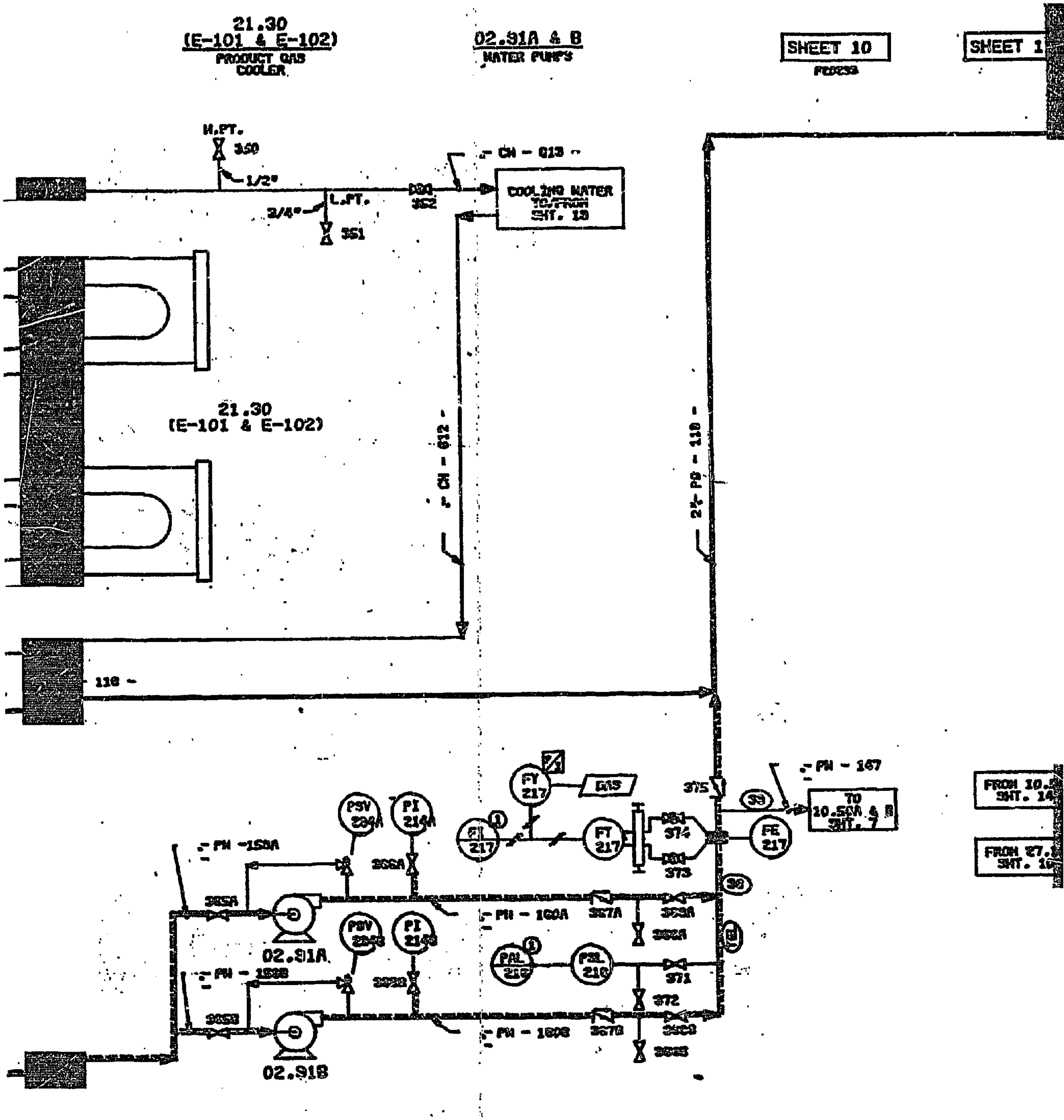


28.30
SLURRY PREP. TANK
SHEET 9
SHEET 10
PSV 200
TO FLARE SHT. 20
329
328
PT 201
PIC 201
TO PV-201 SHT. 13
572
330
PI 202
PY 201
DAS
571
344
LT 103
LI 203
4"- 57 - 144 -
345
LSHL 203
LAHL 203
L.PT.
PV 161
F.C.
573
75
30
PI 210
4"- UO - 134 -
TO/FROM 02.61 SHT. 7
4"- UO - 136 -
28.30
WO - 162
267
LS 175
251
230
574
WO - 163
TO 28.40 SHT. 15
REMOVABLE SPOOLS
TO TOTE BIN
7.13
113

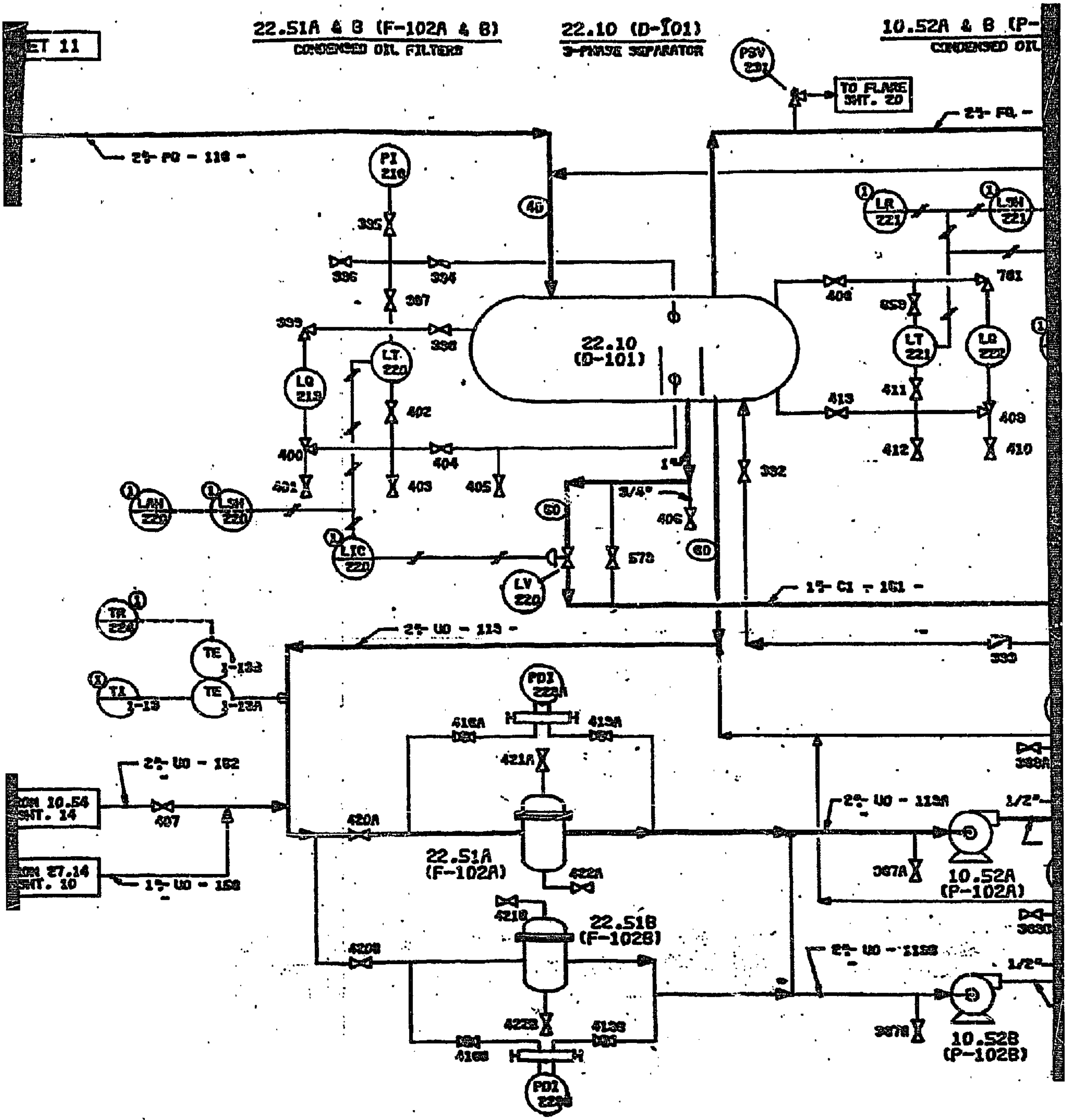


HEET 10
27.14
(D-103)
INTERMEDIATE SEPARATOR
02.92
(D-107)
WATER FEED TANK
2" - PG - 116 -
2" - PG - 117
2" - PG - 118
2" - PG - 119 -
1" - UD - 158
1" - PW - 159
PI 210
LT 211
LIC 211
LV 211
LV 212
F.C.
TI 207
TI 311
TAH 309
TSH 309
TI 1-11
PROCESS WATER FROM SHT.
TO 10.52A & B SHT. 11
LAL 310
LSL 310
LG 213
02.92
(D-107)

p

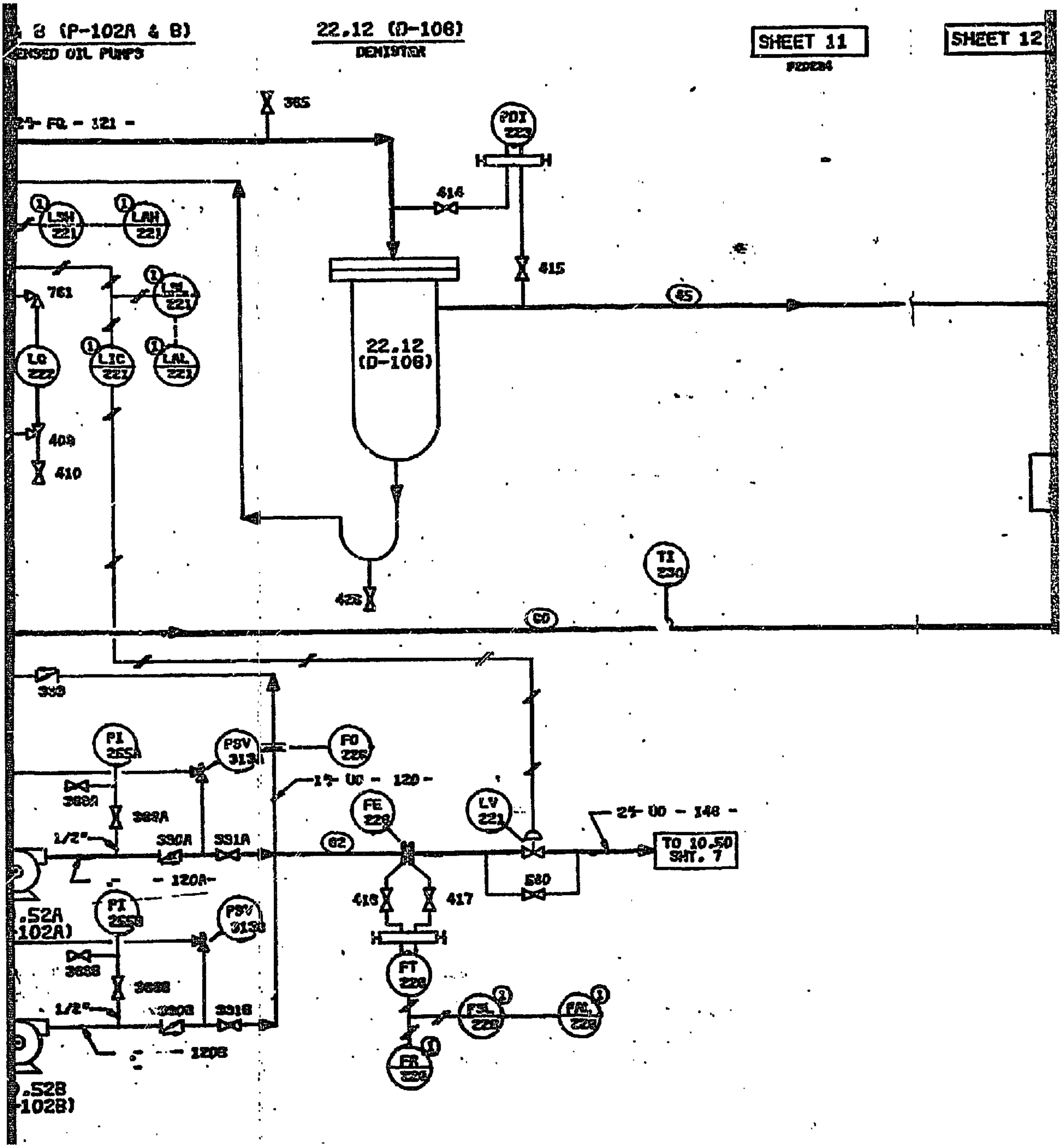


21.30
(E-101 & E-102)
PRODUCT GAS COOLER
02.91A & B
WATER PUMPS
SHEET 10
SHEET 1
H.PT.
350
1/2"
L.PT.
3/4"
351
352
CW - 613
COOLING WATER TO/FROM SHT. 13
21.30
(E-101 & E-102)
CW - 612
2" - PG - 110
110
PW - 167
375
TO 10.50A & B SHT. 7
FROM 10.5 SHT. 14
FY 217
GAS
FI 217
FT 217
FE 217
374
373
PSV
PI 214A
PSV
PI
PW - 158A
PW - 158B
365A
365B
366A
02.91A
02.91B
PW - 160A
PW - 160B
367A
367B
PAL
PSL 218
371
372

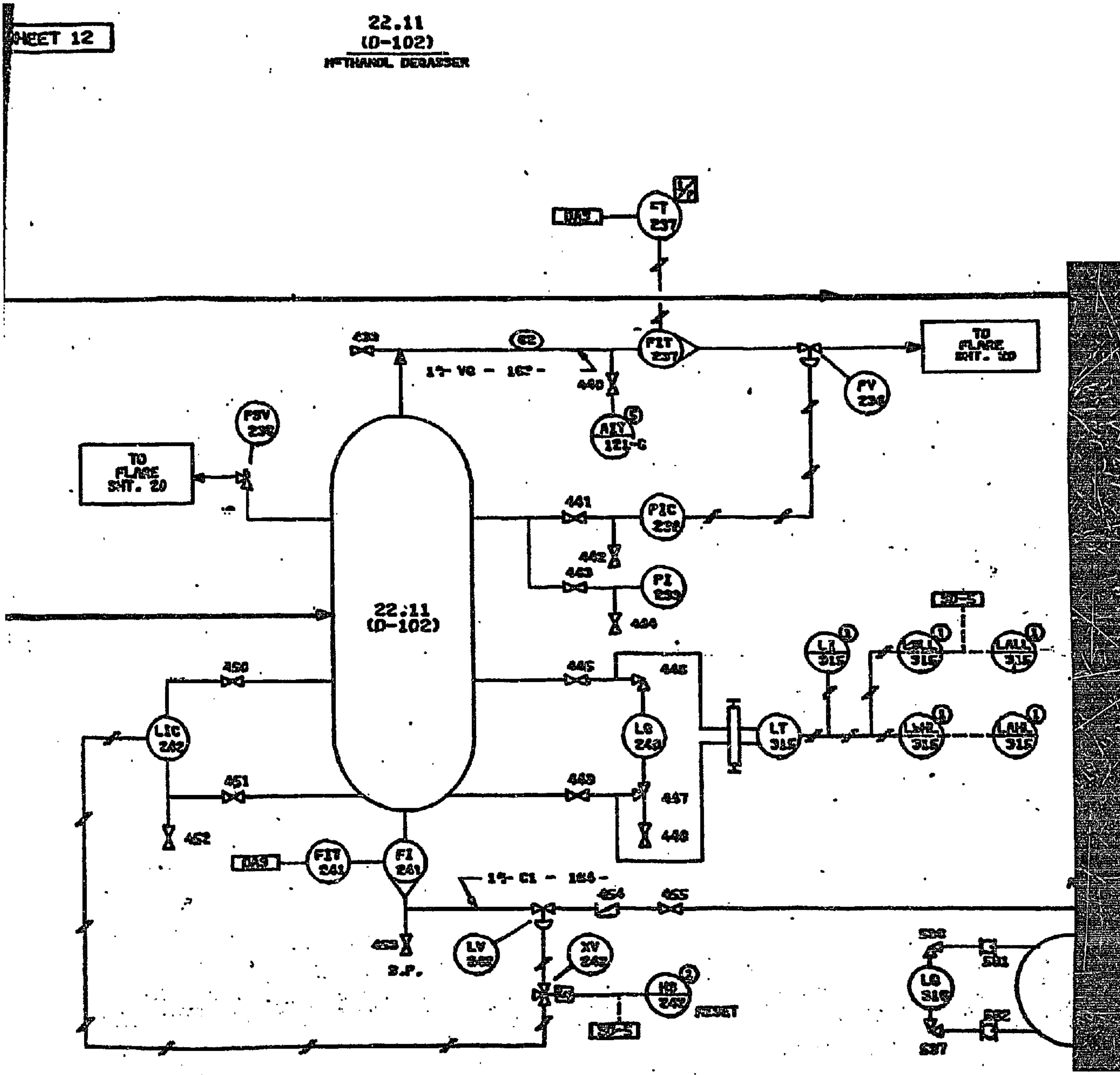


SHEET 11
22.51A & B (F-102A & B)
CONDENSED OIL FILTERS
22.10 (D-101)
3-PHASE SEPARATOR
10.52A & B (P-
CONDENSED OIL
PSV 201
TO FLARE SHT. 20
2½- PO - 118 -
PI 210
LR 221
LSH 221
22.10 (D-101)
LT 220
LG 219
LT 221
LG 222
LAH 220
LSH 220
LIC 220
LV 220
3/4"
1½- C1 - 101 -
2½- UO - 113 -
TR 224
TE
TI
PDI 223A
FROM 10.54 SHT. 14
FROM 27.14 SHT. 10
2½- UO - 102
1½- UO - 150
2½- UO - 113A
22.51A (F-102A)
22.51B (F-102B)
10.52A (P-102A)
10.52B (P-102B)
2½- UO - 113B
PDI 223B

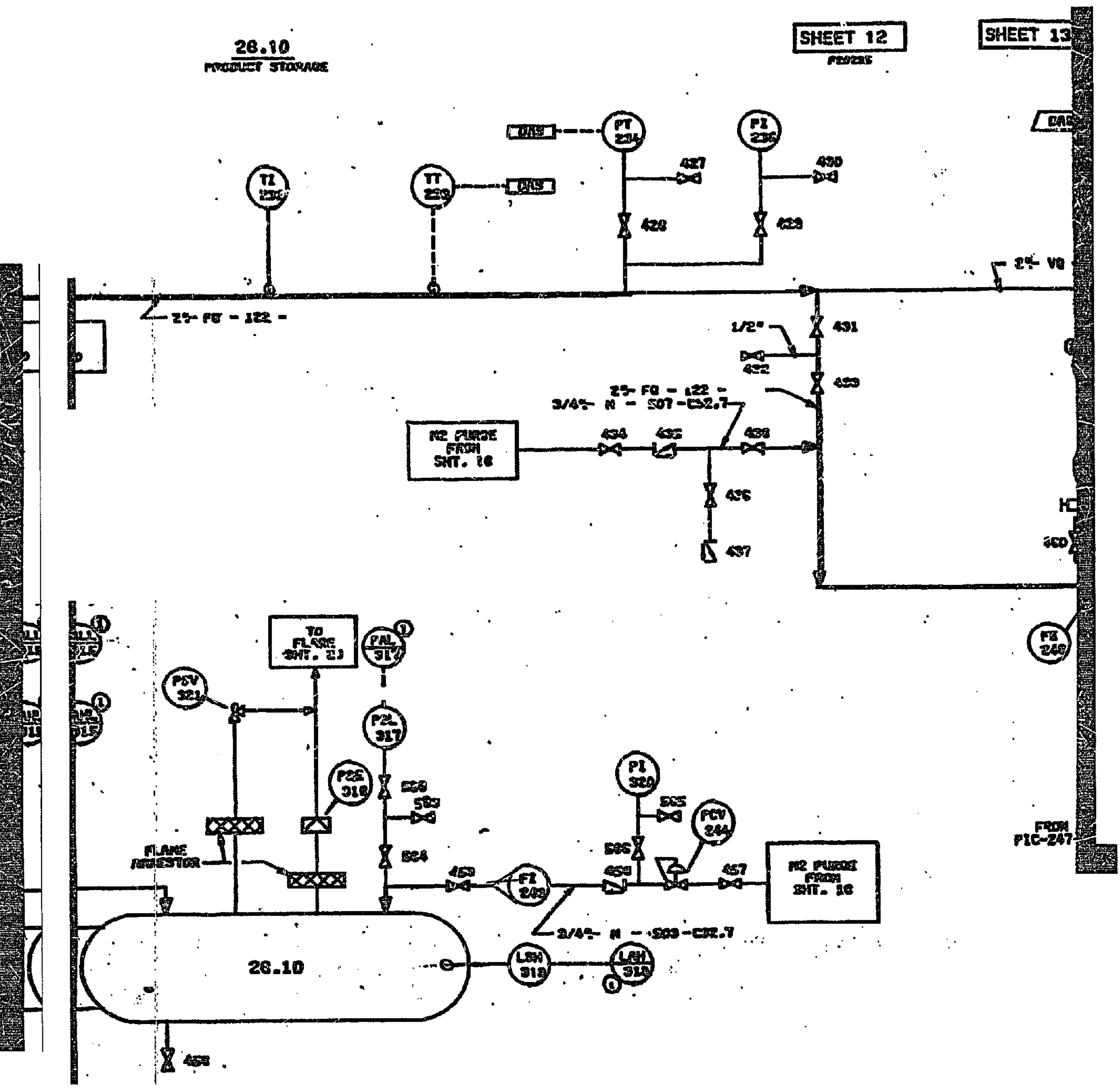
p



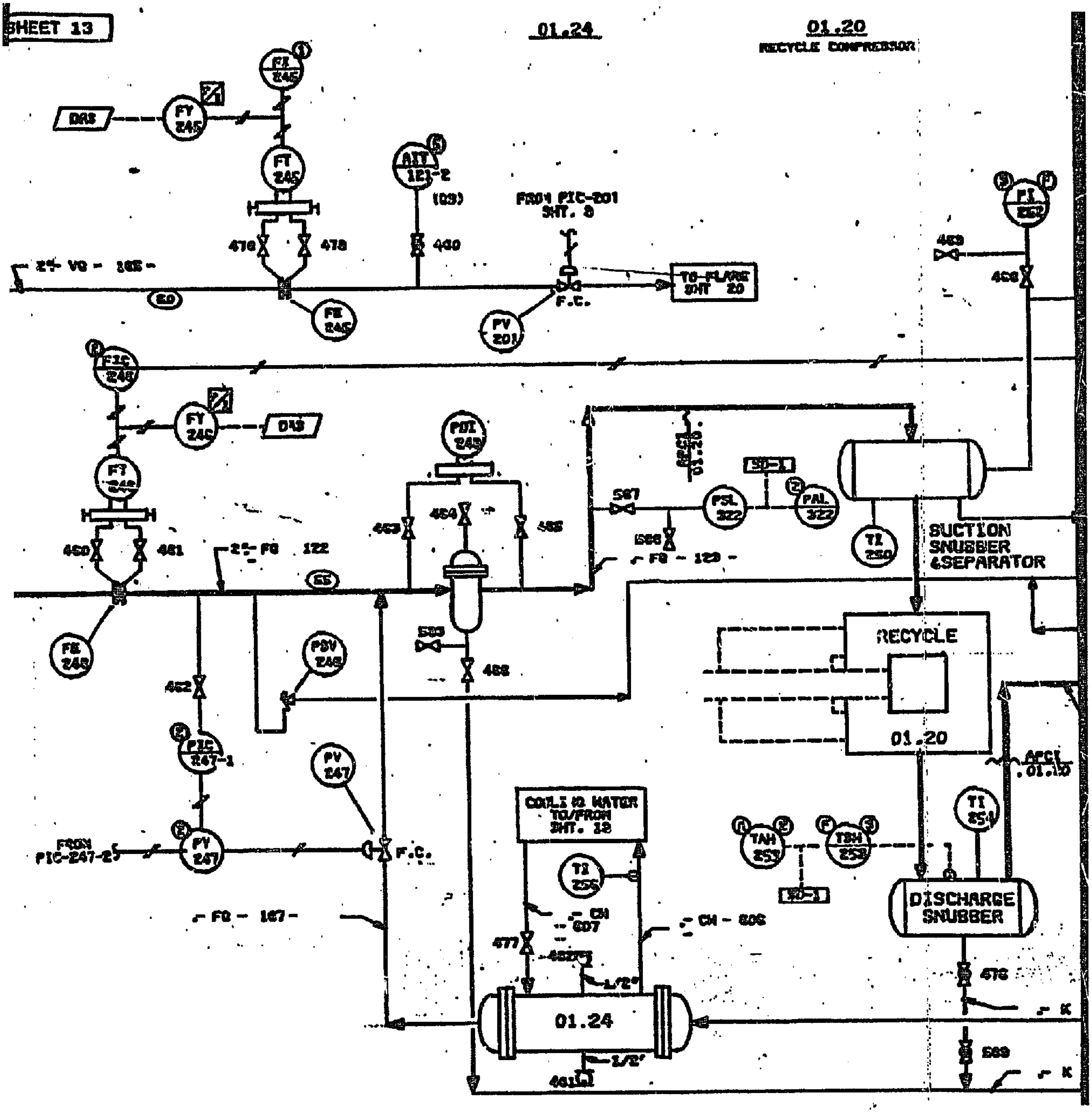
8 (P-102A & B)
ENSED OIL PUMPS
22.12 (D-108)
DEMISTER
SHEET 11
SHEET 12
385
PDI
223
416
415
LSH
221
LAH
221
761
LSL
221
LG
222
LIC
221
LAL
221
22.12
(D-108)
409
410
TI
230
PI
265A
PSV
313A
FO
226
FE
228
LV
221
1½- UO - 120 -
2½- UO - 148 -
TO 10.50
SHT. 7
1/2"
380A
381A
580
416
417
- 120A-
.52A
-102A)
PI
265B
PSV
313B
FT
228
1/2"
380B
381B
- 120B
.52B
-102B)



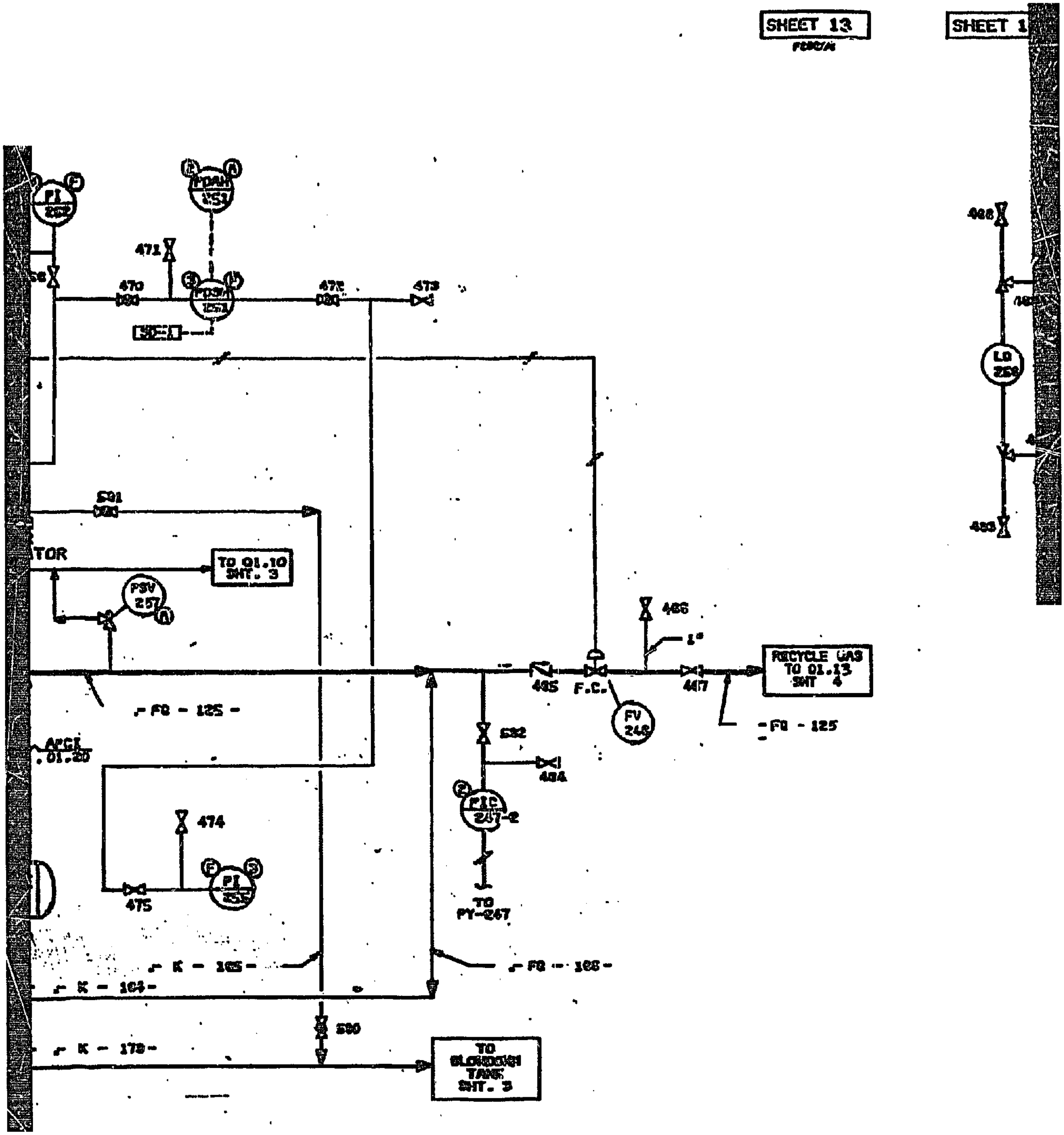
HEET 12
22.11
(D-102)
TO FLARE SHT. 20
FT 237
FIT 237
FV 238
PSV 239
AIY 121-G
PIC 238
PI 239
22.11 (D-102)
LIC 242
LG 243
LT 315
FI 241
FIT 241
LV 242
XV 242
HS 242
RESET
S.P.
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455


26.10
PRODUCT STORAGE
SHEET 12
SHEET 13
PT
PI
TI
TT
427
1/2"
431
433
N2 PURGE
FROM
SHT. 16
437
TO
FLARE
PSV
PAL
PZL
PI
320
PCV
244
FLAME
ARRESTOR
26.10
LSH
LAH
FROM
PIC-247

p

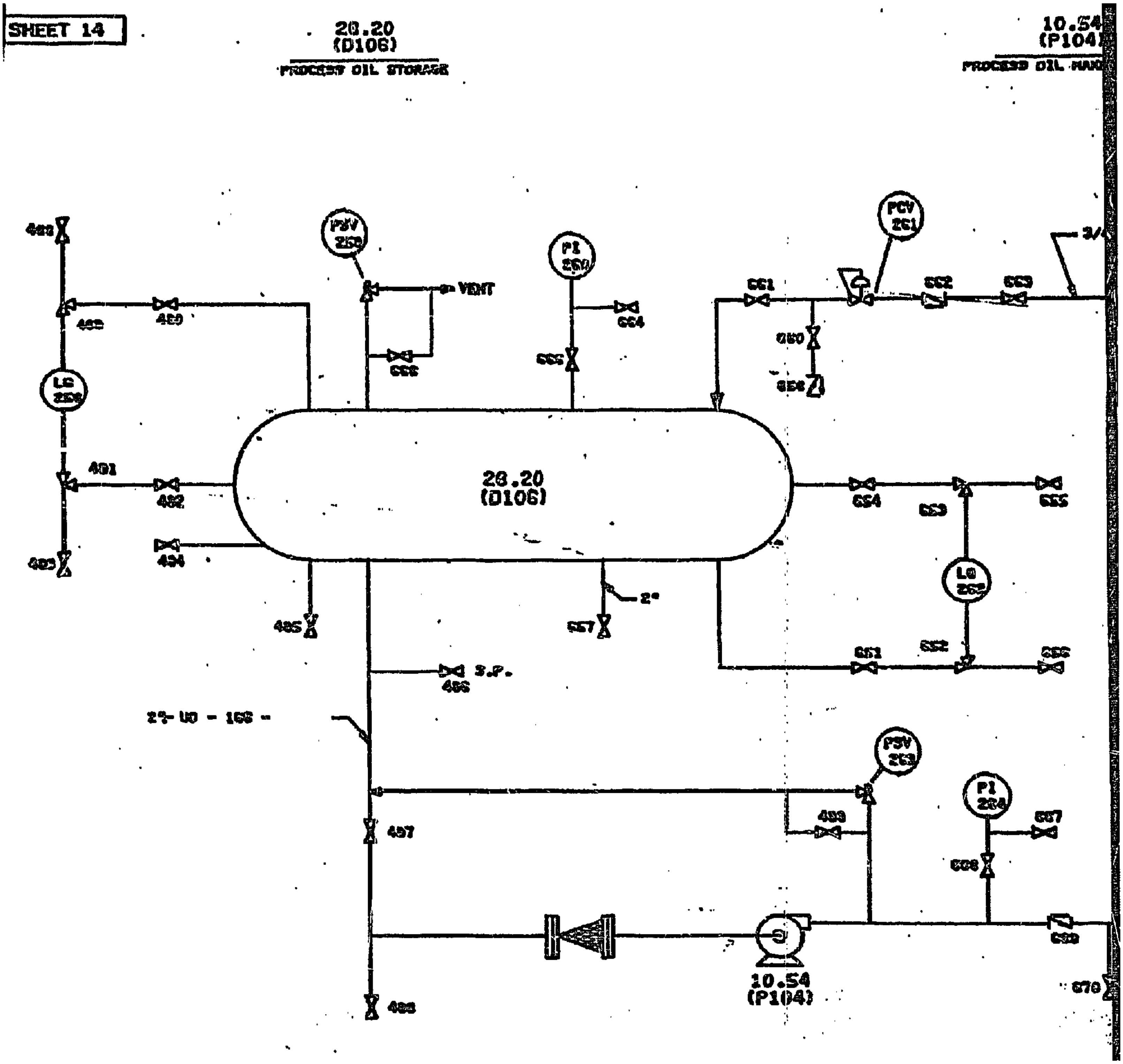


SHEET 13
01.24
01.20
RECYCLE COMPRESSOR
DAS
FY 245
FI 245
FT 245
AIT 121-2
(O2)
440
476
478
FROM PIC-201 SHT. 8
2" - VG - 165 -
TO FLARE SHT 20
F.C.
FE 245
PV 201
FI 252
463
468
FIC 246
FY 246
DAS
FT 246
PDI 249
460
461
2" - FG 122
463
464
465
587
FSL 322
PAL 322
SD-1
588
- FG - 123 -
SUCTION SNUBBER &SEPARATOR
TI 250
FE 246
PSV 246
583
466
462
RECYCLE
01.20
PIC 247-1
PV 247
FROM PIC-247-2
PY 247
F.C.
COOLING WATER TO/FROM SHT. 18
TI 255
TAH 253
TSH 253
SD-1
TI 254
APCI 01.10
DISCHARGE SNUBBER
- FG - 167 -
- CW 607
- CW - 606
477
1/2"
01.24
1/2"
476
589
- K
- K

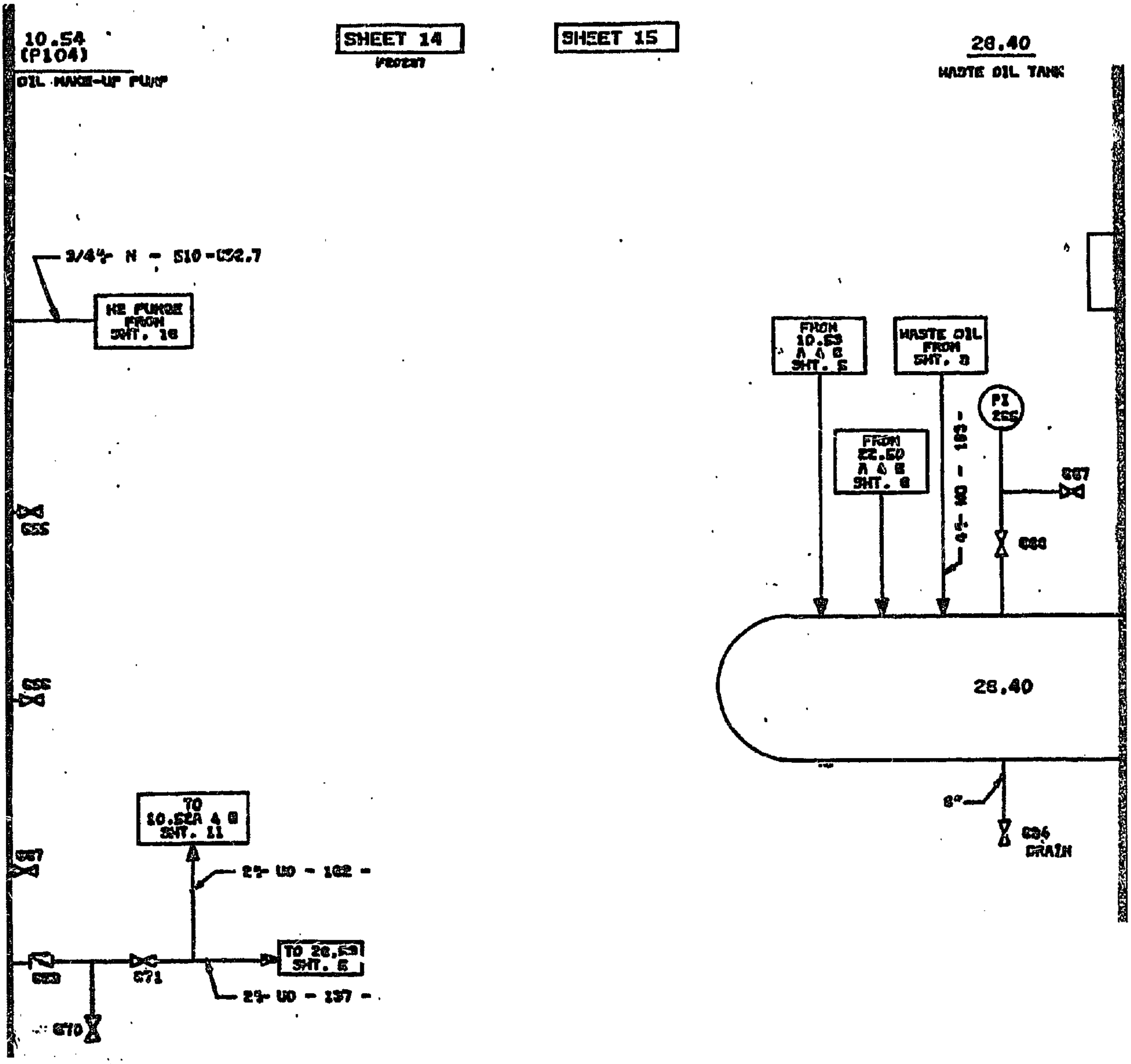


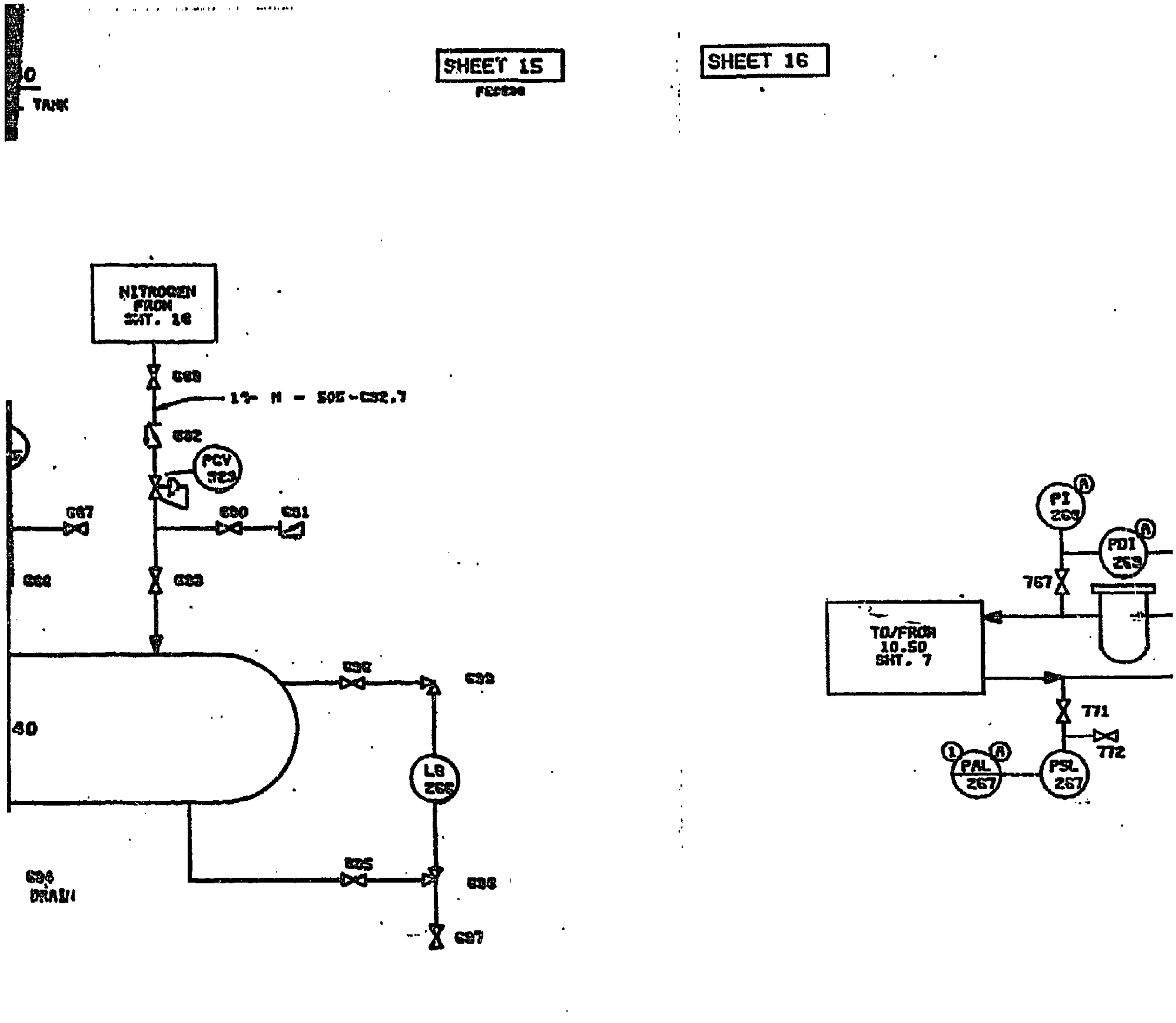
SHEET 13
SHEET 1
FI 252
PDAH 251
471
470
472
473
TO 01.10 SHT. 3
PSV 257
591
TOR
RECYCLE GAS TO 01.13 SHT 4
486
1"
485
F.C.
FV 246
487
FG - 125
592
484
PIC 247-2
TO PY-247
474
FI 255
475
K - 165
FG - 166
K - 164
590
K - 170
TO BLOWDOWN TANK SHT. 3
LG 259

SHEET 14



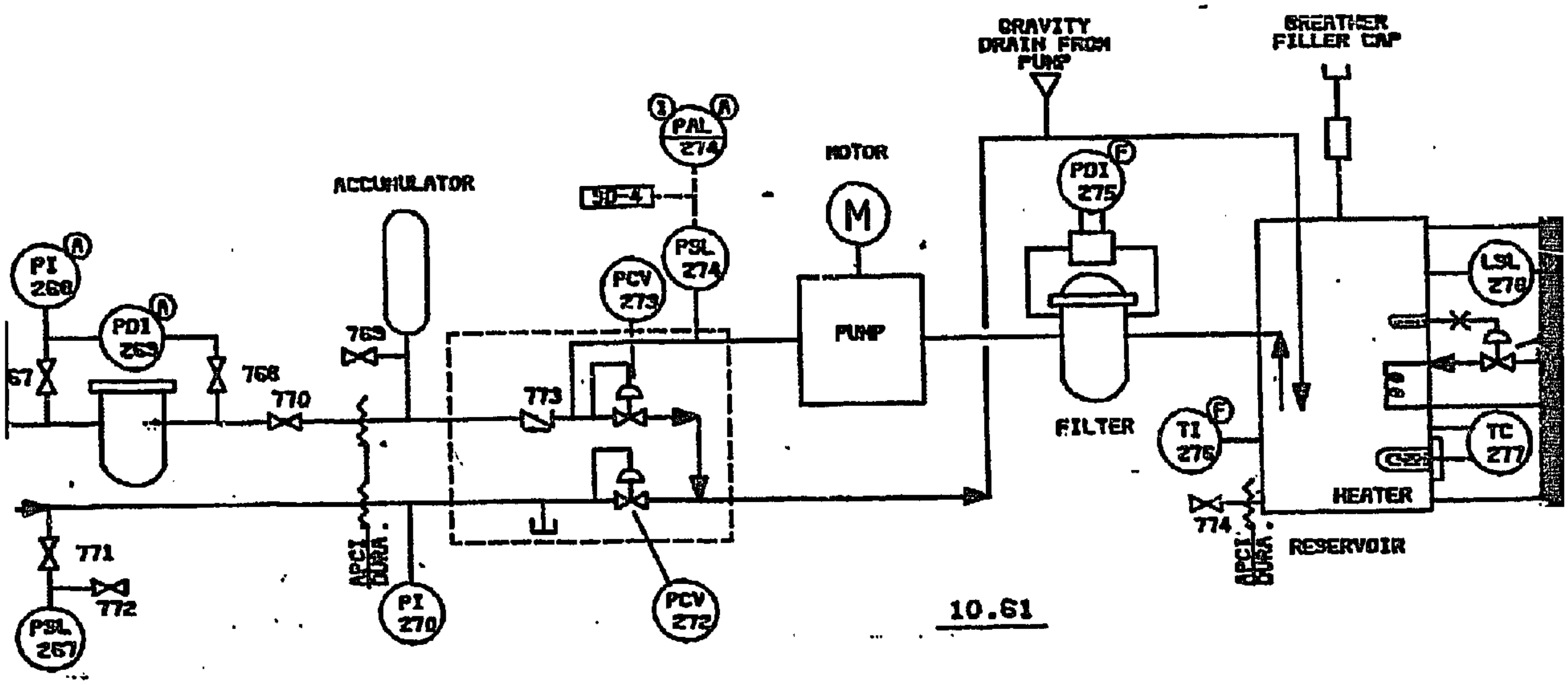
28.20
(D106)
PROCESS OIL STORAGE
10.54
(P104)
PROCESS OIL MAKE
PSV
PI
PCV
LG
VENT
28.20
(D106)
S.P.
10.54
(P104)


10.54
(P104)
SHEET 14
SHEET 15
28.40
HE PURGE FROM SHT. 16
FROM 10.53 A & B SHT. 5
WASTE OIL FROM SHT. 3
PI
26.40
DRAIN
TO 26.53 SHT. 6
2½- UO - 137 -
2½- UO - 182 -


SHEET 15
SHEET 16
TANK
NITROGEN FROM SHT. 16
PCV
LG
DRAIN
PI
PDI
767
TO/FROM 10.50 SHT. 7
771
772
PAL 267
PSL 267

ρ

10.61
BARRIER FLUID SYSTEM



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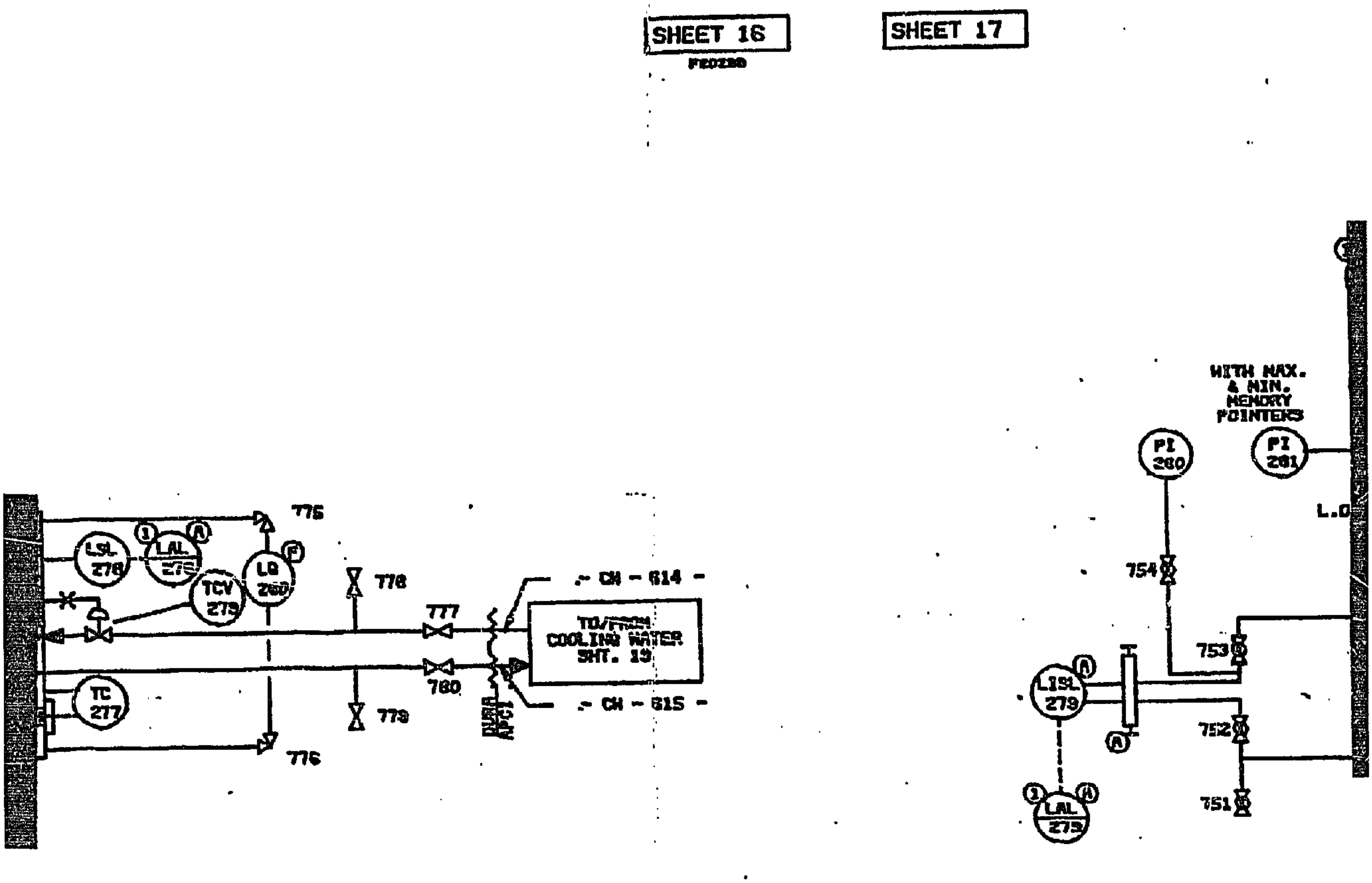
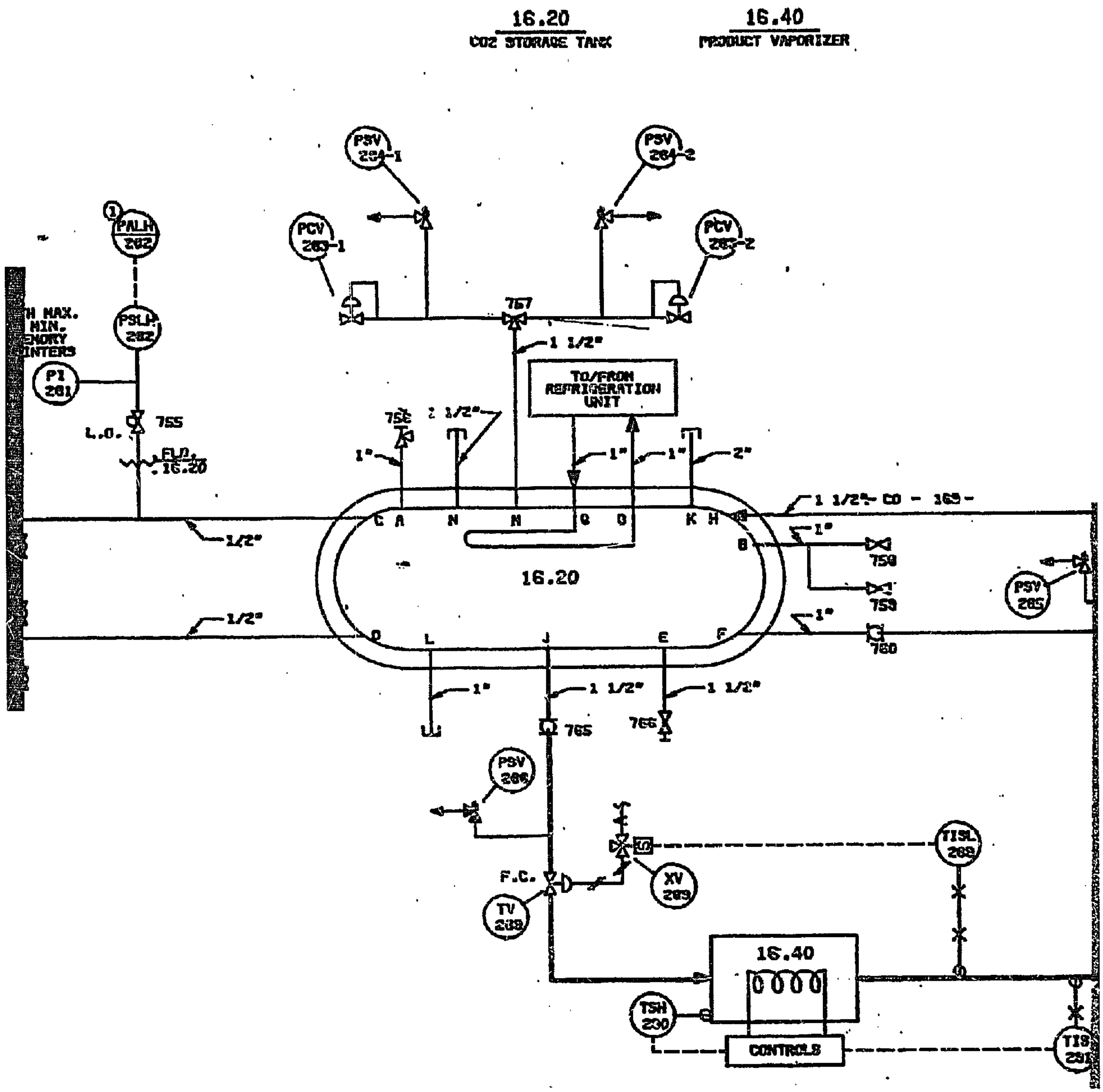
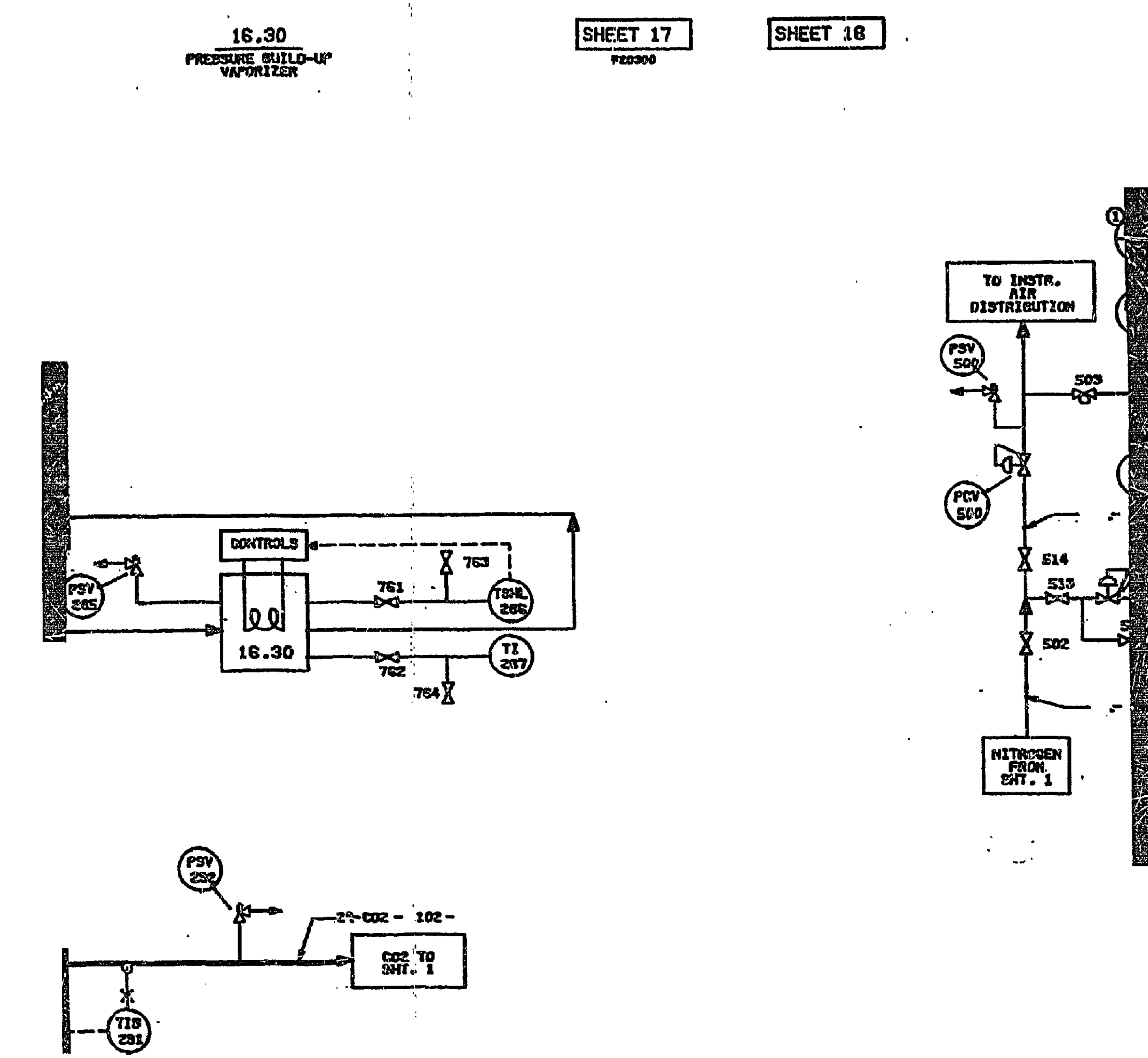


SHEET 16
SHEET 17
WITH MAX. & MIN. MEMORY POINTERS
PI 280
PI 281
L.O
754
753
752
751
LISL 279
LAL 279
776
LSL 276
LAL 276
LG 280
TCV 279
778
777
CH - 614
TO/FROM COOLING WATER SHT. 13
780
CH - 615
779
TC 277
776

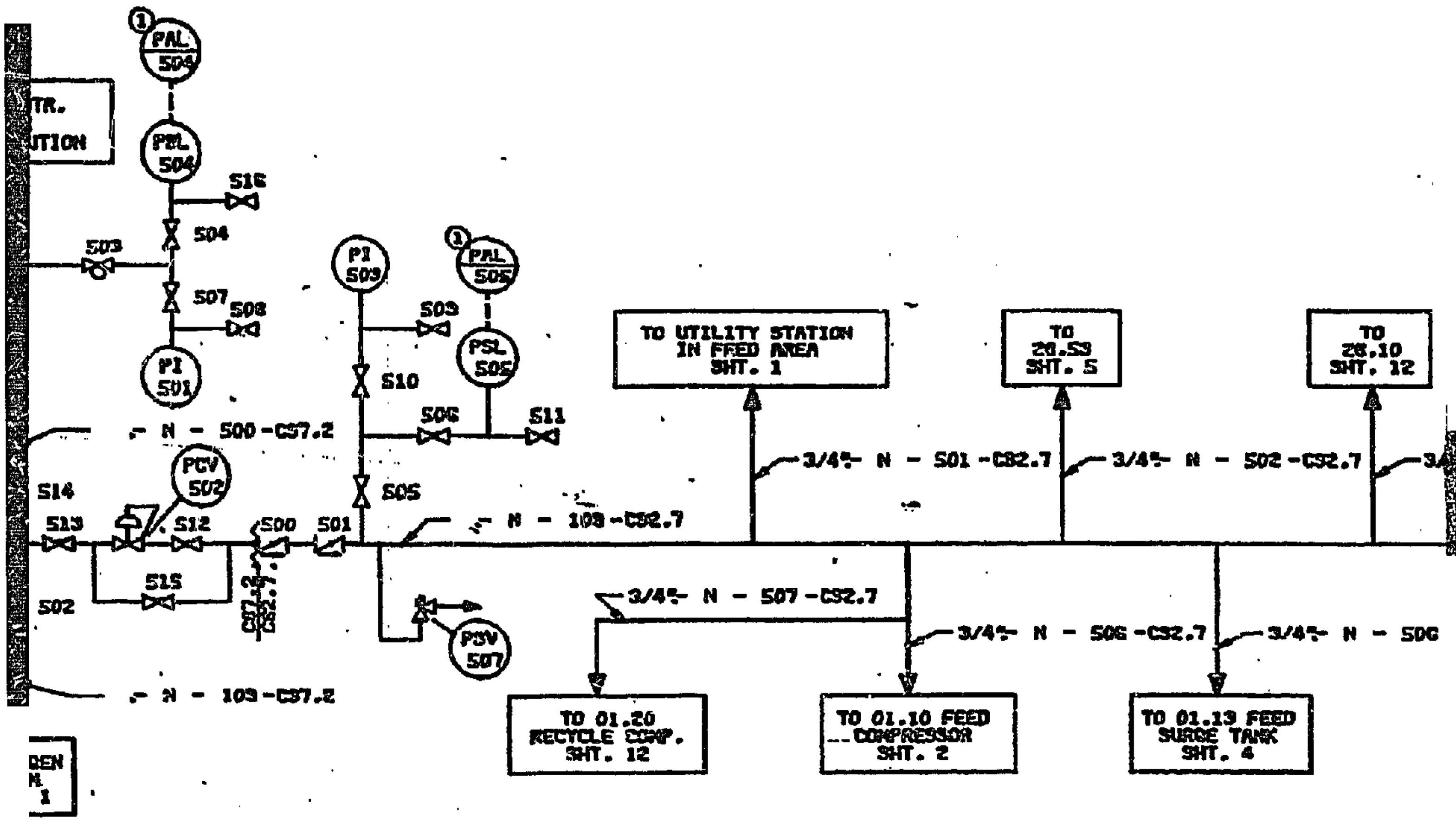
ρ



16.20
CO2 STORAGE TANK
16.40
PRODUCT VAPORIZER
PSV 204-1
PSV 204-2
PCV 203-1
PCV 203-2
PALH 202
PSLH 202
H MAX.
MIN.
MEMORY
POINTERS
PI 201
757
1 1/2"
TO/FROM
REFRIGERATION
UNIT
755
L.O.
FLD.
16.20
1/2"
1 1/2"- CO - 165 -
1"
2"
758
759
PSV 205
16.20
760
1 1/2"
765
766
PSV 206
F.C.
TV 208
XV 209
TISL 209
16.40
TSH 230
CONTROLS
TIS 231


16.30
PRESSURE BUILD-UP VAPORIZER
SHEET 17
F20300
SHEET 18
TO INSTR. AIR DISTRIBUTION
PSV 500
503
PCV 500
514
513
502
NITROGEN FROM SHT. 1
CONTROLS
763
761
PSV 265
TSHL 266
16.30
TI 267
762
764
PSV 252
CO2 TO SHT. 1
TIS 251

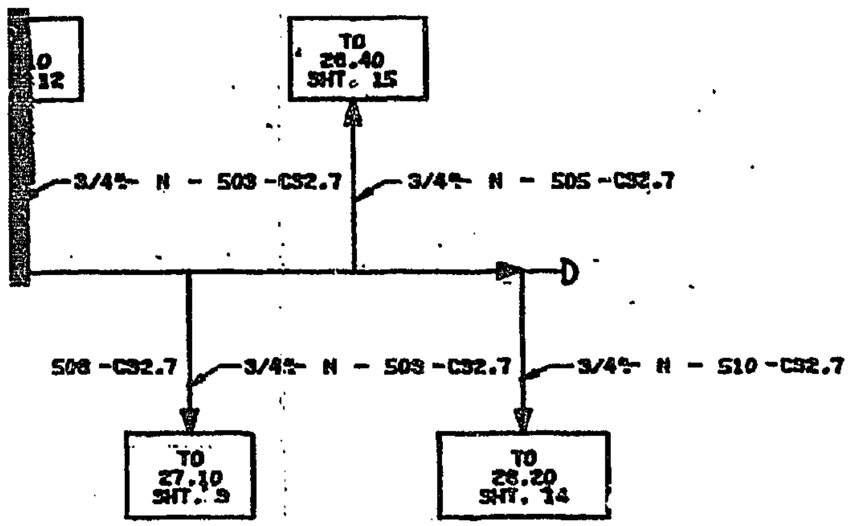
NITROGEN PURGE AND INSTR. AIR SYSTEM

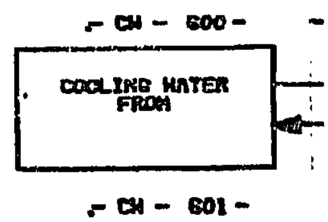


SHEET 18

FE0301

SHEET 19





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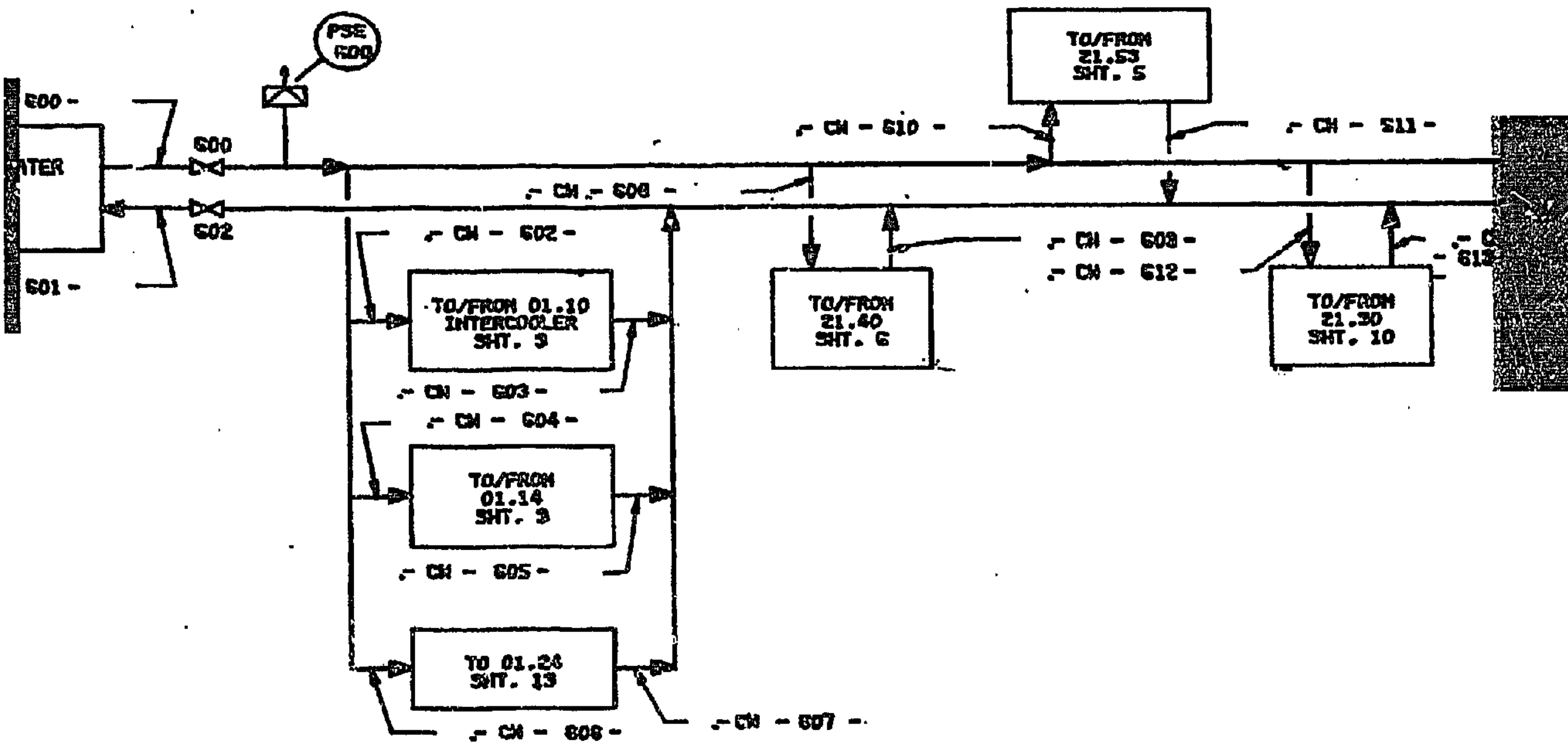
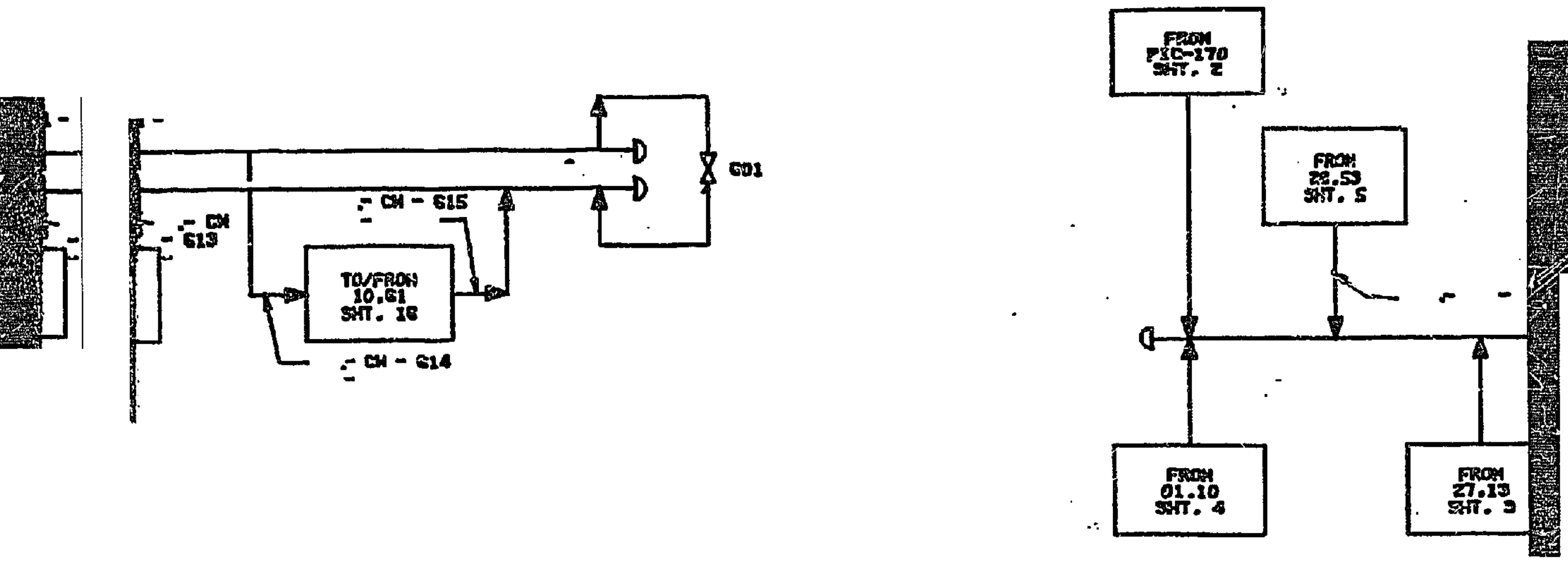
COOLING WATER SYSTEM



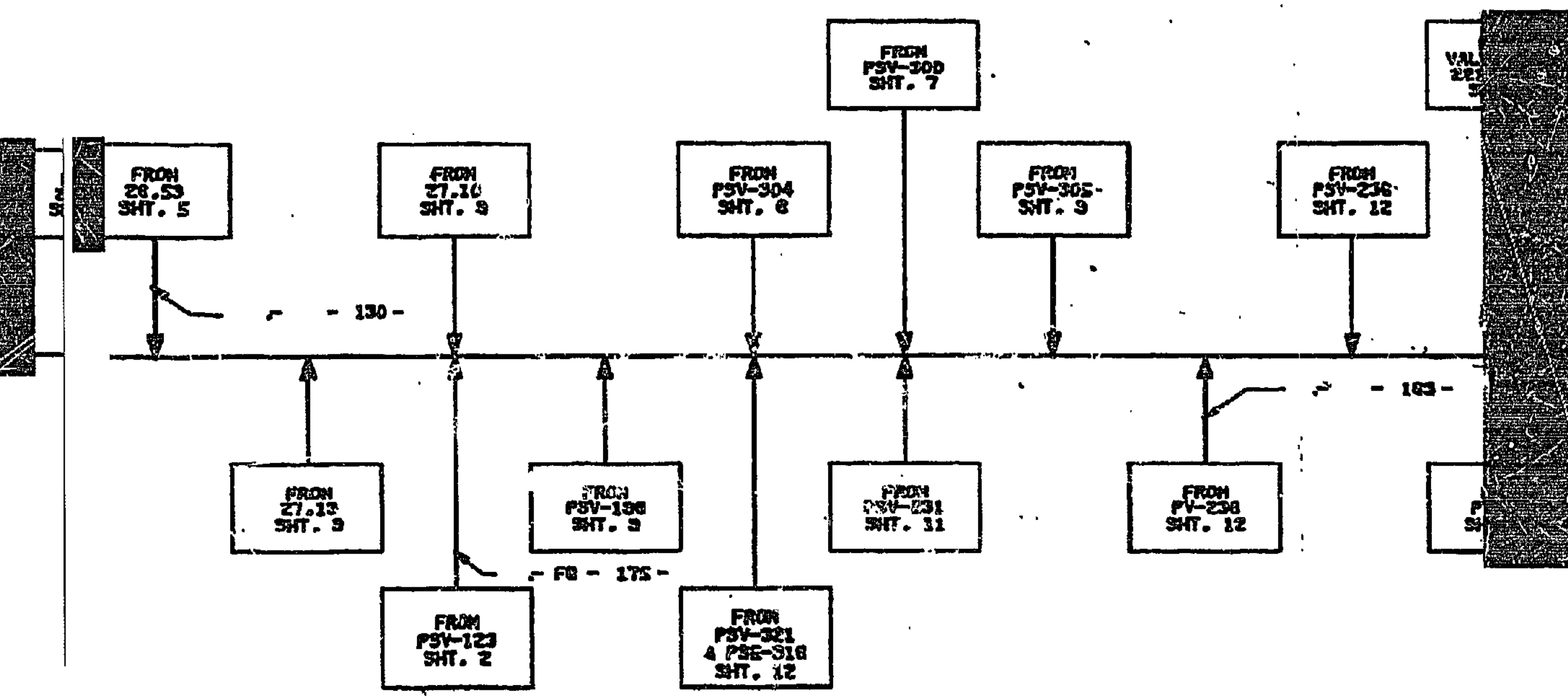
SHEET 19 -

P20302

SHEET 20



FLARE SYSTEM



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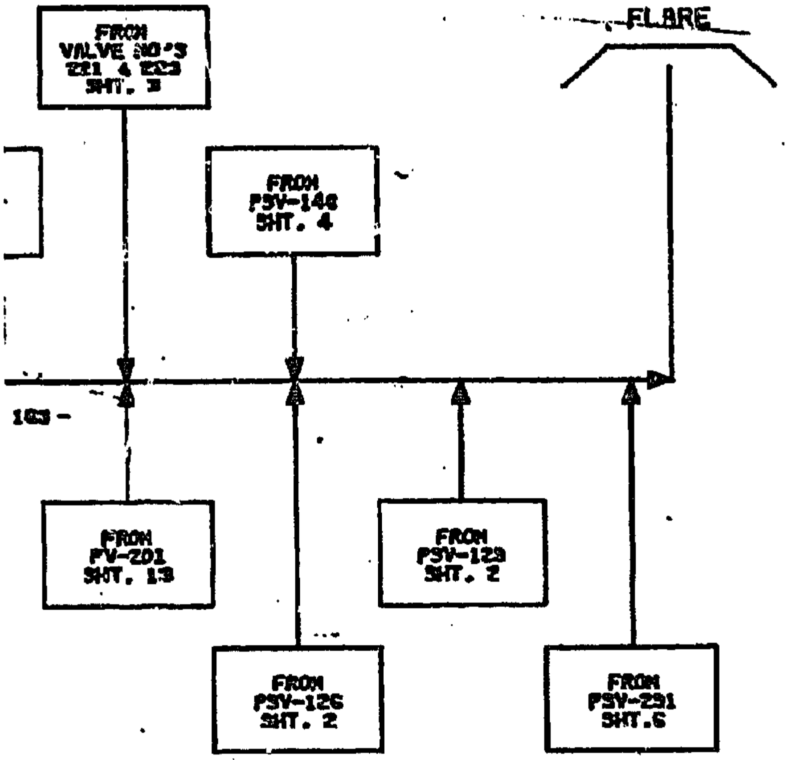
SHEET 20

ENG

LIG

U.



NOTE: DUE TO E

REVISION			
NO.	FCN'S	DATE	MA
P1		10MAR82	JK
OA		13APR82	

ET 20
FE0303

ENGINEERING FLOWSHEET

87-7-1533

LIQUID PHASE METHANOL

PRELIMINARY

FOR

U.S. DEPT. OF ENERGY
(D.O.E.)

LAPORTE, TEXAS

NOTE: DUE TO EXTENSIVE CHANGES THRU-OUT F/S, REV. OA IS NOT CIRCLED

REVISIONS					APPROVED					
NO.	FCN'S	DATE	MADE	CHK'D	PROCESS	START-UP	OPER.	CHF. ENG.	PROJECT	SAFETY
P1		10MAR82	JK/CB	DRC/DB						
OA		13APR82	SN/JK CB	DRC						

FE0307

EXHIBIT 2.3.1-3

Design Cases for Liquid-Fluidized Mode:
Operating Conditions for LaPorte LPMeOH PDU

Case No.	Space Velocity 1/hr kg	Press, psig	Temp. °C	Catalyst Bed. Ht. ft	Catalyst Loading kg/l	%CO Conv. (Single pass)	$\%CO_2$ Conv. (Single pass)	% CH_3OH Select.	% C_2H_5OH Select.	% CO_2 Select.	Reactor Feed lb-Mol/hr	Liq./Vapor Linear Velocity ft/sec	Fresh Feed lb-Mol/hr	Recycle Flow lb-Mol/hr	Purge Flow lb-Mol/hr	MeOH Product Rate ST/D
FB-4930.8	4,000	900	230	7	-	25	3	98	2	0	247	0.16/0.26	53	194	1	6.5
FL-3750.8	2,500	700	250	7	-	20	2	98	2	0	155	0.16/0.22	30	125	10	2.6
FK-2750.6	2,000	700	250	7	-	10	0	83	12	5	124	0.16/0.18	46	78	20	3.3
FK-1570.3	1,000	500	270	7	-	7	0	83	12	5	61	0.16/0.13	41	20	36	0.5

20 April 1982

p

EXHIBIT 2.3.1-4

Design Cases for Liquid-Entrained Mode:

Operating Conditions for LaPorte LPMeOH PDU

Case No.	Space Velocity 1/hr kg	Press. psig	Temp. °C	Catalyst Bed. Ht. ft	Catalyst Loading kg/l	%CO Conv. (Single pass)	% CO_2 Conv. (Single pass)	% CH_3OH Select.	% C_2H_5OH Select.	% CO_2 Select.	Reactor Feed lb-Mol/hr	Liq./Vapor Linear Velocity ft/sec	Fresh Feed lb-Mol/hr	Recycle Flow lb-Mol/hr	Purge Flow lb-Mol/hr	MeOH Product Rate ST/D
EB-X954.8	10,000	900	250	-	0.4	30	3	98	2	0	350	0.20/0.40	77	273	0.5	9.7
EL-6752.7	6,000	700	250	-	0.2	24	2	98	2	0	107	0.16/0.15	27	80	10	2.3
EK-4752.7	4,000	700	250	-	0.2	12	0	83	12	5	72	0.16/0.10	22	50	10	1.6
EK-2571.0	2,000	500	270	-	0.1	7	0	83	12	5	18	0.16/0.04	18	0	17	0.2

20 April 1982

p

EXHIBIT 2.3.1-5

Point-by-point Heat and Mass Balances

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11

STREAM SUMMARY

TOTAL							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	365.00	950.00	950.00	940.00	915.00
TEMPERATURE DEG,F	100.00	332.47	120.00	377.73	172.82	335.00	685.57
DEW POINT DEG,F	-163.52					103.75	226.77
ENTHALPY BTU/HR	-1002607.00	-917740.50	-995593.75	-900552.44	-8817937.00	-8508615.00	-8500615.00
VAP. DENSITY,LB/CUFT	0.280188	0.484719	0.653734	1.156292	2.151783	1.681300	1.311841
AVE. MOL WT	11.269170	11.269170	11.269170	11.269170	15.603806	15.603806	17.998810
FLOW RATES MOLES/HR							
HYDROGEN	34.000000	34.000000	34.000000	34.000000	122.299988	122.299988	88.684891
CARBON MONOXIDE	15.790000	15.790000	15.790000	15.790000	60.989990	60.989990	45.505417
CARBON DIOXIDE	1.500000	1.500000	1.500000	1.500000	29.399994	29.399994	28.517990
METHANE	0.183000	0.183000	0.183000	0.183000	29.182999	29.182999	29.182999
NITROGEN	1.70000E-02	1.70000E-02	1.70000E-02	1.70000E-02	2.316998	2.316998	2.316998
WATER	0.0	0.0	0.0	0.0	8.00000E-02	8.00000E-02	1.132375
METHANOL	0.0	0.0	0.0	0.0	1.700000	1.700000	17.725800
ETHANOL	0.0	0.0	0.0	0.0	1.10000E-02	1.10000E-02	0.181375
WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW MOL/HR	51.489990	51.489990	51.489990	51.489990	245.980927	245.980927	213.247818
LB/HR	580.249268	580.249268	580.249268	580.249268	3838.238770	3838.238770	3838.206787
ACTUAL CFM	34.515503	19.951385	14.793214	8.363649	29.729126	38.048309	48.763611

STREAMS ARE ALL VAPOR

Case FB-4930

STREAM SUMMARY

Section								
TOTAL	STREAM NUMBER	20	25	30	32	35	38	45
	NOTES - BELOW	#4	#4	#4			#2,4	
	PRESSURE PSIA	915.00	910.00	900.00	900.00	890.00	890.00	885.00
	TEMPERATURE DEG,F	446.00	445.99	289.09	289.09	110.00	100.00	110.50
	DEW POINT DEG,F		445.99		289.09			
	ENTHALPY BTU/HR	-51497696.00	-9026661.00	-9343983.00	-9270803.00	-9866395.00	-183777.63	-7986813.00
	AVE. MOL WT	126.847488	18.400757	18.400757	18.018250	18.094879	18.019989	16.767914
	FLOW RATES MOLES/HR							
	HYDROGEN	114.427322	88.740173	88.740173	88.705292	88.712265	0.0	88.636627
	CARBON MONOXIDE	54.594894	45.521759	45.521759	45.508804	45.511383	0.0	45.448410
	CARBON DIOXIDE	35.531540	28.520432	28.520432	28.504654	28.507797	0.0	28.087326
	METHANE	36.008316	29.195602	29.195602	29.184967	29.187088	0.0	29.100388
	NITROGEN	3.212807	2.320560	2.320560	2.319437	2.319661	0.0	2.316882
	WATER	1.132375	1.132375	1.132375	1.132375	1.132375	1.500000	8.05626E-02
	METHANOL	25.933136	17.729584	17.729584	17.710449	17.714254	0.0	1.710452
	ETHANOL	0.429721	0.184559	0.184559	0.183944	0.184067	0.0	1.09998E-02
	WITCO 40 OIL	239.926743	0.372439	0.372439	2.11632E-02	9.14183E-02	0.0	8.50843E-05
	TOTAL FLOW MOL/HR	511.196777	213.717468	213.717468	213.271103	213.360367	1.500000	195.391880
	LB/HR	64844.023438	3932.562988	3932.562988	3842.771729	3860.729980	27.029984	3276.312744
LIQUID	ENTHALPY BTU/HR	-42489328.00	0.0	-73213.50	0.0	-1882061.00	-183777.63	0.0
	LIQ. DENSITY,LB/CUFT	35.595398	0.0	39.285919	0.0	0.0	61.967270	0.0
	AVE. MOL WT	204.429474	0.0	201.009384	0.0	32.488800	18.019989	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	25.954834	0.0	3.50193E-02	0.0	8.49123E-02	0.0	0.0
	CARBON MONOXIDE	9.152252	0.0	1.30017E-02	0.0	7.70865E-02	0.0	0.0
	CARBON DIOXIDE	7.064438	0.0	1.58218E-02	0.0	0.461692	0.0	0.0
	METHANE	6.868515	0.0	1.06658E-02	0.0	0.100146	0.0	0.0
	NITROGEN	0.898972	0.0	1.12673E-03	0.0	3.20829E-03	0.0	0.0
	WATER	0.0	0.0	1.28242E-09	0.0	1.092680	1.500000	0.0
	METHANOL	8.259171	0.0	1.92096E-02	0.0	15.981386	0.0	0.0
	ETHANOL	0.246264	0.0	6.17418E-04	0.0	0.173341	0.0	0.0
	WITCO 40 OIL	239.557281	0.0	0.351315	0.0	9.13350E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	298.001221	0.0	0.446778	0.0	17.985748	1.500000	0.0
	LB/HR	60920.230469	0.0	89.806473	0.0	584.335205	27.029984	0.0
LIQUID 1	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-1871908.00	0.0	0.0
	LIQI DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	48.747177	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	0.0	31.991486	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	8.07444E-02	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	7.53391E-02	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.456632	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	9.84570E-02	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	3.08678E-03	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	1.092680	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	15.900318	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	0.173312	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	4.98581E-02	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	17.930485	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	573.620117	0.0	0.0
LIQUID 2	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-10153.27	0.0	0.0
	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	42.239151	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	0.0	193.562653	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	4.16792E-03	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	1.74741E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	5.06044E-03	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	1.68927E-03	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	1.21516E-04	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	8.15036E-11	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	1.06540E-03	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	2.93373E-05	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	4.14770E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.055358	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	10.715293	0.0	0.0
VAPOR	ENTHALPY BTU/HR	-9008323.00	-9026661.00	-9270773.00	-9270803.00	-7984334.00	0.0	-7986813.00
	VAP. DENSITY,LB/CUFT	1.704211	1.694719	2.009687	2.009698	2.443760	0.0	2.427206
	AVE. MOL WT	18.404709	18.400757	18.018204	18.018250	16.769760	0.0	16.767914
	FLOW RATES MOLES/HR							
	HYDROGEN	88.472488	88.740173	88.705154	88.705292	88.627335	0.0	88.636627
	CARBON MONOXIDE	45.442642	45.521759	45.508743	45.508804	45.434280	0.0	45.448410
	CARBON DIOXIDE	28.467102	28.520432	28.504608	28.504654	28.046097	0.0	28.087326
	METHANE	29.139801	29.195602	29.184937	29.184967	29.086929	0.0	29.100388
	NITROGEN	2.313635	2.320560	2.319433	2.319437	2.316452	0.0	2.316882
	WATER	1.132375	1.132375	1.132375	1.132375	3.96944E-02	0.0	8.05626E-02
	METHANOL	17.673965	17.729584	17.710373	17.710449	1.812878	0.0	1.710452
	ETHANOL	0.183457	0.184559	0.183941	0.183944	1.07261E-02	0.0	1.09998E-02
	WITCO 40 OIL	0.369447	0.372439	2.11238E-02	2.11632E-02	8.32976E-05	0.0	8.50843E-05
	TOTAL VAPOR MOL/HR	213.195099	213.717468	213.270691	213.271103	195.374542	0.0	195.391880
	LB/HR	3923.793701	3932.562988	3842.754639	3842.771729	3276.384033	0.0	3276.312744
	ACTUAL CFM	38.373505	38.674667	31.868576	31.868561	22.345215	0.0	22.497131

STREAM SUMMARY

TOTAL							
STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1,4	#1,4		#4	#4
PRESSURE PSIA	885.00	885.00	885.00	950.00	885.00	20.00	20.00
TEMPERATURE DEG,F	110.50	110.50	110.00	125.32	110.50	102.74	102.74
DEW POINT DEG,F						102.74	
BUBBLE PT DEG,F							102.74
ENTHALPY BTU/HR	-28939.45	-7957872.00	-7939928.00	-7917385.00	-2044963.00	-83480.88	-1961480.00
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.772156	0.0	50.329132
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.772156	0.0	0.0
VAP. DENSITY,LB/CUFT	2.427206	2.427206	2.427012	2.529092	0.0	0.110389	0.0
AVE. MOL WT	16.767899	16.767914	16.751328	16.751328	30.543304	13.045761	30.441544
FLOW RATES MOLES/HR							
HYDROGEN	0.321166	88.315445	88.299988	88.299988	6.80196E-02	6.77980E-02	2.21550E-04
CARBON MONOXIDE	0.164678	45.283722	45.199997	45.199997	5.97810E-02	5.93497E-02	4.31307E-04
CARBON DIOXIDE	0.101772	27.985550	27.899994	27.899994	0.411229	0.372761	3.84682E-02
METHANE	0.105442	28.994934	29.000000	29.000000	8.36070E-02	8.22037E-02	1.40327E-03
NITROGEN	8.39499E-03	2.308487	2.299999	2.299999	2.55547E-03	2.54039E-03	1.50788E-05
WATER	2.91910E-04	8.02706E-02	8.00000E-02	8.00000E-02	2.551812	8.36178E-03	2.543450
METHANOL	6.19765E-03	1.704254	1.700000	1.700000	16.001999	-0.162629	15.839370
ETHANOL	3.98566E-05	1.89599E-02	1.10000E-02	1.10000E-02	0.173014	1.84425E-03	0.171969
WITCO 40 OIL	3.08295E-07	8.47768E-05	0.0	0.0	1.40949E-02	7.26683E-06	1.40876E-02
TOTAL FLOW MOL/HR	0.707983	194.683792	194.490936	194.490936	19.366089	6.756695	18.609390
LB/HR	11.871384	3264.440918	3257.981201	3257.981201	591.504150	25.065554	566.498535
ACTUAL CFM	0.081516	22.415604	22.373047	21.470032	0.0	3.775351	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH FLUIDIZED/BALANCED MAX PRODN: FB-4930

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STREAM SUMMARY

TOTAL							
STREAM NUMBER	75	76	77	78	80	83	89
NOTES - BELOW	#4	#4			#2,4	#4	#4
PRESSURE PSIA	910.00	900.00	900.00	885.00	885.00	910.00	945.00
TEMPERATURE DEG,F	445.99	289.09	289.09	110.50	253.24	253.40	446.98
BUBBLE PT DEG,F	445.99	289.09					
ENTHALPY BTU/HR	-42470976.00	-14636.59	-58546.35	-18843.94	-77390.25	-77372.50	-42492928.00
LIQ. DENSITY,LB/CUFT	35.621307	39.297028	39.297089	49.772156	39.922760	39.519159	35.596100
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	42.300278	0.0	0.0	0.0
AVE. MOL WT	204.750865	201.157776	201.157700	194.667206	199.711136	199.711136	204.751099
FLOW RATES MOLES/HR							
HYDROGEN	25.687149	6.97505E-03	2.79002E-02	7.60282E-03	3.55038E-02	3.55030E-02	25.722641
CARBON MONOXIDE	9.073135	2.59079E-03	1.03632E-02	3.18949E-03	1.35526E-02	1.35526E-02	9.086687
CARBON DIOXIDE	7.011108	3.15333E-03	1.26133E-02	9.22463E-03	2.18380E-02	2.18380E-02	7.032946
METHANE	6.812714	2.12539E-03	8.50157E-03	3.08183E-03	1.15834E-02	1.15834E-02	6.824297
NITROGEN	0.892246	2.24536E-04	8.98142E-04	2.22271E-04	1.12041E-03	1.12041E-03	0.893367
WATER	0.0	2.53454E-10	1.01382E-09	2.76017E-10	1.28983E-09	1.28983E-09	1.28983E-09
METHANOL	8.203552	3.82507E-03	1.53003E-02	1.79742E-03	1.70977E-02	1.70977E-02	8.220650
ETHANOL	0.245162	1.22925E-04	4.91702E-04	5.37040E-05	5.45406E-04	5.45405E-04	0.245707
WITCO 40 OIL	239.554291	7.02551E-02	0.281021	7.72383E-02	0.358259	0.358259	239.912537
TOTAL FLOW MOL/HR	297.479004	0.089272	0.357089	0.102410	0.459499	0.459499	297.938477
LB/HR	60911.460938	17.957779	71.831192	19.935944	91.767136	91.767136	61003.226563
	LIQ	LIQ	LIQ	LIQ2	LIQ	LIQ	LIQ

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH FLUIDIZED/BALANCED MAX PRODN: FB-4930

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STREAM SUMMARY

TOTAL		
STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#2,4
PRESSURE PSIA	945.00	935.00
TEMPERATURE DEG,F	446.98	435.53
ENTHALPY BTU/HR	-42491392.00	-42997088.00
LIQ. DENSITY,LB/CUFT	35.595413	35.882294
AVE. MOL WT	204.752594	204.752594
FLOW RATES MOLES/HR		
HYDROGEN	25.742432	25.742432
CARBON MONOXIDE	9.089486	9.089486
CARBON DIOXIDE	7.013563	7.013563
METHANE	6.825317	6.825317
NITROGEN	0.895809	0.895809
WATER	1.37693E-09	1.37693E-09
METHANOL	8.207340	8.207340
ETHANOL	0.248345	0.248345
WITCO 40 OIL	239.926743	239.926743
TOTAL FLOW MOL/HR	297.948975	297.948975
LB/HR	61005.824219	61005.824219
	LIQ	LIQ

NOTES

1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION: TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 48.77 CPU SECONDS

Case FL-3750

STREAM SUMMARY

TOTAL

STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	335.00	750.00	750.00	740.00	715.00
TEMPERATURE DEG,F	100.00	326.13	120.00	326.56	165.61	395.00	617.21
DEW POINT DEG,F						107.00	191.60
ENTHALPY BTU/HR	-717935.00	-668495.00	-713853.13	-668406.06	-5162946.00	-4880368.00	-4880368.00
VAP. DENSITY,LB/CUFT	0.310386	0.541136	0.665971	1.083788	1.665792	1.193257	1.001349
AVE. MOL WT	12.470467	12.470467	12.470467	12.470467	15.071447	15.071447	16.469666
FLOW RATES MOLES/HR							
HYDROGEN	18.199997	18.199997	18.199997	18.199997	77.121994	77.121994	63.627686
CARBON MONOXIDE	8.658999	8.658999	8.658999	8.658999	38.288986	38.288986	32.006531
CARBON DIOXIDE	1.530000	1.530000	1.530000	1.530000	15.489999	15.489999	15.180199
METHANE	1.610000	1.610000	1.610000	1.610000	21.509979	21.509979	21.509979
NITROGEN	0.110000	0.110000	0.110000	0.110000	1.509999	1.509999	1.509999
WATER	0.0	0.0	0.0	0.0	4.20000E-02	4.20000E-02	0.424166
METHANOL	0.0	0.0	0.0	0.0	1.320000	1.320000	7.767521
ETHANOL	0.0	0.0	0.0	0.0	8.50000E-03	8.50000E-03	8.08662E-02
WITCO 40 OIL	0.0	0.0	0.0	0.0	6.10000E-05	6.10000E-05	6.10000E-05
TOTAL FLOW MOL/HR	30.108963	30.108963	30.108963	30.108963	155.291458	155.291458	142.106964
LB/HR	375.472656	375.472656	375.472656	375.472656	2340.466797	2340.466797	2340.454102
ACTUAL CFM	20.161575	11.564336	9.396616	5.774079	23.416962	32.690170	38.955002

STREAMS ARE ALL VAPOR

STREAM SUMMARY

TOTAL

STREAM NUMBER	20	25	30	32	35	38	45
NOTES - BELOW	#4	#4	#4			#2,4	
PRESSURE PSIA	715.00	710.00	700.00	700.00	690.00	690.00	685.00
TEMPERATURE DEG,F	481.97	481.96	275.40	275.19	110.00	100.00	109.98
DEW POINT DEG,F		481.96		275.19			
ENTHALPY BTU/HR	-40924768.00	-5124670.00	-5407248.00	-5302867.00	-5620347.00	-30631.73	-4873273.00
AVE. MOL WT	144.532928	17.329437	17.329437	16.488693	16.657394	18.019989	15.698318
FLOW RATES MOLES/HR							
HYDROGEN	80.252350	63.667053	63.667053	63.631073	63.638260	0.0	63.608978
CARBON MONOXIDE	38.363144	32.021500	32.021500	32.007156	32.010010	0.0	31.985916
CARBON DIOXIDE	18.727585	15.201065	15.201065	15.186666	15.189546	0.0	15.075942
METHANE	26.464996	21.524475	21.524475	21.511978	21.514465	0.0	21.481415
NITROGEN	2.107590	1.511531	1.511531	1.510372	1.510603	0.0	1.509595
WATER	0.424166	0.424166	0.424166	0.424166	0.424166	0.250000	4.50445E-02
METHANOL	11.145117	7.771978	7.771978	7.758567	7.761489	0.0	1.428310
ETHANOL	0.180463	8.13071E-02	8.13071E-02	8.08808E-02	8.09660E-02	0.0	9.14368E-03
WITCO 40 OIL	215.814529	0.524375	0.524375	1.16218E-02	0.114172	0.0	6.60723E-05
TOTAL FLOW MOL/HR	393.479736	142.727417	142.727417	142.122757	142.243683	0.250000	135.144394
LB/HR	56870.777344	2473.385742	2473.385742	2343.418457	2369.408936	4.504997	2121.539551

LIQUID

STREAM NUMBER	20	25	30	32	35	38	45
ENTHALPY BTU/HR	-35811536.00	0.0	-104599.88	0.0	-7463'4.19	-30631.73	0.0
LIQ. DENSITY,LB/CUFT	35.469940	0.0	40.524979	0.0	0.0	61.967270	0.0
AVE. MOL WT	216.643860	0.0	215.104080	0.0	34.887512	18.019989	0.0
FLOW RATES MOLES/HR							
HYDROGEN	16.779053	0.0	3.57846E-02	0.0	3.06718E-02	0.0	0.0
CARBON MONOXIDE	6.403458	0.0	1.42685E-02	0.0	2.61808E-02	0.0	0.0
CARBON DIOXIDE	3.557779	0.0	1.43185E-02	0.0	0.118552	0.0	0.0
METHANE	4.986237	0.0	1.24286E-02	0.0	3.51230E-02	0.0	0.0
NITROGEN	0.601079	0.0	1.15263E-03	0.0	1.06654E-03	0.0	0.0
WATER	0.0	0.0	2.51906E-10	0.0	0.393925	0.250000	0.0
METHANOL	3.398906	0.0	1.30255E-02	0.0	6.296330	0.0	0.0
ETHANOL	9.96724E-02	0.0	4.23371E-04	0.0	7.18809E-02	0.0	0.0
WITCO 40 OIL	215.295273	0.0	0.512679	0.0	0.114107	0.0	0.0
TOTAL LIQ. MOL/HR	251.121307	0.0	0.604080	0.0	7.087834	0.250000	0.0
LB/HR	54403.886719	0.0	129.940079	0.0	247.276901	4.504997	0.0

LIQUID 1

STREAM NUMBER	20	25	30	32	35	38	45
ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-724589.00	0.0	0.0
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	48.676193	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	32.053848	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	2.43018E-02	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	2.33993E-02	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.112146	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	3.22803E-02	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	8.83581E-04	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.393925	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	6.294628	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	7.18344E-02	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	2.11657E-02	0.0	0.0

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	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	6.974563	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	223.561569	0.0	0.0
LIQUID 2	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-21755.20	0.0	0.0
	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	43.553268	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	0.0	209.365479	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	6.37006E-03	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	2.78153E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	6.40608E-03	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	2.84276E-03	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	1.82960E-04	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	3.50491E-11	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	1.70152E-03	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	4.64418E-05	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	9.29409E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.113272	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	23.715286	0.0	0.0
VAPOR	ENTHALPY BTU/HR	-5113191.00	-5124670.00	-5302654.00	-5302867.00	-4874003.08	0.0	-4873273.00
	VAP. DENSITY,LB/CUFT	1.205289	1.197067	1.451063	1.451491	1.769462	0.0	1.756322
	AVE. MOL WT	17.328690	17.329437	16.488831	16.488693	15.701403	0.0	15.698318
	FLOW RATES MOLES/HR							
	HYDROGEN	63.473297	63.667053	63.631256	63.631073	63.607574	0.0	63.608978
	CARBON MONOXIDE	31.959686	32.021500	32.007217	32.007156	31.983810	0.0	31.985916
	CARBON DIOXIDE	15.169806	15.201065	15.186747	15.186666	15.070992	0.0	15.075942
	METHANE	21.478760	21.524475	21.512039	21.511978	21.479324	0.0	21.481415
	NITROGEN	1.506511	1.511531	1.510378	1.510372	1.509536	0.0	1.509595
	WATER	0.424166	0.424166	0.424166	0.424166	3.02409E-02	0.0	4.50445E-02
	METHANOL	7.746211	7.771978	7.758952	7.758867	1.465158	0.0	1.428310
	ETHANOL	8.07911E-02	8.13071E-02	8.08837E-02	8.08808E-02	9.08508E-03	0.0	9.14368E-03
	WITCO 40 OIL	0.519252	0.524375	1.16966E-02	1.16218E-02	6.56642E-05	0.0	6.60723E-05
	TOTAL VAPOR MOL/HR	142.358429	142.727417	142.123337	142.122757	135.155792	0.0	135.144394
	LB/HR	2466.885010	2473.385742	2343.447510	2343.418457	2122.135498	0.0	2121.539551
	ACTUAL CFM	34.111938	34.436737	26.916428	26.908157	19.988510	0.0	20.132401

STREAM SUMMARY

TOTAL							
STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1	#1,4		#4	#4
PRESSURE PSIA	685.00	685.00	685.00	750.00	685.00	20.00	20.00
TEMPERATURE DEG.F	109.98	109.98	109.98	129.76	109.98	104.26	104.26
DEW POINT DEG.F						104.26	
BUBBLE PT DEG.F							104.26
ENTHALPY BTU/HR	-358442.19	-4514830.00	-4513183.00	-4494540.00	-754303.94	-22203.65	-732099.88
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.171310	0.0	49.669052
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.171310	0.0	0.0
VAP. DENSITY,LB/CUFT	1.756322	1.756322	1.756170	1.852674	0.0	0.104757	0.0
AVE. MOL WT	15.698313	15.698315	15.697038	15.697038	31.333771	31.444412	31.330307
FLOW RATES MOLES/HR							
HYDROGEN	4.678610	58.930359	58.921997	58.921997	2.24200E-02	2.22299E-02	1.90079E-04
CARBON MONOXIDE	2.352649	29.633255	29.629990	29.629990	2.10749E-02	2.07630E-02	3.11878E-04
CARBON DIOXIDE	1.188875	13.967064	13.959999	13.959999	0.106690	9.26392E-02	1.40509E-02
METHANE	1.580015	19.901382	19.899994	19.899994	2.99827E-02	2.91277E-02	8.55058E-04
NITROGEN	0.111035	1.398560	1.400000	1.400000	8.10039E-04	7.99899E-04	1.01398E-05
WATER	3.31314E-03	4.17314E-02	4.20000E-02	4.20000E-02	0.629122	1.70937E-03	0.627412
METHANOL	0.105056	1.323254	1.320000	1.320000	6.331405	5.11792E-02	6.280225
ETHANOL	6.72542E-04	8.47114E-03	8.50000E-03	8.50000E-03	7.17723E-02	3.27596E-04	7.14447E-02
WITCO 40 OIL	4.85979E-06	6.12125E-05	6.10000E-05	6.10000E-05	1.22704E-02	2.11509E-06	1.22683E-02
TOTAL FLOW MOL/HR	9.940230	125.204132	125.182495	125.182495	7.225545	0.218778	7.006766
LB/HR	156.044830	1965.493652	1964.994141	1964.994141	226.403564	6.879342	219.524139
ACTUAL CFM	1.480792	18.651596	18.648468	17.677094	0.0	1.894601	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY

TOTAL							
STREAM NUMBER	75	76	77	78	80	85	89
NOTES - BELOW	#4	#4			#2,4	#2,4	#4
PRESSURE PSIA	710.00	700.00	700.00	685.00	685.00	710.00	745.00
TEMPERATURE DEG,F	481.96	275.19	275.19	109.98	244.68	244.74	482.68
BUBBLE PT DEG,F	481.96	275.19					
ENTHALPY BTU/HR	-35800064.00	-20931.84	-83727.31	-23807.32	-107534.63	-107510.19	-35857904.00
LIQ. DENSITY,LB/CUFT	35.493881	40.517090	40.517090	49.171310	41.107925	41.106659	35.474457
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	43.605042	0.0	0.0	0.0
AVE. MOL WT	216.936737	214.947617	214.947586	210.014771	213.943176	213.943176	216.929489
FLOW RATES MOLES/HR							
HYDROGEN	16.585297	7.19530E-03	2.87812E-02	6.85064E-03	3.56318E-02	3.56318E-02	16.620926
CARBON MONOXIDE	6.341644	2.86773E-03	1.14709E-02	2.99718E-03	1.44681E-02	1.44681E-02	6.356112
CARBON DIOXIDE	3.526520	2.87958E-03	1.15183E-02	6.91237E-03	1.84307E-02	1.84307E-02	3.544950
METHANE	4.940521	2.49824E-03	9.99296E-03	3.06408E-03	1.30570E-02	1.30570E-02	4.953578
NITROGEN	0.596059	2.31603E-04	9.26410E-04	1.97252E-04	1.12366E-03	1.12366E-03	0.597182
WATER	0.0	5.11224E-11	2.04490E-10	5.33963E-11	2.57886E-10	2.57886E-10	2.57886E-10
METHANOL	3.373138	2.62218E-03	1.04887E-02	1.77319E-03	1.22619E-02	1.22619E-02	3.385400
ETHANOL	9.91564E-02	8.52677E-05	3.41071E-04	4.99228E-05	3.90993E-04	3.90993E-04	9.95473E-02
WITCO 40 OIL	215.290146	0.102551	0.410203	0.101836	0.512038	0.512038	215.802170
TOTAL FLOW MOL/HR	250.752319	0.120930	0.483722	0.123680	0.607403	0.607403	251.359711
LB/HR	54397.386719	25.993713	103.974915	25.974701	129.949646	129.949646	54527.332031
	LIQ	LIQ	LIQ	LIQ2	LIQ	LIQ	LIQ

STREAM SUMMARY

TOTAL		
STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#4
PRESSURE PSIA	745.00	735.00
TEMPERATURE DEG,F	482.70	478.14
ENTHALPY BTU/HR	-35859136.00	-36044400.00
LIQ. DENSITY,LB/CUFT	35.473785	35.594376
AVE. MOL WT	216.930008	216.930008
FLOW RATES MOLES/HR		
HYDROGEN	16.624664	16.624664
CARBON MONOXIDE	6.356624	6.356624
CARBON DIOXIDE	3.547398	3.547398
METHANE	4.955025	4.955025
NITROGEN	0.597591	0.597591
WATER	2.64869E-10	2.64869E-10
METHANOL	3.377596	3.377596
ETHANOL	9.95973E-02	9.95973E-02
WITCO 40 OIL	215.814484	215.814484
TOTAL FLOW MOL/HR	251.372940	251.372940
LB/HR	54530.332031	54530.332031
	LIQ	LIQ

NOTES
1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION: TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 27.71 CPU SECONDS

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH FLUIDIZED/KT GAS: FK-2750

T.R.TSAO
87-7-1533

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Case FK-2750

STREAM SUMMARY

TOTAL							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	335.00	750.00	750.00	740.00	715.00
TEMPERATURE DEG.F	100.00	335.22	120.00	335.01	205.17	402.00	863.18
DEW POINT DEG.F						102.65	213.97
ENTHALPY BTU/HR	-1090524.00	-1013941.19	-1084395.00	-1013960.75	-3910410.00	-3730897.00	-3730897.00
VAP. DENSITY,LB/CUFT	0.370654	0.638505	0.794842	1.278620	1.915648	1.453766	1.071272
AVE. MOL WT	14.898660	14.898660	14.898660	14.898660	18.584152	18.584152	21.700775
FLOW RATES MOLES/HR							
HYDROGEN	23.477997	23.477997	23.477997	23.477997	47.093994	47.093994	29.586212
CARBON MONOXIDE	22.709991	22.709991	22.709991	22.709991	74.479980	74.479980	64.969177
CARBON DIOXIDE	0.104560	0.104560	0.104560	0.104560	2.389560	2.389560	2.894155
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.126280	0.126280	0.126280	0.126280	0.622280	0.622280	0.622280
WATER	0.0	0.0	0.0	0.0	2.65000E-03	2.65000E-03	0.106221
METHANOL	0.0	0.0	0.0	0.0	0.792000	0.792000	8.581861
ETHANOL	0.0	0.0	0.0	0.0	3.40000E-02	3.40000E-02	0.642166
WITCO 40 OIL	0.0	0.0	0.0	0.0	4.00000E-05	4.00000E-05	4.00000E-05
TOTAL FLOW MOL/HR	46.418808	46.418808	46.418808	46.418808	125.414429	125.414429	107.402069
LB/HR	691.577881	691.577881	691.577881	691.577881	2330.720703	2330.720703	2330.708008
ACTUAL CFM	31.097229	18.052017	14.501365	9.014642	20.277908	26.720474	36.260757

STREAMS ARE ALL VAPOR

STREAM SUMMARY

TOTAL

STREAM NUMBER	20	25	30	32	35	38	45
NOTES - BELOW	#4	#4	#4			#2,4	
PRESSURE PSIA	715.00	710.00	700.00	700.00	690.00	690.00	685.00
TEMPERATURE DEG,F	482.00	481.99	300.40	300.40	110.00	100.00	111.00
DEW POINT DEG,F		481.99		300.40			
ENTHALPY BTU/HR	-40046560.00	-4125394.00	-4304907.00	-4228292.00	-4520351.00	-85768.81	-3646817.00
AVE. MOL WT	158.836838	22.543457	22.543457	21.728912	21.892380	18.019989	20.751114
FLOW RATES MOLES/HR							
HYDROGEN	41.689316	29.617172	29.617172	29.598190	29.6019[illegible]	0.0	29.577698
CARBON MONOXIDE	81.575775	65.003281	65.003281	64.975113	64.988743	0.0	64.885666
CARBON DIOXIDE	3.777881	2.895759	2.895759	2.893308	2.893797	0.0	2.855729
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.964392	0.622995	0.622995	0.622485	0.622587	0.0	0.621776
WATER	0.106221	0.106221	0.106221	0.106221	0.106221	0.700000	3.30370E-02
METHANOL	13.375248	8.583569	8.583569	8.571045	8.573549	0.0	0.992185
ETHANOL	1.680047	0.629762	0.629762	0.626860	0.627440	0.0	4.27914E-02
WITCO 40 OIL	215.770905	0.400970	0.400970	1.63629E-02	9.32842E-02	0.0	5.00636E-05
TOTAL FLOW MOL/HR	358.939697	107.859680	107.859680	107.409546	107.499557	0.700000	99.008881
LB/HR	57012.843750	2431.530029	2431.530029	2333.892578	2353.420898	12.613992	2054.544434

LIQUID

ENTHALPY BTU/HR	-35933328.00	0.0	-76635.06	0.0	-882112.69	-85768.81	0.0
LIQ. DENSITY,LB/CUFT	35.634705	0.0	40.271378	0.0	0.0	61.967270	0.0
AVE. MOL WT	217.098236	0.0	216.758682	0.0	35.137390	18.019989	0.0
FLOW RATES MOLES/HR							
HYDROGEN	12.220123	0.0	1.90802E-02	0.0	2.72869E-02	0.0	0.0
CARBON MONOXIDE	16.737701	0.0	2.83057E-02	0.0	0.120097	0.0	0.0
CARBON DIOXIDE	0.890105	0.0	2.46237E-03	0.0	4.28258E-02	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.344284	0.0	5.13016E-04	0.0	9.55664E-04	0.0	0.0
WATER	0.0	0.0	4.25167E-11	0.0	0.100997	0.700000	0.0
METHANOL	4.827169	0.0	1.25923E-02	0.0	7.531105	0.0	0.0
ETHANOL	1.055299	0.0	2.91941E-03	0.0	0.586268	0.0	0.0
WITCO 40 OIL	215.374146	0.0	0.384658	0.0	9.32364E-02	0.0	0.0
TOTAL LIQ. MOL/HR	251.448792	0.0	0.450531	0.0	8.502769	0.700000	0.0
LB/HR	54589.085938	0.0	97.656494	0.0	298.764893	12.613992	0.0

LIQUID 1

ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-875358.25	0.0	0.0
LIQI DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	47.795700	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	34.386841	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	2.58702E-02	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	0.117777	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	4.23272E-02	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	9.21017E-04	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.100997	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	7.530669	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	0.586190	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	6.33769E-02	0.0	0.0

TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	8.468127	0.0	0.0
LB/HR	0.0	0.0	0.0	0.0	291.192139	0.0	0.0
LIQUID 2							
ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-6754.49	0.0	0.0
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	44 373154	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	218.611191	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	1.41672E-03	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	2.31918E-03	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	4.98585E-04	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	3.46466E-05	0.0	0.0
WATER	0.0	0.0	0.0	0.0	1.00004E-12	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	4.35865E-04	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	7.75799E-05	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	2.98595E-02	0.0	0.0
TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.034642	0.0	0.0
LB/HR	0.0	0.0	0.0	0.0	7.573143	0.0	0.0
VAPOR							
ENTHALPY BTU/HR	-4113199.00	-4125394.00	-4228271.00	-4228292.00	-3646939.00	0.0	-3646817.00
VAP. DENSITY,LB/CUFT	1.565289	1.554235	1.845561	1.845540	2.326351	0.0	2.304755
AVE. MOL WT	22.548431	22.543457	21.728821	21.728912	20.754776	0.0	20.751114
FLOW RATES MOLES/HR							
HYDROGEN	29.469193	29.617172	29.598083	29.598190	29.574677	0.0	29.577698
CARBON MONOXIDE	64.838074	65.003281	64.974976	64.975113	64.860641	0.0	64.885666
CARBON DIOXIDE	2.887775	2.895759	2.893296	2.893308	2.850970	0.0	2.855729
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.620108	0.622995	0.622482	0.622485	0.621631	0.0	0.621776
WATER	0.106221	0.106221	0.106221	0.106221	5.22422E-03	0.0	3.30370E-02
METHANOL	8.548079	8.583569	8.570976	8.571045	1.042444	0.0	0.992185
ETHANOL	0.624748	0.629762	0.626843	0.626860	4.11723E-02	0.0	4.27914E-02
WITCO 40 OIL	0.396757	0.400970	1.63119E-02	1.63629E-02	4.77412E-05	0.0	5.00636E-05
TOTAL VAPOR MOL/HR	107.490906	107.859680	107.409149	107.409546	98.996750	0.0	99.008881
LB/HR	2423.751221	2431.530029	2333.874023	2333.892578	2054.655273	0.0	2054.544434
ACTUAL CFM	25.807281	26.074234	21.076691	21.076859	14.720160	0.0	14.857287

STREAM SUMMARY

TOTAL	STREAM NUMBER	50	54	55	57	60	62	65
	NOTES - BELOW	#4	#4	#1	#1,4		#4	#4
	PRESSURE PSIA	685.00	685.00	685.00	750.00	685.00	20.00	20.00
	TEMPERATURE DEG,F	111.00	111.00	111.00	132.13	111.00	108.96	108.96
	DEW POINT DEG,F						108.96	
	BUBBLE PT DEG,F							108.96
	ENTHALPY BTU/HR	-736400.81	-2910415.00	-2968312.00	-2896450.00	-950767.88	-13649.44	-937117.88
	LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.157944	0.0	49.557159
	LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.157944	0.0	0.0
	VAP. DENSITY,LB/CUFT	2.304755	2.304755	2.304525	2.424841	0.0	0.095037	0.0
	AVE. MOL WT	20.751129	20.751114	20.749802	20.749802	32.097534	28.829468	32.167007
	FLOW RATES MOLES/HR							
	HYDROGEN	5.972616	23.605072	23.615997	23.615997	2.07488E-02	2.05670E-02	1.81817E-04
	CARBON MONOXIDE	13.102345	51.783310	51.769989	51.769989	8.92947E-02	8.74515E-02	1.84315E-03
	CARBON DIOXIDE	0.576657	2.279072	2.285000	2.285000	3.68308E-02	3.00597E-02	6.77105E-03
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.125555	0.496221	0.496000	0.496000	7.24909E-04	7.12430E-04	1.24788E-05
	WATER	6.67114E-03	2.63658E-02	2.65000E-03	2.65000E-03	0.773184	1.75075E-03	0.771433
	METHANOL	0.200352	0.791834	0.792000	0.792000	7.580351	4.69016E-02	7.533449
	ETHANOL	8.64085E-03	3.41505E-02	3.40000E-02	3.40000E-02	0.584453	2.04483E-03	0.582408
	WITCO 40 OIL	1.01093E-05	3.99542E-05	4.00000E-05	4.00000E-05	1.70170E-02	2.04794E-06	1.70150E-02
	TOTAL FLOW MOL/HR	19.992328	79.016022	78.995621	78.995621	9.102602	0.189490	8.913112
	LB/HR	414.873535	1639.670410	1639.143311	1639.143311	292.170898	5.462889	286.708008
	ACTUAL CFM	3.000121	11.857155	11.854526	11.266329	0.0	0.957997	0.0
		VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY

TOTAL

STREAM NUMBER	75	76	77	78	80	83	89
NOTES - BELOW	#4	#4			#2,4	#2,4	#4
PRESSURE PSIA	710.00	700.00	700.00	685.00	685.00	710.00	745.00
TEMPERATURE DEG,F	481.99	300.40	300.40	111.00	265.80	265.86	482.86
BUBBLE PT DEG,F	481.99	300.40					
ENTHALPY BTU/HR	-35921136.00	-15321.54	-61286.15	-17209.13	-78495.25	-78476.94	-35950[illegible]00.00
LIQ. DENSITY,LB/CUFT	35.657761	40.282776	40.282776	49.157944	41.073166	41.071793	35.634506
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	44.420074	0.0	0.0	0.0
AVE. MOL WT	217.386124	216.906281	216.906265	219.465149	217.408966	217.408966	217.386154
FLOW RATES MOLES/HR							
HYDROGEN	12.072144	3.79392E-03	1.51757E-02	3.51491E-03	1.86906E-02	1.86906E-02	12.090834
CARBON MONOXIDE	16.572495	5.63329E-03	2.25332E-02	5.77578E-03	2.83090E-02	2.83090E-02	16.600800
CARBON DIOXIDE	0.882122	4.90130E-04	1.96052E-03	1.23642E-03	3.19694E-03	3.19694E-03	0.885319
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.341397	1.02087E-04	4.08348E-04	8.63717E-05	4.94720E-04	4.94720E-04	0.341891
WATER	0.0	8.39855E-12	3.35942E-11	1.45882E-11	4.81823E-11	4.81823E-11	4.81823E-11
METHANOL	4.791679	2.50470E-03	1.00188E-02	1.01225E-03	1.10310E-02	1.10310E-02	4.802710
ETHANOL	1.050284	5.80516E-04	2.32206E-03	1.95941E-04	2.51800E-03	2.51800E-03	1.052802
WITCO 40 OIL	215.369934	7.69213E-02	0.307686	7.62171E-02	0.383903	0.383903	215.753830
TOTAL FLOW MOL/HR	251.080017	0.090026	0.360104	0.088039	0.448143	0.448143	251.528152
LB/HR	54581.308594	19.527191	78.108841	19.321411	97.430267	97.430267	54678.734375
	LIQ	LIQ	LIQ	LIQ2	LIQ	LIQ	LIQ

STREAM SUMMARY

TOTAL

STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#4
PRESSURE PSIA	745.00	735.00
TEMPERATURE DEG,F	482.86	473.87
ENTHALPY BTU/HR	-35950592.00	-36315664.00
LIQ. DENSITY,LB/CUFT	35.633942	35.873840
AVE. MOL WT	217.391464	217.391464
FLOW RATES MOLES/HR		
HYDROGEN	12.103110	12.103110
CARBON MONOXIDE	16.606598	16.606598
CARBON DIOXIDE	0.883726	0.883726
METHANE	0.0	0.0
NITROGEN	0.342112	0.342112
WATER	4.87067E-11	4.87067E-11
METHANOL	4.793387	4.793387
ETHANOL	1.037881	1.037881
WITCO 40 OIL	215.770874	215.770874
TOTAL FLOW MOL/HR	251.537643	251.537643
LB/HR	54682.132813	54682.132813
	LIQ	LIQ

NOTES

1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION: TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 41.56 CPU SECONDS

Case FK-1750

STREAM SUMMARY   AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS   V.H.EISENHA   21JAN.82   PAGE   8
VERSION 82.021-A   LPMEOH FLUIDIZED/K-T MIN PRODN: FK-1570   87-7-1533   17:21:30

STREAM SUMMARY

TOTAL							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#1,4	#4
PRESSURE PSIA	150.00	287.00	282.00	550.00	550.00	540.00	515.00
TEMPERATURE DEG,F	100.00	261.91	120.00	293.27	241.01	503.00	717.84
DEW POINT DEG,F							156.80
ENTHALPY BTU/HR	-1269828.00	-1222689.00	-1264395.00	-1213707.00	-1926855.00	-1808823.00	-1808823.00
VAP. DENSITY,LB/CUFT	0.449639	0.663442	0.813572	1.203411	1.335936	0.953338	0.797885
AVE. MOL WT	18.050034	18.050034	18.050034	18.050034	18.544342	18.544342	19.873077
FLOW RATES MOLES/HR							
HYDROGEN	16.309998	16.309998	16.309998	16.309998	23.479996	23.479996	19.453690
CARBON MONOXIDE	24.269989	24.269989	24.269989	24.269989	37.134979	37.134979	34.913666
CARBON DIOXIDE	0.720000	0.720000	0.720000	0.720000	1.219999	1.219999	1.358768
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.110000	0.110000	0.110000	0.110000	0.174000	0.174000	0.174000
WATER	0.0	0.0	0.0	0.0	1.00000E-02	1.80000E-02	1.75429E-02
METHANOL	0.0	0.0	0.0	0.0	0.260000	0.260000	2.049905
ETHANOL	0.0	0.0	0.0	0.0	1.30000E-02	1.30000E-02	0.159312
WITCO 40 OIL	0.0	0.0	0.0	0.0	1.00000E-05	1.00000E-05	1.00000E-05
TOTAL FLOW MOL/HR	41.409958	41.409958	41.409958	41.409958	62.291916	62.291916	58.126846
LB/HR	747.450928	747.450928	747.450928	747.450928	1155.162354	1155.162354	1155.159180
ACTUAL CFM	27.705627	18.777100	15.312116	10.309004	14.411409	20.195053	24.129593

STREAMS ARE ALL VAPOR

STREAM SUMMARY

TOTAL

STREAM NUMBER	20	25	30	32	35	38	45
NOTES - BELOW	#4	#4	#4			#2,4	
PRESSURE PSIA	515.00	510.00	500.00	500.00	490.00	590.00	485.00
TEMPERATURE DEG,F	518.00	517.98	317.72	318.25	110.00	110.00	110.00
DEW POINT DEG,F		517.98		318.25			
ENTHALPY BTU/HR	-35746944.00	-1962833.00	-2080865.00	-1988732.00	-2122871.00	-20922.10	-1945371.00
AVE. MOL WT	187.550339	21.813324	21.813324	19.938492	20.316162	18.019989	19.522125
FLOW RATES MOLES/HR							
HYDROGEN	27.920456	19.470413	19.470413	19.453796	19.457108	0.0	19.450485
CARBON MONOXIDE	46.215249	34.938644	34.938644	34.915421	34.920059	0.0	34.903488
CARBON DIOXIDE	1.858758	1.360917	1.360917	1.359201	.359544	0.0	1.354306
METHANE	0.0	0.0	0.0	0.0	0	0.0	0.0
NITROGEN	0.295842	0.174411	0.174411	0.174191	0.174235	0.0	0.174146
WATER	1.75429E-02	1.75429E-02	1.75429E-02	1.75429E-02	1.75429E-02	0.171000	2.77779E-02
METHANOL	3.477294	2.055002	2.055002	2.050904	2.051723	0.0	0.693439
ETHANOL	0.480698	0.161746	0.161746	0.160766	0.160962	0.0	3.60832E-02
WITCO 40 OIL	215.839401	0.494321	0.494321	1.62224E-02	0.111842	0.0	3.32781E-05
TOTAL FLOW MOL/HR	296.104980	58.672958	58.672958	58.148026	58.253006	0.171003	56.639709
LB/HR	55534.585938	1279.852051	1279.852051	1159.383789	1183.477295	3.081417	1105.727295

LIQUID

ENTHALPY BTU/HR	-33792976.00	0.0	-91928.00	0.0	-174779.75	-20922.10	0.0
LIQ. DENSITY,LB/CUFT	35.380753	0.0	40.702026	0.0	0.0	61.833420	0.0
AVE. MOL WT	228.255081	0.0	229.519318	0.0	48.309799	18.019989	0.0
FLOW RATES MOLES/HR							
HYDROGEN	8.573242	0.0	1.65796E-02	0.0	6.96459E-03	0.0	0.0
CARBON MONOXIDE	11.415451	0.0	2.31820E-02	0.0	1.96986E-02	0.0	0.0
CARBON DIOXIDE	0.503619	0.0	1.71587E-03	0.0	5.62774E-03	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.122646	0.0	2.19619E-04	0.0	9.80236E-05	0.0	0.0
WATER	0.0	0.0	3.37815E-12	0.0	1.42418E-02	0.171000	0.0
METHANOL	1.435139	0.0	4.09994E-03	0.0	1.296435	0.0	0.0
ETHANOL	0.320716	0.0	9.80770E-04	0.0	0.124142	0.0	0.0
WITCO 40 OIL	215.352432	0.0	0.478277	0.0	0.111808	0.0	0.0
TOTAL LIQ. MOL/HR	237.723038	0.0	0.525855	0.0	1.579014	0.171000	0.0
LB/HR	54261.488281	0.0	120.510239	0.0	76.281830	3.081417	0.0

LIQUID 1

ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-152359.75	0.0	0.0
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	47.873260	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	34.742783	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	3.66651E-03	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	1.46780E-02	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	4.63761E-03	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	5.99723E-05	0.0	0.0
WATER	0.0	0.0	0.0	0.0	1.42418E-02	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	1.295226	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	0.123691	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	1.16688E-02	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	1.468068	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	51.004761	0.0	0.0
L	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-22420.02	0.0	0.0
I	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	45.291992	0.0	0.0
Q	AVE. MOL WT	0.0	0.0	0.0	0.0	227.832504	0.0	0.0
U	FLOW RATES MOLES/HR							
I	HYDROGEN	0.0	0.0	0.0	0.0	3.29809E-03	0.0	0.0
D	CARBON MONOXIDE	0.0	0.0	0.0	0.0	5.02060E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	9.90129E-04	0.0	0.0
2	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	3.80513E-05	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	1.18920E-12	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	1.20853E-03	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	2.51049E-04	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.100139	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.110946	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	25.277069	0.0	0.0
V	ENTHALPY BTU/HR	-1953951.00	-1962833.00	-1988935.00	-1988732.00	-1948092.00	0.0	-1945371.00
A	VAP. DENSITY,LB/CUFT	1.052593	1.042886	1.179970	1.179193	1.556845	0.0	1.539728
P	AVE. MOL WT	21.806320	21.813324	19.937790	19.938492	19.536240	0.0	19.522125
O	FLOW RATES MOLES/HR							
R	HYDROGEN	19.347214	19.470413	19.453827	19.453796	19.450119	0.0	19.450485
	CARBON MONOXIDE	34.799789	34.938644	34.915451	34.915421	34.900360	0.0	34.903688
	CARBON DIOXIDE	1.355139	1.360917	1.359200	1.359201	1.353915	0.0	1.354306
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.173196	0.174411	0.174191	0.174191	0.174137	0.0	0.174146
	WATER	1.75429E-02	1.75429E-02	1.75429E-02	1.75429E-02	3.30105E-03	0.0	2.77779E-02
	METHANOL	2.042155	2.055002	2.050901	2.050904	0.755287	0.0	0.693439
	ETHANOL	0.159782	0.161746	0.160765	0.160766	3.68199E-02	0.0	3.60832E-02
	WITCO 40 OIL	0.486969	0.494321	1.60436E-02	1.62224E-02	3.36383E-05	0.0	3.32781E-05
	TOTAL VAPOR MOL/HR	58.381943	58.672958	58.147983	58.148026	56.673935	0.0	56.639709
	LB/HR	1273.095215	1279.852051	1159.340576	1159.383789	1107.195557	0.0	1105.727295
	ACTUAL CFM	20.158066	20.453690	16.375259	16.386673	11.852989	0.0	11.968859

STREAM SUMMARY
VERSION 02.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH FLUIDIZED/K-T MIN PRODN: FK-1570

V.H.EISENHA
87-7-1533

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STREAM SUMMARY

TOTAL

STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1,4	#1,4		#4	#4
PRESSURE PSIA	485.00	485.00	485.00	550.00	485.00	20.00	20.00
TEMPERATURE DEG.F	110.00	110.00	110.00	139.40	110.00	108.96	108.96
DEW POINT DEG.F						108.96	
BUBBLE PT DEG.F							108.96
ENTHALPY BTU/HR	-1228278.00	-717092.50	-717505.50	-713148.94	-174599.25	-1547.97	-173051.13
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.478851	0.0	49.745651
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.478851	0.0	0.0
VAP. DENSITY,LB/CUFT	1.539728	1.539728	1.539976	1.655247	0.0	0.092080	0.0
AVE. MOL WT	19.522125	19.522141	19.524643	19.524643	32.009460	27.942444	32.065665
FLOW RATES MOLES/HR							
HYDROGEN	12.280747	7.169736	7.169999	7.169999	2.95176E-03	2.91074E-03	4.10115E-05
CARBON MONOXIDE	22.037537	12.865942	12.865000	12.865000	1.09961E-02	1.06459E-02	3.50177E-04
CARBON DIOXIDE	0.855089	0.499217	0.500000	0.500000	4.13852E-03	3.07978E-03	1.05874E-03
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.109953	6.41927E-02	6.40000E-02	6.40000E-02	4.68583E-05	4.56001E-05	1.26817E-06
WATER	1.75386E-02	1.02394E-02	1.00000E-02	1.00000E-02	0.160765	2.36211E-04	0.160529
METHANOL	0.437627	0.255612	0.260000	0.260000	1.357057	5.45722E-03	1.351599
ETHANOL	2.27824E-02	1.33008E-02	1.30000E-02	1.30000E-02	0.124606	2.86077E-04	0.124320
WITCO 40 OIL	2.10113E-05	1.22668E-05	1.00000E-05	1.00000E-05	2.47072E-03	2.35849E-07	2.47049E-03
TOTAL FLOW MOL/HR	35.761459	20.878220	20.881958	20.881958	1.663030	0.022662	1.640358
LB/HR	698.139648	407.587402	407.712646	407.712646	53.232681	0.633225	52.599426
ACTUAL CFM	7.556958	4.411887	4.412535	4.105252	0.0	0.114612	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY

TOTAL							
STREAM NUMBER	75	76	77	78	80	83	89
NOTES - BELOW	#4	#4			#2,4	#2,4	#2,4
PRESSURE PSIA	510.00	500.00	500.00	485.00	485.00	510.00	545.00
TEMPERATURE DEG,F	517.98	318.25	318.25	110.00	275.76	275.77	518.68
BUBBLE PT DEG,F	517.98	318.25					
ENTHALPY BTU/HR	-33784096.00	-18370.96	-73483.81	-24479.11	-97962.88	-97939.88	-33832368.00
LIQ. DENSITY,LB/CUFT	35.401764	40.686447	40.686447	49.478351	41.665131	41.664917	35.382339
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	45.264511	0.0	0.0	0.0
AVE. MOL WT	228.506378	229.490585	229.490601	227.786024	229.090897	229.090897	228.507706
FLOW RATES MOLES/HR							
HYDROGEN	8.450043	3.32126E-03	1.32850E-02	3.65796E-03	1.69430E-02	1.69430E-02	8.466986
CARBON MONOXIDE	11.276596	4.64232E-03	1.85693E-02	5.56990E-03	2.41392E-02	2.41392E-02	11.300735
CARBON DIOXIDE	0.497841	3.43005E-04	1.37202E-03	1.09361E-03	2.47063E-03	2.47063E-03	0.500311
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.121431	4.40003E-05	1.76001E-04	4.22449E-05	2.18246E-04	2.18246E-04	0.121649
WATER	0.0	6.74925E-13	2.69970E-12	1.09081E-11	1.36078E-11	1.36078E-11	1.36078E-11
METHANOL	1.422292	8.19564E-04	3.27826E-03	1.22659E-03	4.50485E-03	4.50485E-03	1.426796
ETHANOL	0.318952	1.96023E-04	7.84091E-04	2.72408E-04	1.05650E-03	1.05650E-03	0.320009
WITCO 40 OIL	215.345078	9.56196E-02	0.382479	0.109338	0.491817	0.491817	215.835884
TOTAL FLOW MOL/HR	237.432022	0.104986	0.419943	0.121206	0.541149	0.541149	237.973160
LB/HR	54254.730469	24.093246	96.373032	27.599243	123.972275	123.972275	54378.699219
	LIQ	LIQ	LIQ	LIQ2	LIQ	LIQ	LIQ

STREAM SUMMARY

TOTAL		
STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#4
PRESSURE PSIA	545.00	535.00
TEMPERATURE DEG,F	518.68	516.14
ENTHALPY BTU/HR	-33833072.00	-33938128.00
LIQ. DENSITY,LB/CUFT	35.382294	35.453888
AVE. MOL WT	228.505798	228.505798
FLOW RATES MOLES/HR		
HYDROGEN	8.466772	8.466772
CARBON MONOXIDE	11.301579	11.301579
CARBON DIOXIDE	0.499991	0.499991
METHANE	0.0	0.0
NITROGEN	0.121842	0.121842
WATER	1.29744E-11	1.29744E-11
METHANOL	1.427389	1.427389
ETHANOL	0.321386	0.321386
WITCO 40 OIL	215.839401	215.839401
TOTAL FLOW MOL/HR	237.978333	237.978333
LB/HR	54379.425781	54379.425781
	LIQ	LIQ

NOTES

1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. <u>CAUTION</u>: TWO LIQUID PHASES NOT CONSIDERED. *RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 27.37 CPU SECONDS

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STREAM SUMMARY
VERSION 82.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/BALANCED MAX PRODN: EB-X954

BONNELL
87-7-1533

STREAM SUMMARY

TOTAL							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	365.00	950.00	950.00	940.00	915.00
TEMPERATURE DEG.F	100.00	333.30	120.00	378.78	175.45	370.00	743.64
DEW POINT DEG.F						103.41	229.80
ENTHALPY BTU/HR	-1418418.00	-1291209.00	-1407896.00	-1265368.00	-11579949.00	-11037388.00	-11037388.00
VAP. DENSITY,LB/CUFT	0.275162	0.475541	0.641910	1.134044	2.062237	1.549935	1.214838
AVE. MOL WT	11.068531	11.068531	11.068531	11.068531	15.035516	15.035516	17.521133
FLOW RATES MOLES/HR							
HYDROGEN	51.189987	51.189987	51.189987	51.189987	174.389984	174.389984	123.630386
CARBON MONOXIDE	24.059998	24.059998	24.059998	24.059998	86.449997	86.449997	62.642807
CARBON DIOXIDE	1.650000	1.650000	1.650000	1.650000	34.946991	34.946991	33.898575
METHANE	0.220000	0.220000	0.220000	0.220000	48.546982	48.546982	48.546982
NITROGEN	2.00000E-02	2.00000E-02	2.00000E-02	2.00000E-02	3.543999	3.543999	3.543999
WATER	0.0	0.0	0.0	0.0	0.111000	0.111000	1.411713
METHANOL	0.0	0.0	0.0	0.0	2.389999	2.389999	26.740982
ETHANOL	0.0	0.0	0.0	0.0	1.50000E-02	1.50000E-02	0.267304
WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW MOL/HR	77.139954	77.139954	77.139954	77.139954	350.393311	350.393311	300.682373
LB/HR	853.825928	853.825928	853.825928	853.825928	5268.343750	5268.343750	5268.292969
ACTUAL CFM	51.716553	29.924744	22.168884	12.548399	42.577805	56.651093	72.276978

STREAMS ARE ALL VAPOR

Case EB-X954

STREAM SUMMARY

TOTAL

STREAM NUMBER	20	25	30	32	35	38	45
NOTES - BELOW	#4	#4	#4			#2,4	
PRESSURE PSIA	915.00	910.00	900.00	900.00	890.00	890.00	885.00
TEMPERATURE DEG,F	482.01	482.00	300.24	300.24	110.00	100.00	110.83
DEW POINT DEG,F		482.00		300.24			
ENTHALPY BTU/HR	-57568480.00	-11911480.00	-12454061.00	-12281009.00	-13190355.00	-306296.06	-10370231.00
AVE. MOL WT	116.029831	18.203125	18.203125	17.552795	17.683228	18.019989	16.156082
FLOW RATES MOLES/HR							
HYDROGEN	153.268631	123.709167	123.709167	123.625305	123.642075	0.0	123.521851
CARBON MONOXIDE	72.812653	62.675201	62.675201	62.644684	62.650772	0.0	62.554703
CARBON DIOXIDE	40.166946	33.946793	33.946793	33.915985	33.922134	0.0	33.377136
METHANE	57.575378	48.579971	48.579971	48.550171	48.556122	0.0	48.398102
NITROGEN	4.673783	3.545218	3.545218	3.542253	3.542845	0.0	3.538059
WATER	1.411713	1.411712	1.411712	1.411712	1.411712	2.500000	0.112035
METHANOL	36.220856	26.788528	26.788528	26.741608	26.750977	0.0	2.413450
ETHANOL	0.541141	0.270494	0.270494	0.269052	0.269340	0.0	1.50010E-02
WITCO 40 OIL	269.934326	0.880471	0.880471	3.83675E-02	0.206788	0.0	1.19881E-04
TOTAL FLOW MOL/HR	636.604980	'301.806885	301.806885	300.738281	300.951904	2.500000	273.930176
LB/HR	73865.125000	5493.828125	5493.828125	5278.796875	5321.800781	45.049973	4425.636719

LIQUID

ENTHALPY BTU/HR	-45676592.00	0.0	-173043.06	0.0	-2824587.00	-306296.06	0.0
LIQ. DENSITY,LB/CUFT	34.604614	0.0	39.031647	0.0	0.0	61.967270	0.0
AVE. MOL WT	203.872894	0.0	201.276703	0.0	33.117844	18.019989	0.0
FLOW RATES MOLES/HR							
HYDROGEN	29.880783	0.0	8.38581E-02	0.0	0.136697	0.0	0.0
CARBON MONOXIDE	10.226974	0.0	3.05180E-02	0.0	0.120080	0.0	0.0
CARBON DIOXIDE	6.268677	0.0	3.07968E-02	0.0	0.607116	0.0	0.0
METHANE	9.070129	0.0	2.98039E-02	0.0	0.185307	0.0	0.0
NITROGEN	1.137325	0.0	2.[illegible]604E-03	0.0	5.60666E-03	0.0	0.0
WATER	1.90735E-06	0.0	2.4[illegible]557E-09	0.0	1.364987	2.500000	0.0
METHANOL	9.498306	0.0	4.6[illegible]200E-02	0.0	24.189545	0.0	0.0
ETHANOL	0.271997	0.0	1.44[illegible]16E-03	0.0	0.254859	0.0	0.0
WITCO 40 OIL	269.060791	0.0	0.[illegible]2299	0.0	0.206677	0.0	0.0
TOTAL LIQ. MOL/HR	335.414795	0.0	1.068603	0.0	27.070847	2.500000	0.0
LB/HR	68381.937500	0.0	215.0[illegible]4793	0.0	896.527832	45.049973	0.0

LIQUID II

ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-2795046.00	0.0	0.0
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	48.510986	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	32.156845	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	0.123276	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	0.114592	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.593563	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.178981	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	5.18128E-03	0.0	0.0
WATER	0.0	0.0	0.0	0.0	1.364987	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	24.186050	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	0.254767	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	8.55607E-02	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	26.906967	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	865.243164	0.0	0.0
L	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-29541.69	0.0	0.0
I	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	41.944458	0.0	0.0
Q	AVE. MOL WT	0.0	0.0	0.0	0.0	190.887741	0.0	0.0
U	FLOW RATES MOLES/HR							
I	HYDROGEN	0.0	0.0	0.0	0.0	1.34207E-02	0.0	0.0
D	CARBON MONOXIDE	0.0	0.0	0.0	0.0	5.48764E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	1.35346E-02	0.0	0.0
2	METHANE	0.0	0.0	0.0	0.0	6.32662E-03	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	4.25390E-04	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	2.38673E-10	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	3.48851E-03	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	9.19538E-05	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.121116	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.163891	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	31.284866	0.0	0.0
V	ENTHALPY BTU/HR	-11891866.00	-11911480.00	-12281009.00	-12281009.00	-10365798.00	0.0	-10370231.00
A	VAP. DENSITY,LB/CUFT	1.618416	1.609595	1.927362	1.927361	2.351846	0.0	2.334481
P	AVE. MOL WT	18.205048	18.203125	17.552628	17.552795	16.157623	0.0	16.156082
O	FLOW RATES MOLES/HR							
R	HYDROGEN	123.367848	123.709167	123.625305	123.625305	123.505371	0.0	123.521851
	CARBON MONOXIDE	62.585678	62.675201	62.644684	62.644684	62.530685	0.0	62.554703
	CARBON DIOXIDE	33.898270	33.946793	33.915985	33.915985	33.315002	0.0	33.377136
	METHANE	48.505249	48.579971	48.550156	48.550171	48.370804	0.0	48.398102
	NITROGEN	3.536458	3.545218	3.542252	3.542253	3.537238	0.0	3.538059
	WATER	1.411711	1.411712	1.411712	1.411712	4.67244E-02	0.0	0.112035
	METHANOL	26.722549	26.788528	26.741608	26.741608	2.561426	0.0	2.413450
	ETHANOL	0.269144	0.270494	0.269052	0.269052	1.44818E-02	0.0	1.50010E-02
	WITCO 40 OIL	0.873458	0.880471	3.81720E-02	3.83675E-02	1.11104E-04	0.0	1.19881E-04
	TOTAL VAPOR MOL/HR	301.189697	301.806885	300.738281	300.738281	273.881348	0.0	273.930176
	LB/HR	5483.171875	5493.828125	5278.746094	5278.796875	4425.269531	0.0	4425.636719
	ACTUAL CFM	56.466446	56.886215	45.647446	45.647949	31.368229	0.0	31.596054

STREAM SUMMARY

TOTAL	50	54	55	57	60	62	65
STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1,4	#1,4		#4	#4
PRESSURE PSIA	885.00	885.00	885.00	950.00	885.00	20.00	20.00
TEMPERATURE DEG,F	110.83	110.83	110.00	125.33	110.83	104.19	104.19
DEW POINT DEG,F						104.19	
BUBBLE PT DEG,F							104.19
ENTHALPY BTU/HR	-17271.32	-10352956.00	-10346293.00	-10314581.00	-3081865.00	-107778.44	-2974083.00
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.658737	0.0	50.229095
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.658737	0.0	0.0
VAP. DENSITY,LB/CUFT	2.334481	2.334481	2.338123	2.436488	0.0	0.106008	0.0
AVE. MOL WT	16.156082	16.156097	16.155380	16.155380	30.522278	31.808578	30.475159
FLOW RATES MOLES/HR							
HYDROGEN	0.205722	123.316086	123.199997	123.199997	0.101846	9.93629E-02	2.48349E-03
CARBON MONOXIDE	0.104183	62.450500	62.389999	62.389999	8.85128E-02	8.59734E-02	2.53546E-03
CARBON DIOXIDE	5.55886E-02	33.321533	33.296997	33.296997	0.526325	0.462904	6.34201E-02
METHANE	8.06056E-02	48.317474	48.326996	48.326996	0.149305	0.143468	5.83684E-03
NITROGEN	5.89253E-03	3.532166	3.523999	3.523999	4.19647E-03	4.08209E-03	1.14385E-04
WATER	1.86591E-04	0.111848	0.111000	0.111000	3.799677	1.15018E-02	3.788175
METHANOL	4.01953E-03	2.409430	2.389999	2.389999	24.333267	0.226663	24.106598
ETHANOL	2.49837E-05	1.49760E-02	1.50000E-02	1.50000E-02	0.254218	1.40724E-03	0.252810
WITCO 40 OIL	1.99658E-07	1.19681E-04	0.0	0.0	2.19663E-02	9.94952E-06	2.19564E-02
TOTAL FLOW MOL/HR	0.456223	273.473633	273.253418	273.253418	29.279297	1.035372	28.243912
LB/HR	7.370771	4418.265625	4414.511719	4414.511719	893.670654	32.933701	860.737549
ACTUAL CFM	0.052623	31.543488	31.467590	30.197205	0.0	5.179864	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY

TOTAL							
STREAM NUMBER	75	76	77	78	80	83	89
NOTES - BELOW	#4	#4			#2,4	#4	#4
PRESSURE PSIA	910.00	900.00	900.00	885.00	885.00	910.00	945.00
TEMPERATURE DEG,F	482.00	300.24	300.24	110.83	262.39	262.56	482.62
BUBBLE PT DEG,F	482.00	300.24					
ENTHALPY BTU/HR	-45656776.00	-34601.07	-138404.25	-44493.20	-182897.44	-182854.75	-45775840.00
LIQ. DENSITY,LB/CUFT	34.631424	39.031250	39.031250	49.658737	39.714432	39.710602	34.614868
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	42.302536	0.0	0.0	0.0
AVE. MOL WT	204.216827	201.271973	201.271988	195.714249	200.042068	200.042068	204.263140
FLOW RATES MOLES/HR							
HYDROGEN	29.559464	1.67699E-02	6.70797E-02	1.83582E-02	8.54379E-02	8.54379E-02	29.644897
CARBON MONOXIDE	10.137451	6.10297E-03	2.44119E-02	7.54448E-03	3.19564E-02	3.19564E-02	10.169407
CARBON DIOXIDE	6.220154	6.15865E-03	2.46346E-02	1.86518E-02	4.32864E-02	4.32864E-02	6.263440
METHANE	8.995407	5.96015E-03	2.38406E-02	8.70287E-03	3.25435E-02	3.25435E-02	9.027950
NITROGEN	1.128565	5.93153E-04	2.37261E-03	5.87934E-04	2.96055E-03	2.96055E-03	1.131525
WATER	9.53674E-07	4.84961E-10	1.93984E-09	5.64691E-10	2.50453E-09	2.50453E-09	9.56178E-07
METHANOL	9.432327	9.38258E-03	3.75303E-02	4.24897E-03	4.17793E-02	4.17793E-02	9.474106
ETHANOL	0.270647	2.88390E-04	1.15356E-03	1.21773E-04	1.27533E-03	1.27533E-03	0.271922
WITCO 40 OIL	269.053711	0.168421	0.673682	0.184702	0.858384	0.858384	269.911865
TOTAL FLOW MOL/HR	334.797607	0.213676	0.854706	0.242918	1.097623	1.097623	335.895020
LB/HR	68371.250000	43.007050	172.028275	47.542450	219.570740	219.570740	68590.812500
	LIQ	LIQ	LIQ	LIQ2	LIQ	LIQ	LIQ

STREAM SUMMARY

TOTAL		
STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#4
PRESSURE PSIA	945.00	935.00
TEMPERATURE DEG,F	482.60	467.92
ENTHALPY BTU/HR	-45781856.00	-46531104.00
LIQ. DENSITY,LB/CUFT	34.615616	34.995331
AVE. MOL WT	204.204407	204.204407
FLOW RATES MOLES/HR		
HYDROGEN	29.638245	29.638245
CARBON MONOXIDE	10.169850	10.169850
CARBON DIOXIDE	6.268373	6.268373
METHANE	9.028399	9.028399
NITROGEN	1.129785	1.129785
WATER	2.52267E-09	2.52267E-09
METHANOL	9.479876	9.479876
ETHANOL	0.273837	0.273837
WITCO 40 OIL	269.934326	269.934326
TOTAL FLOW MOL/HR	335.922607	335.922607
LB/HR	68596.875000	68596.875000
	LIQ	LIQ

NOTES

1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION: TWO LIQUID PHASES NOT CONSIDERED. RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 34.43 CPU SECONDS

STREAM SUMMARY
VERSION 82.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/LURGI: EL-6752

T.R.TSAO
87-7-1533

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15:29:10

STREAM SUMMARY

TOTAL							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	335.00	750.00	750.00	740.00	715.00
TEMPERATURE DEG,F	100.00	325.29	120.00	325.78	176.46	395.00	672.93
DEW POINT DEG,F						105.42	201.53
ENTHALPY BTU/HR	-671626.75	-626617.13	-667916.13	-626545.56	-3602679.00	-3414431.00	-3414431.00
VAP. DENSITY,LB/CUFT	0.315538	0.550684	0.677133	1.102942	1.636417	1.193558	0.974652
AVE. MOL WT	12.675305	12.675305	12.675305	12.675305	15.075493	15.075493	16.857285
FLOW RATES MOLES/HR							
HYDROGEN	16.319992	16.319992	16.319992	16.319992	53.919983	53.919983	42.227661
CARBON MONOXIDE	7.856000	7.856000	7.856000	7.856000	26.755981	26.755981	21.236221
CARBON DIOXIDE	1.469999	1.469999	1.469999	1.469999	10.879999	10.879999	10.662398
METHANE	1.660000	1.660000	1.660000	1.660000	15.030000	15.030000	15.030000
NITROGEN	0.120000	0.120000	0.120000	0.120000	1.070000	1.070000	1.070000
WATER	0.0	0.0	0.0	0.0	2.70000E-02	2.70000E-02	0.306139
METHANOL	0.0	0.0	0.0	0.0	0.865000	0.865000	6.479280
ETHANOL	0.0	0.0	0.0	0.0	5.30000E-03	5.30000E-03	6.68387E-02
WITCO 40 OIL	0.0	0.0	0.0	0.0	4.00000E-05	4.00000E-05	4.00000E-05
TOTAL FLOW MOL/HR	27.425949	27.425949	27.425949	27.425949	108.553223	108.553223	97.078537
LB/HR	347.632080	347.632080	347.632080	347.632080	1636.493164	1636.493164	1636.480469
ACTUAL CFM	18.361862	10.521221	8.556461	5.253101	16.667435	22.851746	27.984009

STREAMS ARE ALL VAPOR

Case EL-6752

STREAM SUMMARY

TOTAL

	20	25	30	32	35	38	45
STREAM NUMBER	20	25	30	32	35	38	45
NOTES - BELOW	#4	#4	#4			#2,4	
PRESSURE PSIA	715.00	710.00	700.00	700.00	690.00	690.00	685.00
TEMPERATURE DEG.F	482.00	481.99	284.12	283.27	110.00	100.00	109.97
DEW POINT DEG.F		481.99		283.27			
ENTHALPY BTU/HR	-39535728.00	-3635037.00	-3823285.00	-3752281.00	-3995316.00	-33082.27	-3355355.00
AVE. MOL WT	161.150482	17.729401	17.729401	16.883942	17.053604	18.019989	15.890015
FLOW RATES MOLES/HR							
HYDROGEN	58.320496	42.2[illegible]140	42.246140	42.221573	42.226471	0.0	42.202087
CARBON MONOXIDE	27.382874	21.244247	21.244247	21.234512	21.236450	0.0	21.216095
CARBON DIOXIDE	14.297179	10.682517	10.682517	10.672491	10.674496	0.0	10.572238
METHANE	20.078506	15.039678	15.039678	15.030800	15.032575	0.0	15.003041
NITROGEN	1.683623	1.070206	1.070206	1.069365	1.069532	0.0	1.068634
WATER	0.306139	0.306139	0.306139	0.306139	0.306139	0.270000	3.02973E-02
METHANOL	10.621188	6.490904	6.490904	6.480024	6.482200	0.0	0.966367
ETHANOL	0.183752	6.60120E-02	6.60120E-02	6.56724E-02	6.57403E-02	0.0	5.91319E-03
WITCO 40 OIL	215.818054	0.362612	0.362612	9.78546E-03	8.03507E-02	0.0	4.33624E-05
TOTAL FLOW MOL/HR	348.691650	97.508423	97.508423	97.090347	97.173950	0.270000	91.064651
LB/HR	56191.824219	1728.765869	1728.765869	1639.267578	1657.166016	4.865396	1447.018555

LIQUID

	20	25	30	32	35	38	45
ENTHALPY BTU/HR	-35912624.00	0.0	-71598.00	0.0	-639088.13	-33082.27	0.0
LIQ. DENSITY,LB/CUFT	35.502167	0.0	40.346024	0.0	0.0	61.967270	0.0
AVE. MOL WT	216.536545	0.0	214.632431	0.0	34.371353	18.019989	0.0
FLOW RATES MOLES/HR							
HYDROGEN	16.259155	0.0	2.41019E-02	0.0	2.55879E-02	0.0	0.0
CARBON MONOXIDE	6.199509	0.0	9.56132E-03	0.0	2.24729E-02	0.0	0.0
CARBON DIOXIDE	3.647156	0.0	9.82907E-03	0.0	0.107235	0.0	0.0
METHANE	5.085999	0.0	8.72152E-03	0.0	3.16768E-02	0.0	0.0
NITROGEN	0.618422	0.0	8.27238E-04	0.0	9.56321E-04	0.0	0.0
WATER	0.5	0.0	1.81178E-10	0.0	0.288535	0.270000	0.0
METHANOL	4.160729	0.0	1.06263E-02	0.0	5.479515	0.0	0.0
ETHANOL	[illegible].118276	0.0	3.31137E-04	0.0	5.98573E-02	0.0	0.0
WITCO 40 OIL	215.459366	0.0	0.352536	0.0	8.03071E-02	0.0	0.0
TOTAL LIQ. MOL/HR	251.548492	0.0	0.416535	0.0	6.096140	0.270000	0.0
LB/HR	54469.437500	0.0	89.401840	0.0	209.532578	4.865396	0.0

LIQUID 1

	20	25	30	32	35	38	45
ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-625101.00	0.0	0.0
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	48.535919	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	0.0	32.270233	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	0.0	2.13176E-02	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	0.0	2.06175E-02	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.102735	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	2.96822E-02	0.0	0.0
NITROGEN	0.0	0.0	0.0	0.0	8.26575E-04	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.288535	0.0	0.0
METHANOL	0.0	0.0	0.0	0.0	5.478323	0.0	0.0
ETHANOL	0.0	0.0	0.0	0.0	5.98262E-02	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	0.0	2.09407E-02	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	6.022802	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	194.357224	0.0	0.0
LIQUID 2	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-13987.18	0.0	0.0
	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	43.348067	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	0.0	206.923782	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	4.27032E-03	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	1.85543E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	4.49938E-03	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	1.99455E-03	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	1.29746E-04	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	2.38543E-11	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	1.19154E-03	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	3.10236E-05	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	5.93665E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.073338	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	15.175444	0.0	0.0
VAPOR	ENTHALPY BTU/HR	-3623099.00	-3635037.00	-3751687.00	-3752281.00	-3356228.00	0.0	-3355355.00
	VAP. DENSITY,LB/CUFT	1.234344	1.225801	1.471037	1.472763	1.793103	0.0	1.779609
	AVE. MOL WT	17.730347	17.729401	16.884674	16.883942	15.894503	0.0	15.890815
	FLOW RATES MOLES/HR							
	HYDROGEN	42.061340	42.246140	42.222031	42.221573	42.200867	0.0	42.202087
	CARBON MONOXIDE	21.183365	21.244247	21.234680	21.234512	21.213959	0.0	21.216095
	CARBON DIOXIDE	10.650023	10.682517	10.672688	10.672491	10.567261	0.0	10.572238
	METHANE	14.992508	15.039678	15.030955	15.030800	15.000896	0.0	15.003041
	NITROGEN	1.065202	1.070206	1.069378	1.069365	1.068576	0.0	1.068634
	WATER	0.306139	0.306139	0.306139	0.306139	1.76038E-02	0.0	3.02973E-02
	METHANOL	6.460459	6.490904	6.480277	6.480024	1.002685	0.0	0.966367
	ETHANOL	6.54757E-02	6.60120E-02	6.56808E-02	6.56724E-02	5.88303E-03	0.0	5.91319E-03
	WITCO 40 OIL	0.358686	0.362612	1.00756E-02	9.78546E-03	4.35346E-05	0.0	4.33624E-05
	TOTAL VAPOR MOL/HR	97.143158	97.508423	97.091888	97.090347	91.077728	0.0	91.064651
	LB/HR	1722.381836	1728.765869	1639.364746	1639.267578	1447.635010	0.0	1447.018555
	ACTUAL CFM	23.256378	23.505234	18.573792	18.550919	13.455583	0.0	13.551844

STREAM SUMMARY

TOTAL

STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1	#1,4		#4	#4
PRESSURE PSIA	685.00	685.00	685.00	750.00	685.00	20.00	20.00
TEMPERATURE DEG,F	109.97	109.97	109.98	129.70	109.97	103.97	103.97
DEW POINT DEG,F						103.97	
BUBBLE PT DEG,F							103.97
ENTHALPY BTU/HR	-365171.56	-2990183.04	-2988203.00	-2975134.00	-657066.94	-19980.19	-637086.25
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.176254	0.0	49.684326
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.176254	0.0	0.0
VAP. DENSITY,LB/CUFT	1.779609	1.779609	1.779241	1.877176	0.0	0.105447	0.0
AVE. MOL WT	15.890013	15.890018	15.886910	15.886910	31.328415	31.630569	31.318756
FLOW RATES MOLES/HR							
HYDROGEN	4.592957	37.609116	37.599991	37.599991	1.93458E-02	1.91109E-02	2.34812E-04
CARBON MONOXIDE	2.309000	18.907089	18.899994	18.899994	1.81498E-02	1.78179E-02	3.31931E-04
CARBON DIOXIDE	1.150602	9.421634	9.410000	9.410000	9.69459E-02	8.40843E-02	1.28617E-02
METHANE	1.632817	13.370222	13.370000	13.370000	2.71801E-02	2.63200E-02	8.60054E-04
NITROGEN	0.116302	0.952332	0.950000	0.950000	7.44156E-04	7.32203E-04	1.19533E-05
WATER	3.29733E-03	2.70000E-02	2.70000E-02	2.70000E-02	0.545841	1.49811E-03	0.544343
METHANOL	0.105172	0.861194	0.865000	0.865000	5.514483	4.51456E-02	5.469337
ETHANOL	6.43547E-04	5.26964E-03	5.30000E-03	5.30000E-03	5.97904E-02	2.76148E-04	5.95143E-02
WITCO 40 OIL	4.71924E-06	3.86432E-05	4.00000E-05	4.00000E-05	1.04028E-02	1.80831E-06	1.04010E-02
TOTAL FLOW MOL/HR	9.910791	81.153839	81.127274	81.127274	6.292862	0.194987	6.097895
LB/HR	157.482590	1289.535889	1288.861572	1288.861572	197.146011	6.167543	190.978470
ACTUAL CFM	1.474880	12.076961	12.073144	11.443266	0.0	0.975023	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY

TOTAL	STREAM NUMBER	75	76	77	78	80	83	89
	NOTES - BELOW	#4	#4			#2,4	#2,4	#4
	PRESSURE PSIA	710.00	700.00	700.00	685.00	685.00	710.00	745.08
	TEMPERATURE DEG,F	481.99	283.27	283.27	109.97	251.45	251.47	482.87
	BUBBLE PT DEG,F	481.99	283.27					
	ENTHALPY BTU/HR	-35900672.00	-14355.02	-57420.10	-16468.38	-73888.44	-73871.56	-35924848.00
	AVE. MOL WT	216.825004	214.075897	214.075821	206.989105	212.621964	212.621964	216.818954
	FLOW RATES MOLES/HR							
	HYDROGEN	1[illegible].074356	4.91186E-03	1.96475E-02	5.03041E-03	2.46779E-02	2.46779E-02	16.099030
	CARBON MONOXIDE	6.138626	1.94557E-03	7.78228E-03	2.18790E-03	9.97017E-03	9.97017E-03	6.148596
	CARBON DIOXIDE	3.614662	2.00512E-03	8.02047E-03	5.31036E-03	1.33308E-02	1.33308E-02	3.627993
	METHANE	5.038829	1.77556E-03	7.10223E-03	2.35227E-03	9.45450E-03	9.45450E-03	5.048283
	NITROGEN	0.613418	1.68160E-04	6.72641E-04	1.53046E-04	8.25686E-04	8.25686E-04	0.614243
	WATER	0.0	3.81985E-11	1.52794E-10	4.72748E-11	2.00069E-10	2.00069E-10	2.00069E-10
	METHANOL	4.130284	2.17576E-03	8.70304E-03	1.34920E-03	1.00522E-02	1.00522E-02	4.140336
	ETHANOL	0.117740	6.79054E-05	2.71621E-04	3.66592E-05	3.08281E-04	3.08281E-04	0.118048
	WITCO 40 OIL	215.455429	7.05653E-02	0.282261	6.99044E-02	0.352166	0.352166	215.807587
	TOTAL FLOW MOL/HR	251.183228	0.083615	0.334461	0.086324	0.420785	0.420785	251.604004
	LB/HR	54463.054688	17.899994	71.599976	17.868179	89.468155	89.468155	54552.515625
LIQUID	ENTHALPY BTU/HR	-35900672.00	-14355.02	-57420.10	-16468.38	-73888.44	-73850.13	-35924832.00
	LIQ. DENSITY,LB/CUFT	35.525681	40.321716	40.321716	49.176254	40.896469	40.918900	35.501877
	AVE. MOL WT	216.826004	214.075897	214.075821	206.989105	212.621964	212.866440	216.818893
	FLOW RATES MOLES/HR							
	HYDROGEN	16.074356	4.91186E-03	1.96475E-02	5.03041E-03	2.46779E-02	2.44521E-02	16.099038
	CARBON MONOXIDE	6.138626	1.94557E-03	7.78228E-03	2.18790E-03	9.97017E-03	9.85450E-03	6.148596
	CARBON DIOXIDE	3.614662	2.00512E-03	8.02047E-03	5.31036E-03	1.33308E-02	1.32634E-02	3.627993
	METHANE	5.038829	1.77556E-03	7.10223E-03	2.35227E-03	9.45450E-03	9.37116E-03	5.048283
	NITROGEN	0.613418	1.68160E-04	6.72641E-04	1.53046E-04	8.25686E-04	8.19895E-04	0.614243
	WATER	0.0	3.81985E-11	1.52794E-10	4.72748E-11	2.00069E-10	3.12944E-14	2.00069E-10
	METHANOL	4.130284	2.17576E-03	8.70304E-03	1.34920E-03	1.00522E-02	1.00246E-02	4.140336
	ETHANOL	0.117740	6.79054E-05	2.71621E-04	3.66592E-05	3.08281E-04	3.08020E-04	0.118048
	WITCO 40 OIL	215.455429	7.05653E-02	0.282261	6.99044E-02	0.352166	0.352166	215.807587
	TOTAL LIQ. MOL/HR	251.183228	0.083615	0.334461	0.086324	0.420785	0.420259	251.604095
	LB/HR	54463.054688	17.899994	71.599976	17.858179	89.468155	89.459076	54552.519531
LIQUID 2	ENTHALPY BTU/HR	0.0	0.0	0.0	-16468.38	0.0	0.0	0.0
	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	43.345093	0.0	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	206.989105	0.0	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	5.03041E-03	0.0	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	2.18790E-03	0.0	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	5.31036E-03	0.0	0.0	0.0
	METHANE	0.0	0.0	0.0	2.35227E-03	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	1.53046E-04	0.0	0.0	0.0
	WATER	0.0	0.0	0.0	4.72748E-11	0.0	0.0	0.0
	METHANOL	0.0	0.0	0.0	1.34920E-03	0.0	0.0	0.0
	ETHANOL	0.0	0.0	0.0	3.66592E-05	0.0	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	6.99044E-02	0.0	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.086324	0.0	0.0	0.0
	LB/HR	0.0	0.0	0.0	17.868179	0.0	0.0	0.0
V	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	0.0	-21.35	0.0
A	VAP. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	0.0	1.595034	0.0
P	AVE. MOL WT	0.0	0.0	0.0	0.0	0.0	17.235901	0.0
O	FLOW RATES MOLES/HR							
R	HYDROGEN	0.0	0.0	0.0	0.0	0.0	2.25756E-04	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	0.0	1.15671E-04	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.0	6.74096E-05	0.0
	METHANE	0.0	0.0	0.0	0.0	0.0	8.33336E-05	0.0
	NITROGEN	0.0	0.0	0.0	0.0	0.0	5.79065E-06	0.0
	WATER	0.0	0.0	0.0	0.0	0.0	2.00037E-10	0.0
	METHANOL	0.0	0.0	0.0	0.0	0.0	2.76233E-05	0.0
	ETHANOL	0.0	0.0	0.0	0.0	0.0	2.60958E-07	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	2.40082E-08	0.0
	TOTAL VAPOR MOL/HR	0.0	0.0	0.0	0.0	0.0	0.000526	0.0
	LB/HR	0.0	0.0	0.0	0.0	0.0	0.009064	0.0
	ACTUAL CFM	0.0	0.0	0.0	0.0	0.0	0.000095	0.0

STREAM SUMMARY

T	STREAM NUMBER	90	95
O	NOTES - BELOW	#2,4	#4
T	PRESSURE PSIA	745.00	735.00
A	TEMPERATURE DEG,F	482.88	478.12
L	ENTHALPY BTU/HR	-35927536.00	-36121312.00
	LIQ. DENSITY,LB/CUFT	35.502228	35.628586
	AVE. MOL WT	216.822250	216.822250
	FLOW RATES MOLES/HR		
	HYDROGEN	16.092834	16.092836
	CARBON MONOXIDE	6.146657	6.146657
	CARBON DIOXIDE	3.634781	3.634781
	METHANE	5.048519	5.048519
	NITROGEN	0.613624	0.613624
	WATER	1.83656E-10	1.83656E-10
	METHANOL	4.141909	4.141909
	ETHANOL	0.116913	0.116913
	WITCO 40 OIL	215.818024	215.818024
	TOTAL FLOW MOL/HR	251.613235	251.613235
	LB/HR	54555.347656	54555.347656
		LIQ	LIQ

NOTES

1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION' TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 34.15 CPU SECONDS

STREAM SUMMARY
VERSION 82.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/KT GAS: EK-4752

T.R.TSAO
87-7-1533

STREAM SUMMARY

T O T A L							
STREAM NUMBER	1	3	5	8	10	15	18
NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#1,4	#4	#4
PRESSURE PSIA	150.00	370.00	335.00	750.00	750.00	740.00	715.00
TEMPERATURE DEG.F	100.00	335.30	120.00	335.09	192.89	402.00	786.79
DEW POINT DEG.F						103.40	203.81
ENTHALPY BTU/HR	-528254.25	-490745.94	-525249.63	-490750.88	-2284232.00	-2173366.00	-2173366.00
VAP. DENSITY,LB/CUFT	0.368087	0.634032	0.789311	1.269641	1.956014	1.456134	1.107812
AVE. MOL WT	14.796109	14.796109	14.796109	14.796109	18.613785	18.613785	21.150818
FLOW RATES MOLES/HR							
HYDROGEN	11.577000	11.577000	11.577000	11.577000	27.276993	27.276993	18.792923
CARBON MONOXIDE	11.061999	11.061999	11.061999	11.061999	43.311996	43.311996	38.685501
CARBON DIOXIDE	3.37000E-02	3.37000E-02	3.37000E-02	3.37000E-02	1.387699	1.38769	1.644003
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	6.04000E-02	6.04000E-02	6.04000E-02	6.04000E-02	0.363400	0.363400	0.363409
WATER	0.0	0.0	0.0	0.0	1.64000E-02	1.64000E-02	6.06805E-02
METHANOL	0.0	0.0	0.0	0.0	0.487000	0.487000	4.256008
ETHANOL	0.0	0.0	0.0	0.0	2.10000E-02	2.10000E-02	0.321585
WITCO 40 OIL	0.0	0.0	0.0	0.0	2.40000E-05	2.40000E-05	2.40000E-05
TOTAL FLOW MOL/HR	22.733078	22.733078	22.733078	22.733078	72.864456	72.864456	64.124069
LB/HR	336.361084	336.361084	336.361084	336.361084	1356.283203	1356.283203	1356.276367
ACTUAL CFM	15.230133	8.841858	7.102422	4.415436	11.556527	15.523796	20.404724

STREAMS ARE ALL VAPOR

Case EK-4752

STREAM SUMMARY
VERSION 82.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/KT GAS: EK-4752

T.R.TSAO
87-7-1533

STREAM SUMMARY

TOTAL	STREAM NUMBER	20	25	30	32	35	38	45
	NOTES - BELOW	#4	#4	#4			#2,4	
	PRESSURE PSIA	715.00	710.00	700.00	700.00	690.00	690.00	685.00
	TEMPERATURE DEG,F	482.00	481.99	290.23	291.22	110.00	100.00	109.95
	DEW POINT DEG,F		481.99		291.22			
	ENTHALPY BTU/HR	-38225824.00	-2363045.00	-2473911.00	-2427595.00	-2587263.00	-40433.89	-2158758.00
	AVE. MOL WT	177.558426	21.982254	21.982254	21.169586	21.332672	18.019989	20.354401
	FLOW RATES MOLES/HR							
	HYDROGEN	31.678818	18.809006	18.809006	18.796600	18.799872	0.0	18.786453
	CARBON MONOXIDE	55.319504	38.698456	38.698456	38.681152	38.684601	0.0	38.638885
	CARBON DIOXIDE	2.491321	1.646322	1.646322	1.644837	1.645134	0.0	1.627523
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.698560	0.362807	0.362807	0.362502	0.362563	0.0	0.362178
	WATER	6.06805E-02	6.06805E-02	6.06805E-02	6.06805E-02	6.06805E-02	0.330000	1.92394E-02
	METHANOL	8.247676	4.260136	4.260136	4.253481	4.254811	0.0	0.584736
	ETHANOL	1.165630	0.306689	0.306689	0.305156	0.305463	0.0	2.49309E-02
	WITCO 40 OIL	215.817841	0.236090	0.236090	7.57834E-03	5.32806E-02	0.0	2.87411E-05
	TOTAL FLOW MOL/HR	315.479736	64.380142	64.380142	64.111938	64.165573	0.330000	60.043915
	LB/HR	56016.082031	1415.220459	1415.220459	1357.223145	1368.822998	5.946595	1222.157715
LIQUID	ENTHALPY BTU/HR	-35874368.00	0.0	-45761.24	0.0	-427209.63	-40433.89	0.0
	LIQ. DENSITY,LB/CUFT	35.587677	0.0	40.488052	0.0	0.0	61.967270	0.0
	AVE. MOL WT	217.157181	0.0	217.343353	0.0	35.526917	18.019989	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	13.021103	0.0	1.18777E-02	0.0	1.40549E-02	0.0	0.0
	CARBON MONOXIDE	16.793289	0.0	1.66783E-02	0.0	5.68054E-02	0.0	0.0
	CARBON DIOXIDE	0.852882	0.0	1.43813E-03	0.0	1.94416E-02	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.338450	0.0	2.94003E-04	0.0	4.47510E-04	0.0	0.0
	WATER	0.0	0.0	2.43777E-11	0.0	5.70113E-02	0.330000	0.0
	METHANOL	4.015853	0.0	6.42181E-03	0.0	3.626724	0.0	0.0
	ETHANOL	0.862344	0.0	1.47700E-03	0.0	0.280707	0.0	0.0
	WITCO 40 OIL	215.584778	0.0	0.228537	0.0	5.32521E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	251.468704	0.0	0.266724	0.0	4.108442	0.330000	0.0
	LB/HR	54608.234375	0.0	57.970581	0.0	145.960281	5.946595	0.0
LIQUID 1	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-421759.94	0.0	0.0
	LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	47.850601	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	0.0	34.272034	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	1.28617E-02	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	5.49612E-02	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	1.90614E-02	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	4.20591E-04	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	5.70113E-02	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	3.626370	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	0.288645	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	2.91377E-02	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	4.080468	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	139.845932	0.0	0.0
L	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	-5449.73	0.0	0.0
I	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	44.362900	0.0	0.0
Q	AVE. MOL WT	0.0	0.0	0.0	0.0	218.564728	0.0	0.0
U	FLOW RATES MOLES/HR							
I	HYDROGEN	0.0	0.0	0.0	0.0	1.19322E-03	0.0	0.0
D	CARBON MONOXIDE	0.0	0.0	0.0	0.0	1.84414E-03	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	3.80218E-04	0.0	0.0
2	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	2.69189E-05	0.0	0.0
	WATER	0.0	0.0	0.0	0.0	9.46561E-13	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	3.53632E-04	0.0	0.0
	ETHANOL	0.0	0.0	0.0	0.0	6.25075E-05	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	2.41144E-02	0.0	0.0
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.027975	0.0	0.0
	LB/HR	0.0	0.0	0.0	0.0	6.114345	0.0	0.0
V	ENTHALPY BTU/HR	-2351447.00	-2563045.00	-2428147.00	-2427595.00	-2166054.00	0.0	-2158738.00
A	VAP. DENSITY,LB/CUFT	1.525253	1.514030	1.819180	1.816683	2.280256	0.0	2.263008
P	AVE. MOL WT	21.993683	21.982254	21.169495	21.169586	20.361679	0.0	20.354401
O	FLOW RATES MOLES/HR							
R	HYDROGEN	18.657715	18.809006	18.797119	18.796600	18.785004	0.0	18.786453
	CARBON MONOXIDE	38.526215	38.698456	38.681778	38.681152	38.327792	0.0	38.638885
	CARBON DIOXIDE	1.638438	1.646322	1.644884	1.644837	1.625691	0.0	1.627523
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.360110	0.362807	0.362513	0.362502	0.362115	0.0	0.362178
	WATER	6.06805E-02	6.06805E-02	6.06805E-02	6.06805E-02	3.66922E-03	0.0	1.92394E-02
	METHANOL	4.231823	4.260136	4.253714	4.253481	0.628087	0.0	0.584736
	ETHANOL	0.303286	0.306689	0.305212	0.305156	2.47553E-02	0.0	2.49309E-02
	WITCO 40 OIL	0.233050	0.236090	7.55316E-03	7.57834E-03	2.65692E-05	0.0	2.87411E-05
	TOTAL VAPOR MOL/HR	64.011276	64.380142	64.113419	64.111938	60.057083	0.0	60.043915
	LB/HR	1407.843506	1415.220459	1357.248535	1357.223145	1222.863037	0.0	1222.157715
	ACTUAL CFM	15.383712	15.578962	12.434621	12.451478	8.938054	0.0	9.000981

STREAM SUMMARY
VERSION 82.021-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/KT GAS: EK-4752

T.R.TSAO
87-7-1533

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STREAM SUMMARY

TOTAL							
STREAM NUMBER	50	54	55	57	60	62	65
NOTES - BELOW	#4	#4	#1	#1,4		#4	#4
PRESSURE PSIA	685.00	685.00	685.00	750.00	685.00	20.00	20.00
TEMPERATURE DEG,F	109.95	109.95	109.95	131.07	109.95	108.15	108.15
DEW POINT DEG,F						108.15	
BUBBLE PT DEG,F							108.15
ENTHALPY BTU/HR	-358010.06	-1800727.00	-1801002.00	-1793482.60	-459482.00	-6323.04	-453158.56
LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.200256	0.0	49.589294
LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	49.200256	0.0	0.0
VAP. DENSITY,LB/CUFT	2.263008	2.263008	2.261893	2.379966	0.0	0.094189	0.0
AVE. MOL WT	20.354401	20.354401	20.345016	20.345016	32.089401	28.536682	32.162933
FLOW RATES MOLES/HR							
HYDROGEN	3.115588	15.670862	15.700000	15.700000	1.04359E-02	1.03414E-02	9.44845E-05
CARBON MONOXIDE	6.407961	32.230911	32.250000	32.250000	4.23403E-02	4.14396E-02	9.00697E-07
CARBON DIOXIDE	0.269912	1.357611	1.353999	1.353999	1.69134E-02	1.37135E-02	3.19992E-03
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	6.00645E-02	0.302114	0.303000	0.303000	3.35529E-04	3.29581E-04	5.94789E-06
WATER	3.19070E-03	1.60487E-02	1.64000E-02	1.64000E-02	0.371441	7.98424E-04	0.370643
METHANOL	9.69738E-02	0.487762	0.487000	0.487000	3.669479	2.16585E-02	3.647820
ETHANOL	4.13460E-03	2.07963E-02	2.10000E-02	2.10000E-02	0.280418	9.33420E-04	0.279485
WITCO 40 OIL	4.76649E-06	2.39746E-05	2.40000E-05	2.40000E-05	8.13739E-03	9.23663E-07	8.13647E-03
TOTAL FLOW MOL/HR	9.957820	50.086075	50.131378	50.131378	4.399499	0.089215	4.310284
LB/HR	202.685455	1019.471924	1019.923584	1019.923584	141.177277	2.545704	138.631363
ACTUAL CFM	1.492744	7.508234	7.515265	7.142425	0.0	0.450481	0.0
	VAP	VAP	VAP	VAP	LIQ1	VAP	LIQ

STREAM SUMMARY   AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS   T.R.TSAO   21JAN.82 PAGE 11
VERSION 82.021-A   LPMEOH ENTRAINED/KT GAS: EK-4752   87-7-1533   15:41:04

STREAM SUMMARY

		75	76	77	78	80	83	89
TOTAL	STREAM NUMBER	75	76	77	78	80	83	89
	NOTES - BELOW	#4	#4			#2,4	#2,4	#4
	PRESSURE PSIA	710.00	700.00	700.00	685.00	685.00	710.00	745.00
	TEMPERATURE DEG,F	481.99	291.22	291.22	109.95	258.09	258.14	483.00
	BUBBLE PT DEG,F	481.99	291.22					
	ENTHALPY BTU/HR	-35862768.00	-9158.22	-36632.90	-10183.68	-46816.58	-46805.73	-35859872.00
	AVE. MOL WT	217.446823	216.245728	216.245697	219.399338	216.862030	216.862030	217.446182
	FLOW RATES MOLES/HR							
	HYDROGEN	12.869812	2.48079E-03	9.92315E-03	2.17204E-03	1.20952E-02	1.20952E-02	12.881907
	CARBON MONOXIDE	16.621048	3.45957E-03	1.38383E-02	3.37232E-03	1.72106E-02	1.72106E-02	16.638245
	CARBON DIOXIDE	0.844998	2.96890E-04	1.18756E-03	6.96947E-04	1.88451E-03	1.88451E-03	0.846883
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.335753	6.10961E-05	2.44385E-04	4.92040E-05	2.93588E-04	2.93588E-04	0.336046
	WATER	2.23517E-08	5.28317E-12	2.11327E-11	8.50404E-12	2.96367E-11	2.96367E-11	2.23814E-08
	METHANOL	3.987540	1.33095E-03	5.32380E-03	5.95510E-04	5.91930E-03	5.91930E-03	3.993459
	ETHANOL	0.858941	3.06576E-04	1.22630E-03	1.13745E-04	1.34005E-03	1.34005E-03	0.860281
	WITCO 40 OIL	215.581741	4.57023E-02	0.182809	4.51145E-02	0.227924	0.227924	215.809662
	TOTAL FLOW MOL/HR	251.099838	0.053638	0.214553	0.052114	0.266667	0.266657	251.366501
	LB/HR	54600.859375	11.599019	46.396072	11.433830	57.829895	57.829895	54658.683594
LIQUID	ENTHALPY BTU/HR	-35862763.00	-9158.22	-36632.90	-10183.68	-46816.57	-46804.44	-35859856.00
	LIQ. DENSITY,LB/CUFT	35.511115	40.375137	40.375137	49.200256	41.146332	41.147568	35.584213
	AVE. MOL WT	217.446823	216.245682	216.245636	219.399338	216.862030	216.886734	217.446213
	FLOW RATES MOLES/HR							
	HYDROGEN	12.869812	2.48079E-03	9.92315E-03	2.17204E-03	1.20952E-02	1.20853E-02	12.881907
	CARBON MONOXIDE	16.621048	3.45957E-03	1.38383E-02	3.37232E-03	1.72106E-02	1.71906E-02	16.638245
	CARBON DIOXIDE	0.844998	2.96890E-04	1.18756E-03	6.96947E-04	1.88451E-03	1.88352E-03	0.846883
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.335753	6.10961E-05	2.44385E-04	4.92040E-05	2.93588E-04	2.93396E-04	0.336046
	WATER	2.23517E-08	5.28317E-12	2.11327E-11	8.50404E-12	2.96367E-11	2.79360E-14	2.23814E-08
	METHANOL	3.987540	1.33095E-03	5.32380E-03	5.95510E-04	5.91930E-03	5.91755E-03	3.993459
	ETHANOL	0.858941	3.06576E-04	1.22630E-03	1.13745E-04	1.34005E-03	1.33993E-03	0.860281
	WITCO 40 OIL	215.581741	4.57023E-02	0.182809	4.51145E-02	0.227924	0.227924	215.809662
	TOTAL LIQ. MOL/HR	251.099838	0.053638	0.214553	0.052114	0.266667	0.266633	251.366455
	LB/HR	54600.859375	11.599019	46.396057	11.433830	57.829895	57.829178	54658.683594
LIQUID 2	ENTHALPY BTU/HR	0.0	0.0	0.0	-10183.68	0.0	0.0	0.0
	LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	44.427689	0.0	0.0	0.0
	AVE. MOL WT	0.0	0.0	0.0	219.399338	0.0	0.0	0.0
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	2.17204E-03	0.0	0.0	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	3.37232E-03	0.0	0.0	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	6.96947E-04	0.0	0.0	0.0
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	4.92040E-05	0.0	0.0	0.0
	WATER	0.0	0.0	0.0	8.50404E-12	0.0	0.0	0.0
	METHANOL	0.0	0.0	0.0	5.95510E-04	0.0	0.0	0.0
	ETHANOL	0.0	0.0	0.0	1.13745E-04	0.0	0.0	0.0
	WITCO 40 OIL	0.0	0.0	0.0	4.51145E-02	0.0	0.0	0.0

	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.052114	0.0	0.0	0.0
	LB/HR	0.0	0.0	0.0	11.433830	0.0	0.0	0.0
V	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	0.0	-1.27	0.0
A	VAP. DENSITY,LB/CUF.	0.0	0.0	0.0	0.0	0.0	1.920968	0.0
P	AVE. MOL WT	0.0	0.0	0.0	0.0	0.0	21.098526	0.0
O	FLOW RATES MOLES/HR							
R	HYDROGEN	0.0	0.0	0.0	0.0	0.0	9.92566E-06	0.0
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	0.0	2.06581E-05	0.0
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.0	9.91943E-07	0.0
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	0.0	1.92120E-07	0.0
	WATER	0.0	0.0	0.0	0.0	0.0	2.96088E-11	0.0
	METHANOL	0.0	0.0	0.0	0.0	0.0	1.75578E-06	0.0
	ETHANOL	0.0	0.0	0.0	0.0	0.0	1.18340E-07	0.0
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	1.77522E-09	0.0
	TOTAL VAPOR MOL/HR	0.0	0.0	0.0	0.0	0.0	0.000034	0.0
	LB/HR	0.0	0.0	0.0	0.0	0.0	0.000710	0.0
	ACTUAL CFM	0.0	0.0	0.0	0.0	0.0	0.000006	0.0

STREAM SUMMARY

TOTAL		
STREAM NUMBER	90	95
NOTES - BELOW	#2,4	#4
PRESSURE PSIA	745.00	735.00
TEMPERATURE DEG,F	483.00	478.25
ENTHALPY BTU/HR	-35859408.00	-36052464.00
LIQ. DENSITY,LB/CUFT	35.584747	35.711426
AVE. MOL WT	217.459839	217.459839
FLOW RATES MOLES/HR		
HYDROGEN	12.885908	12.885908
CARBON MONOXIDE	16.634003	16.634003
CARBON DIOXIDE	0.847319	0.847319
METHANE	0.0	0.0
NITROGEN	0.335160	0.335160
WATER	2.77442E-11	2.77442E-11
METHANOL	3.991668	3.991668
ETHANOL	0.844045	0.844045
WITCO 40 OIL	215.817825	215.817825
TOTAL FLOW MOL/HR	251.355881	251.355881
LB/HR	54659.808594	54659.808594
	LIQ	LIQ

NOTES
1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. CAUTION: TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 31.74 CPU SECONDS

STREAM SUMMARY

TOTAL	STREAM NUMBER	1	3	5	10	15	18	20
	NOTES - BELOW	#1,4	#1,4	#1,4	#1,4	#4	#4	#4
	PRESSURE PSIA	150.00	287.00	282.00	550.00	540.00	515.00	515.00
	TEMPERATURE DEG.F	100.00	261.78	120.00	293.08	503.00	758.84	518.00
	DEW POINT DEG.F					-153.09	160.08	
	ENTHALPY BTU/HR	-569678.44	-549210.00	-567326.75	-545320.19	-518126.75	-518126.75	-34421408.00
	AVE. MOL WT	18.449860	18.449860	18.449860	18.449860	18.449860	20.049591	215.021988
	FLOW RATES MOLES/HR							
	HYDROGEN	6.830000	6.830000	6.830000	6.830000	6.830000	5.432695	13.730790
	CARBON MONOXIDE	10.790000	10.790000	10.790000	10.790000	10.790000	10.034699	21.410446
	CARBON DIOXIDE	0.350000	0.350000	0.350000	0.350000	0.350000	0.387765	0.886584
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	5.29203E-02
	WATER	0.0	0.0	0.0	0.0	0.0	7.55270E-03	7.55270E-03
	METHANOL	0.0	0.0	0.0	0.0	0.0	0.626899	2.180542
	ETHANOL	0.0	0.0	0.0	0.0	0.0	4.53180E-02	0.350521
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	0.0	215.849014
	TOTAL FLOW MOL/HR	17.984985	17.984985	17.984985	17.984985	17.984985	16.549911	254.468323
	LB/HR	331.820313	331.820313	331.820313	331.820313	331.820313	331.818848	54716.281250
LIQUID	ENTHALPY BTU/HR	0.0	0.0	0.0	0.0	0.0	0.0	-33862640.00
	LIQ. DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	0.0	0.0	35.395447
	AVE. MOL WT	0.0	0.0	0.0	0.0	0.0	0.0	228.341064
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	0.0	0.0	0.0	8.402276
	CARBON MONOXIDE	0.0	0.0	0.0	0.0	0.0	0.0	11.521195
	CARBON DIOXIDE	0.0	0.0	0.0	0.0	0.0	0.0	0.504674
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	0.0	0.0	0.0	3.78746E-02
	WATER	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	METHANOL	0.0	0.0	0.0	0.0	0.0	0.0	1.557477
	ETHANOL	0.0	0.0	0.0	0.0	0.0	0.0	0.307408
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	0.0	215.711655
	TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.0	0.0	0.0	238.842557
	LB/HR	0.0	0.0	0.0	0.0	0.0	0.0	54354.890625
VAPOR	ENTHALPY BTU/HR	-569678.44	-549209.56	-567326.75	-545320.13	-518126.75	-518126.44	-558755.63
	VAP. DENSITY,LB/CUFT	0.459686	0.678357	0.831853	1.235754	0.948408	0.777984	1.862128
	AVE. MOL WT	18.449860	18.449860	18.449860	18.449860	18.449860	20.049591	22.081434
	FLOW RATES MOLES/HR							
	HYDROGEN	6.830000	6.830000	6.830000	6.830000	6.830000	5.432695	5.328514
	CARBON MONOXIDE	10.790000	10.790000	10.790000	10.790000	10.790000	10.034699	9.889251
	CARBON DIOXIDE	0.350000	0.350000	0.350000	0.350000	0.350000	0.387765	0.381910
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50000E-02	1.50458E-02
	WATER	0.0	0.0	0.0	0.0	0.0	7.55270E-03	7.55270E-03
	METHANOL	0.0	0.0	0.0	0.0	0.0	0.626899	0.623064
	ETHANOL	0.0	0.0	0.0	0.0	0.0	4.53180E-02	4.31126E-02
	WITCO 40 OIL	0.0	0.0	0.0	0.0	0.0	0.0	[illegible].137347
	TOTAL VAPOR MOL/HR	17.984985	17.984985	17.984985	17.984985	17.984985	16.549911	16.425781
	LB/HR	331.820313	331.820313	331.820313	331.820313	331.820313	331.818848	361.390625
	ACTUAL CFM	12.030686	8.152549	6.648220	4.475275	5.831181	7.198518	5.670857

Case EK-2571

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/K-1 MIN PRODN: EK-2571

V.H.EISENHAU
87-7-1533

STREAM SUMMARY

TOTAL	STREAM NUMBER	25	30	32	35	38	50	60
	NOTES - BELOW	#4		#4		#2,4		
	PRESSURE PSIA	510.00	500.00	500.00	490.00	590.00	485.00	485.00
	TEMPERATURE DEG,F	517.98	360.62	360.62	110.00	110.00	111.44	111.44
	DEW POINT DEG,F	517.98						
	ENTHALPY BTU/HR	-567705.06	-594892.38	-570833.25	-615320.31	-11378.69	-558339.94	-60137.52
	AVE. MOL WT	21.993561	21.993561	20.206207	20.566193	18.019989	19.664474	30.794464
	FLOW RATES MOLES/HR							
	HYDROGEN	5.437839	5.437839	5.433322	5.434225	0.0	5.432254	7.97694E-04
	CARBON MONOXIDE	10.040298	10.040298	10.033877	10.035161	0.0	10.030476	2.84835E-03
	CARBON DIOXIDE	0.388000	0.388000	0.387587	0.387669	0.0	0.386114	1.19888E-03
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	1.53618E-02	1.53618E-02	1.53426E-02	1.53464E-02	0.0	1.533[illegible]3E-02	3.82734E-06
	WATER	7.55270E-03	7.55270E-03	7.55270E-03	7.55270E-03	9.30000E-02	1.24499E-02	8.81028E-02
	METHANOL	0.635257	0.635257	0.634171	0.634388	0.0	0.194309	0.439695
	ETHANOL	4.42076E-02	4.42076E-02	4.39823E-02	4.40274E-02	0.0	9.31798E-03	3.46310E-02
	WITCO 40 OIL	0.141125	0.141125	1.11410E-02	3.71378E-02	0.0	1.01819E-05	2.91435E-04
	TOTAL FLOW MOL/HR	16.709625	16.709625	16.566956	16.595474	0.093000	16.080215	0.567569
	LB/HR	367.504150	367.504150	334.755127	341.305664	1.675858	316.208984	17.477966
LIQUID	ENTHALPY BTU/HR	0.0	-24059.16	0.0	-56140.00	-11378.69	0.0	-60137.52
	LIQ. DENSITY,LB/CUFT	0.0	39.658020	0.0	0.0	61.833420	0.0	50.139236
	AVE. MOL WT	0.0	229.552429	0.0	48.682968	18.019989	0.0	30.794464
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	4.51576E-03	0.0	2.18962E-03	0.0	0.0	7.97694E-04
	CARBON MONOXIDE	0.0	6.42070E-03	0.0	6.16672E-03	0.0	0.0	2.84835E-03
	CARBON DIOXIDE	0.0	4.13212E-04	0.0	1.77795E-03	0.0	0.0	1.19888E-03
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	1.92697E-05	0.0	9.52465E-06	0.0	0.0	3.82734E-06
	WATER	0.0	1.08481E-12	0.0	6.28826E-03	9.30000E-02	0.0	8.81028E-02
	METHANOL	0.0	1.08567E-03	0.0	0.417752	0.0	0.0	0.439695
	ETHANOL	0.0	2.25239E-04	0.0	3.47845E-02	0.0	0.0	3.46310E-02
	WITCO 40 OIL	0.0	0.129984	0.0	3.71282E-02	0.0	0.0	2.91435E-04
	TOTAL LIQ. MOL/HR	0.0	0.142664	0.0	0.506097	0.093000	0.0	0.567569
	LB/HR	0.0	32.748764	0.0	24.638275	1.675858	0.0	17.477966
LIQUID 1	ENTHALPY BTU/HR	0.0	0.0	0.0	-48593.45	0.0	0.0	-60137.52
	LIQ1 DENSITY,LB/CUFT	0.0	0.0	0.0	47.960266	0.0	0.0	50.139236
	AVE. MOL WT	0.0	0.0	0.0	34.409256	0.0	0.0	30.794464
	FLOW RATES MOLES/HR							
	HYDROGEN	0.0	0.0	0.0	1.09878E-03	0.0	0.0	7.97694E-04
	CARBON MONOXIDE	0.0	0.0	0.0	4.46196E-03	0.0	0.0	2.84835E-03
	CARBON DIOXIDE	0.0	0.0	0.0	1.44431E-03	0.0	0.0	1.19888E-03
	METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NITROGEN	0.0	0.0	0.0	5.56012E-06	0.0	0.0	3.82734E-06
	WATER	0.0	0.0	0.0	6.28826E-03	0.0	0.0	8.81028E-02
	METHANOL	0.0	0.0	0.0	0.417344	0.0	0.0	0.439695
	ETHANOL	0.0	0.0	0.0	3.47102E-02	0.0	0.0	3.46310E-02
	WITCO 40 OIL	0.0	0.0	0.0	3.42050E-03	0.0	0.0	2.91435E-04

TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.468773	0.0	0.0	0.567569
LB/HR	0.0	0.0	0.0	16.130127	0.0	0.0	17.477966
LIQUID 2							
ENTHALPY BTU/HR	0.0	0.0	0.0	-7546.55	0.0	0.0	0.0
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	45.304474	0.0	0.0	0.0
AVE. MOL WT	0.0	0.0	0.0	227.956909	0.0	0.0	0.0
FLOW RATES MOLES/HR							
HYDROGEN	0.0	0.0	0.0	1.09084E-03	0.0	0.0	0.0
CARBON MONOXIDE	0.0	0.0	0.0	1.70477E-03	0.0	0.0	0.0
CARBON DIOXIDE	0.0	0.0	0.0	3.33634E-04	0.0	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.0	0.0	0.0	3.96453E-06	0.0	0.0	0.0
WATER	0.0	0.0	0.0	5.32150E-13	0.0	0.0	0.0
METHANOL	0.0	0.0	0.0	4.08405E-04	0.0	0.0	0.0
ETHANOL	0.0	0.0	0.0	7.43109E-05	0.0	0.0	0.0
WITCO 40 OIL	0.0	0.0	0.0	3.37077E-02	0.0	0.0	0.0
TOTAL LIQ. MOL/HR	0.0	0.0	0.0	0.037324	0.0	0.0	0.0
LB/HR	0.0	0.0	0.0	8.508172	0.0	0.0	0.0
VAPOR							
ENTHALPY BTU/HR	-567705.06	-570833.25	-570833.25	-559180.38	0.0	-558339.94	0.0
VAP. DENSITY,LB/CUFT	1.051615	1.132570	1.132570	1.568791	0.0	1.547176	0.0
AVE. MOL WT	21.993561	20.206207	20.206207	19.681747	0.0	19.664474	0.0
FLOW RATES MOLES/HR							
HYDROGEN	5.437839	5.433322	5.433322	5.432034	0.0	5.432254	0.0
CARBON MONOXIDE	10.040298	10.033877	10.033877	10.028994	0.0	10.030476	0.0
CARBON DIOXIDE	0.388000	0.387587	0.387587	0.385891	0.0	0.386114	0.0
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	1.53618E-02	1.53426E-02	1.53426E-02	1.53369E-02	0.0	1.53383E-02	0.0
WATER	7.55270E-03	7.55270E-03	7.55270E-03	1.26444E-03	0.0	1.24499E-02	0.0
METHANOL	0.635257	0.634171	0.634171	0.216636	0.0	0.194309	0.0
ETHANOL	4.42076E-02	4.39823E-02	4.39823E-02	9.24288E-03	0.0	9.31798E-03	0.0
WITCO 40 OIL	0.141125	1.11410E-02	1.11410E-02	9.58710E-06	0.0	1.01819E-05	0.0
TOTAL VAPOR MOL/HR	16.709625	16.566956	16.566956	16.089371	0.0	16.080215	0.0
LB/HR	367.504150	334.755127	334.755127	316.666748	0.0	316.208984	0.0
ACTUAL CFM	5.824442	4.926187	4.926187	3.364235	0.0	3.406306	0.0

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/K-T MIN PRODN: EK-2571

V.H.EISENHAU
87-7-1533

STREAM SUMMARY

TOTAL

STREAM NUMBER	62	65	75	76	77	78	80
NOTES - BELOW	#4	#4	#4	#4	#4		#2,4
PRESSURE PSIA	20.00	20.00	510.00	500.00	500.00	485.00	485.00
TEMPERATURE DEG,F	110.95	110.95	517.98	360.62	360.62	111.44	301.30
DEW POINT DEG,F	110.95						
BUBBLE PT DEG,F		110.95	517.98				
ENTHALPY BTU/HR	-420.59	-59716.89	-33853696.00	-4811.83	-19247.33	-8231.73	-27479.85
LIQ. DENSITY,LB/CUFT	0.0	50.337173	35.416061	39.658096	39.658020	50.139236	41.079178
LIQ2 DENSITY,LB/CUFT	0.0	0.0	0.0	0.0	0.0	45.308197	0.0
VAP. DENSITY,LB/CUFT	0.091790	0.0	0.0	0.0	0.0	0.0	0.0
AVE. MOL WT	27.950607	30.825104	228.587967	229.552414	229.552490	228.546821	229.288132
FLOW RATES MOLES/HR							
HYDROGEN	7.85976E-04	1.17184E-05	8.292952	9.03152E-04	3.61261E-03	1.17247E-03	4.78507E-03
CARBON MONOXIDE	2.75960E-03	8.87543E-05	11.370148	1.28414E-03	5.13656E-03	1.83617E-03	6.97273E-03
CARBON DIOXIDE	8.72240E-04	3.26645E-04	0.498584	8.26423E-05	3.30569E-04	3.56114E-04	6.86683E-04
METHANE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NITROGEN	3.72299E-06	1.04352E-07	3.75585E-02	3.85393E-06	1.54157E-05	4.28025E-06	1.96960E-05
WATER	1.01322E-04	8.80014E-02	0.0	2.16961E-13	8.67845E-13	5.20628E-12	6.07413E-12
METHANOL	1.45187E-03	0.438243	1.545284	2.17134E-04	8.68536E-04	3.84657E-04	1.25319E-03
ETHANOL	6.98264E-05	3.45612E-02	0.306313	4.50478E-05	1.80191E-04	7.83795E-05	2.58571E-04
WITCO 40 OIL	6.78559E-08	2.91367E-04	215.707886	2.59968E-02	0.103987	3.68362E-02	0.140823
TOTAL FLOW MOL/HR	0.006045	0.561524	237.758713	0.028533	0.114131	0.040668	0.154799
LB/HR	0.168953	17.309036	54348.777344	6.549754	26.199005	9.294561	35.493561
ACTUAL CFM	0.030677	0.0	0.0	0.0	0.0	0.0	0.0
	VAP	LIQ	LIQ	LIQ	LIQ	LIQ2	LIQ

STREAM SUMMARY
VERSION 82.011-A

AIR PRODUCTS & CHEMICALS, INC -- CYCLE SYNTHESIS
LPMEOH ENTRAINED/K-T MIN PRODN: EK-2571

V.H.EISENHAU
87-7-1533

STREAM SUMMARY

TOTAL

STREAM NUMBER	83	89	90	95
NOTES - BELOW	#2,4	#2,4	#2,4	#4
PRESSURE PSIA	510.00	545.00	545.00	535.00
TEMPERATURE DEG,F	301.33	519.05	519.34	517.32
ENTHALPY BTU/HR	-27472.39	-33831440.00	-33831952.00	-33903296.00
LIQ. DENSITY,LB/CUFT	41.078445	35.386124	35.386185	35.434830
AVE. MOL WT	229.288132	228.588425	228.584518	228.584518
FLOW RATES MOLES/HR				
HYDROGEN	4.78507E-03	8.297736	8.298095	8.298095
CARBON MONOXIDE	6.97273E-03	11.377120	11.375752	11.375752
CARBON DIOXIDE	6.86683E-04	0.499270	0.498818	0.498818
METHANE	0.0	0.0	0.0	0.0
NITROGEN	1.96960E-05	3.75782E-02	3.79203E-02	3.79203E-02
WATER	6.07413E-12	6.07413E-12	6.49384E-12	6.49384E-12
METHANOL	1.25319E-03	1.546537	1.553643	1.553643
ETHANOL	2.58571E-04	0.306572	0.305203	0.305203
WITCO 40 OIL	0.140823	215.848694	215.849014	215.849014
TOTAL FLOW MOL/HR	0.154799	237.913498	237.918411	237.918411
LB/HR	35.493561	54384.269531	54384.464844	54384.464844
	LIQ	LIQ	LIQ	LIQ

NOTES
1. STREAM SPECIFIED AS ALL VAPOR
2. STREAM SPECIFIED AS ALL LIQUID
4. <u>CAUTION</u>: TWO LIQUID PHASES NOT CONSIDERED. 'RESULTS MAY BE IN ERROR.

CYCLE SYNTHESIS RUN TIME : 29.41 CPU SECONDS

p

Air Products

DATE 1/29/82
REVISED

EXHIBIT 2.3.1-6

CENTRIFUGAL PUMP SPECIFICATION SHEET

CUSTOMER APCI
VENDOR By Elec. Mech. UNIT LP MeOH PDU PROJECT NO. 87-7-1533

No.	Item	Liquid Fluidized Mode	Liquid Entrained Mode
	GENERAL INFORMATION	Slurry Circulation Pump	
1.	ITEM NO.	10.50 A & B	
2.	NO. REQUIRED	Two (2) - one on stream & one spare	
3.	TYPE		
4.	DUTY (CONTINUOUS, INTERMITTENT)	Continuous	
5.	SERVICE	To circulate hot oil and hot oil-catalyst slurry	
6.			
	PROCESS INFORMATION	Liquid Fluidized Mode	Liquid Entrained Mode
7.	FLUID	*Hydrocarbon Fluid & Dissolved Syngas+CH_3OH	Hydrocarbon Fluid-Catalyst
8.	CORROSIVE COMPOUNDS		Slurry & Dissolved Syngas &CH_3O
9.	SOLIDS	None	Metal oxides powder: ~50μ[illegible]
10.	TEMPERATURE, OPERATING, °F	430~530	430~530
11.	TEMPERATURE, MAXIMUM, °F	550	550
12.	VAPOR PRESSURE, OPERATING	@530°F, psia 5 sat'd w/H_2	5
13.	SPECIFIC GRAVITY, OPERATING	@480°F 0.63	0.89
14.	SPECIFIC GRAVITY, @ 60°F	0.8[illegible]	1.15
15.	VISCOSITY, OPERATING	@480°F CPS 0.7	1.0 Max. Slurry Conditions
16.	VISCOSITY, @ 60°F	CPS 6	9
17.	NORMAL FLOW - GPM	200	200
18.	MAXIMUM FLOW GPM	250	250
19.	Minimum Flow GPM	150	150
20.	Solid Concentration Wt.%	0	33 Max. (8% by vol. @ 100°F (6% by vol. @ 480°F
	HYDRAULIC INFORMATION		
21.	NPSH REQUIRED	By Elec. Mech.	By Elec. Mech.
22.	NPSH AVAILABLE		
23.	SUCTION PRESSURE PSI	495/695/895	495/695/895
24.	DISCHARGE PRESSURE PSI	545/745/945	545/745/945
25.	HEAD REQUIRED PSI	50 = 185 ft. @ 480°F	50 = 130 ft. @ 480°F
26.	HEAD AVAILABLE PSI		
27.	Avail. Condensed Oil for Seal Flush, GPM @280°F, Min/Max.	0.1/1	0.1/0.7
28.			
	CONSTRUCTION		
29.	MATERIAL OF CONSTRUCTION		
30.	CONNECTIONS (INCLUDE FIG. RATING)	3-1/2" in/3-1/2"out or by vendor	
31.	PACKING AND/OR SEALS	Seal flush requirement should be minimized to less than 0.1 GPM	
32.	IMPELLER TYPE	if possible. The use of water as supplment seal flush should	
33.	STUFFING BOX	only be considered as the last alternative when other means to	
34.	SMOOTHERING GLAND	provide adequate seal flush fail. Vendor should specify the	
35.	MANUFACTURERS MODEL NO.	desired quality of seal flush, allowable solid loading,	
36.		particle size, etc.	
	DRIVER		
37.	TYPE	Electric Motor	
38.	CURRENT CHARACTERISTICS		
39.	MOTOR CLASS		
40.	RPM & HORSEPOWER RATING		
41.	BHP @ REQUIRED CAPACITY		
42.	MANUFACTURE & MODEL NO.		
43.		*See attached Table 1	
44.			

SPECIFIED BY T. R. Tsao 1/29/82

FORM 8243 (REV. 11/75)

p

29 January 82

SPECIFICATION SHEET

For Slurry Circulation Pump 10.50 A&B

EXHIBIT 2.3.1-6

RELEASED FOR PROJECT

Table 1

PROPERTIES OF WITCO #40 OIL

1. Composition - (72% paraffinic, 28% naphthenic)

Component	%
C_{14}	5
C_{14}-C_{15}	15
C_{16}-C_{17}	20
C_{18}-C_{19}	25
C_{20}-C_{21}	20
$>C_{21}$	15
Sulfur	1 ppm

2. Viscosity,
   Kinematic = 4.2 cSt @100°F
   Saybolt = 40-43 SUS @100°F

3. Vapor Pressure $<$0.002 mm Hg @100°F

4. Specific Gravity = 0.810 @ 60°F
   Density = 0.810 g/cc @100°F

5. Initial Boiling Point = 471°F @ 1 atm.

6. Solubility in Methanol:
   7.2 wt. % oil @ 0 wt. % H_2O in methanol and 120°F
   2.9 wt. % oil @ 0 wt. % H_2O in methanol and 70°F
   2.1 wt. % oil @ 5 wt. % H_2O in methanol and 120°F
   (Insoluable in Water)

7. M.W. = 268.5 lb./lb. mole

8. ASTM Pour Point = -35°F, maximum

9. Surface Tension = 32 dynes/cm. @~ 68°F
   = 13 dynes/cm. @~464°F

10. ASTM Cloud Point = +40°F, Maximum

11. Saybolt Color = +30

12. Odor or Taste→ None

13. U.V. Absorbance→ Passes FDA Requirements

14. USP Acid Test→ Passes

JK
29-1-82

p

Air Products

COMPRESSOR SPECIFICATION SHEET

EXHIBIT 2.3.1-7A

PAGE 1/2
DATE 29 January 1982
REVISED

CUSTOMER APCI
VENDOR By Elec. Mech. UNIT LP MeOH PDU PROJECT NO. 87-7-1533

GENERAL INFORMATION		Feed Compressor		
1.	ITEM NO.	01.10		
2.	NO. REQUIRED	one (1)		
3.	TYPE	Reciprocating Compressor expected		
4.	DUTY	Continuous		
5.	SERVICE	Compress Dry Synthesis Gas (H_2, CO, CO_2, N_2, CH_4)		
PROCESS INFORMATION				
6.	FLUID	Synthesis Gas		
7.	COMPOSITION - MOL%	(see page 2/2)		
8.	AVERAGE MOLECULAR WEIGHT	(see page 2/2)		
9.	CORROSIVE COMPOUNDS			
10.	RELATIVE HUMIDITY	7% ($7x10^{-4}$LB H_2O/lb of Gas, D.P. = 27°F)		
11.	SUCTION TEMPERATURE °F.	100 Norm., 125 Max.		
12.	SUCTION PRESSURE - PSIA	150	150	150
13.	DISCHARGE PRESSURE - PSIA*	550*	750**	950***
14.	DISCHARGE TEMPERATURE °F.			
15.	NORMAL SUCTION FLOW RATE			
	A. A.C.F.M.		see page 2/2	
	B. POUNDS/HOUR			
16.	STANDARD CUBIC FEET/MINUTE			
17.	COOLING WATER SUPPLY °F.	90 Nor., 105 Max. @ 43 psig‡		
18.	COOLING WATER RETURN °F.	120 Nor., 105 Max. @ 10 psig‡		
19.	CP/CV			
CONSTRUCTION				
20.	TYPE OF COMPRESSOR			
21.	MATERIAL OF CONSTRUCTION			
22.	SUCTION CONNECTIONS	2-1/2" or by vendor		
23.	DISCHARGE CONNECTIONS	2-1/2" or by vendor/interstage relief valve inlet flange		
24.	TYPE OF LUBRICATION	2-1/2" with 450 psig design press		
25.	COMPRESSOR SPEED			
26.	AFTERCOOLER REQUIRED	Intercooler & recycle cooler design for 100% recycle		
27.	CODE STAMP FOR AFTERCOOLER	Yes, ASME Sec. VIII		
28.	AFTERCOOLER SURFACE FT²	Intercooler by compressor vendor; recycle cooler by proce		
29.	WATER REQUIRED GPM	By vendor **Cooling water is a premium		
30.	Utility	Minimize cooling water requirement		
ACCESSORIES				
31.	FILTER			
32.	CLEARANCE POCKETS			
33.	UNLOADERS			
34.				
35.				
36.				
DRIVER				
37.	TYPE	Electric Motor		
38.	POWER CHARACTERISTICS			
39.				
40.		+Vendor to specify the inlet condition of recycle cooler		
41.	MOTOR CLASS	*Design/Elec.Mech. should confirm that the max. discharge		
42.	MOTOR TYPE	pressure, 950 psig = 935 psig is attainable when the		
43.	POWER FACTOR	relief valves of the compressor is set at 1000 psig,		
44.	M. G. SET	the design pressure of the PDU.		
45.		*For cases operating at 500 psig		
STARTER		**For cases operating at 700 psig		
46.	TYPE	***For cases operating at 900 psig		
47.	ENCLOSURE	‡Project should confirm temp. and pressure of cooling water in writing.		
48.				

FORM 8240 (REV. 2/76)

T. R. Tsao 1/29/82

EXHIBIT 2.3.1-7A

LPMeOH PDU; FEED COMPRESSOR, 01.10

87-7-1533

	For Lurgi-type Reactor Feed, Mol %	For KT-type Reactor Feed, Mol %	For Balanced Fresh Feed, Mol %	N_2 Mol %
H_2	50 ~ 63	38 ~ 51	65 ~ 67	
CO	25 ~ 29	49 ~ 60	30 ~ 33	
CO_2	4 ~ 10	0 ~ 2	0 ~ 3	
N_2	0 ~ 15	0 ~ 1	0 ~ 1	99.99
CH_4	0 ~ 15	trace	trace	
O_2	trace	trace	trace	trace

	Lightest Mol %	Heaviest Mol %	Lightest Mol %	Heaviest Mol %	Lightest Mol %	Heaviest Mol %	
H_2	63	50	51	38	67	67	-
CO	29	25	49	60	33	29	-
CO_2	4	10	-	2	-	3	-
N_2	4	15	-	-	-	1	99.99
CH_4	-	-	-	-	-	-	-
O_2	-	-	-	-	-	-	Trace
Total	100	100	100	100	100	100	100
M.W.	12.3	16.6	14.7	18.5	10.6	11.1	28

Suction Flow Rate	Min	Nor	Max	Min	Nor	Max	Min	Nor	Max	Nor	Max
lb-mol/hr	18	60	100	18	40	55	18	50	80	20	30
A.C.F.M.	12	40	67	12	27	37	12	34	54	13	20
lb/hr	220	870	1660	265	660	1020	190	540	890	560	840
SCFM @ 1 atm. 70°F ‡	116	387	644	116	258	354	116	322	516	129	193

‡386.68 SCF/lb-mol

T. R. Tsao
1/29/82

Air Products

COMPRESSOR SPECIFICATION SHEET

EXHIBIT 2.3.1-7B

PAGE 1/2
DATE 29 January 1982
REVISED

CUSTOMER APCI
VENDOR By Elec. Mech. UNIT LP MeOH PDU PROJECT NO. 87-7-1533

GENERAL INFORMATION	Recycle Compressor		
1. ITEM NO.	01.20		
2. NO. REQUIRED	one (1)		
3. TYPE	Reciprocating Compressor Expected		
4. DUTY	Continuous		
5. SERVICE	Compress Recycle Gas		
PROCESS INFORMATION			
6. FLUID	Unconverted Synthesis Gas or Nitrogen		
7. COMPOSITION - MOL%	(see page 2/2)		
8. AVERAGE MOLECULAR WEIGHT	(see page 2/2)		
9. CORROSIVE COMPOUNDS	H_2O, CO_2, CH_3OH, C_2H_5OH & Higher Alcohols		
10. RELATIVE HUMIDITY	100% Saturated w/H_2O & CH_3OH		
11. SUCTION TEMPERATURE °F.	110 Norm., 125 Max.		
12. SUCTION PRESSURE - PSIA	485*	685**	885***
13. DISCHARGE PRESSURE - PSIA ✱	550	750	950
14. DISCHARGE TEMPERATURE °F.			
15. NORMAL SUCTION FLOW RATE			
A. A.C.F.M.			
B. POUNDS/HOUR	see page 2/2		
16. STANDARD CUBIC FEET/MINUTE			
17. COOLING WATER SUPPLY °F.	90 Nor., 105 Max. @ 43 psig ‡		
18. COOLING WATER RETURN °F.	120 Nor., 105 Max. @ 10 psig‡		
19. CP/CV			
CONSTRUCTION			
20. TYPE OF COMPRESSOR			
21. MATERIAL OF CONSTRUCTION			
22. SUCTION CONNECTIONS	2-1/2" or by vendor		
23. DISCHARGE CONNECTIONS	2-1/2" or by vendor		
24. TYPE OF LUBRICATION			
25. COMPRESSOR SPEED			
26. AFTERCOOLER REQUIRED	Only required for the compressor recycle stream. Design		
27. CODE STAMP FOR AFTERCOOLER	Yes, ASME Sec. VIII 100% Recycle		
28. AFTERCOOLER SURFACE FT^2	By Process, vendor to specify inlet condition of recycle		
29. WATER REQUIRED GPM	By vendor. **Cooling water is a premium cooler		
30. UTILITY	Minimize cooling water requirement		
ACCESSORIES			
31. FILTER			
32. CLEARANCE POCKETS			
33. UNLOADERS			
34.			
35.			
36.			
DRIVER			
37. TYPE	Electric Motor		
38. POWER CHARACTERISTICS			
39.			
40.			
41. MOTOR CLASS			
42. MOTOR TYP.	✱Design/Elec. Mech. should confirm that the max.		
43. POWER FACTOR	discharge pressure, 950 psia = 935 psig, is attainable		
44. M. G. SET	when the relief valves of the compressor is set at		
45.	1000 psig, the design pressure of the PDU.		
STARTER	*For cases operating at 500 psig		
46. TYPE	**For cases operating at 700 psig		
47. ENCLOSURE	***For cases operating at 900 psig		
48.	‡Project should confirm temp. and pressure of cooling water in writing.		

T. R. Tsao
1/29/82

FORM 8240 (REV. 2/76)

87-7-1533 EXHIBIT 2.3.1-7B

	For Lurgi-type Reactor Feed, Mol %	For KT-type Reactor Feed, Mol %	For Balanced Fresh Feed, Mol %	N_2 Mol %
H_2	45 ~ 63	25 ~ 51	40 ~ 50	
CO	22 ~ 29	60 ~ 70	20 ~ 25	
CO_2	10 ~ 15	1 ~ 3	10 ~ 20	
N_2	15 ~ 18	0 ~ 2	10 ~ 20	99.99
CH_4	15 ~ 18	trace	10 ~ 20	
CH_3OH	1 ~ 2	1 ~ 2	1 ~ 2	
C_2H_5OH	(0 ~ 1200 ppmv)	(0 ~ 1200 ppmv)	(0 ~ 1200 ppmv)	
H_2O	(200 ~ 1000 ppmv)	(200 ~ 1000 ppmv)	(200 ~ 1000 ppmv)	
O_2	trace	trace	trace	trace
Witco #40 Oil	trace	trace	trace	trace

	Lightest Mol %	Heaviest Mol %	Lightest Mol %	Heaviest Mol %	Lightest Mol %	Heaviest Mol %	N_2 Mol %
H_2	63	45	51	25	67	40	-
CO	29	22	49	70	33	20	-
CO_2	4	15	-	3	-	19	-
N_2	4	16	-	-	-	19	99.99
CH_4	-	-	-	-	-	-	-
CH_3OH	-	2	-	2	-	2	-
C_2H_5OH	-	1200 ppmv	-	1200 ppmv	-	1200 ppmv	-
H_2O	-	1000 ppmv	-	1000 ppmv	-	1000 ppmv	-
O_2	-	-	-	-	-	-	trace
Total	100	100	100	100	100	100	100
M.W.	12.3	18.8	14.7	22.1	10.6	20.7	28

Suction Flow Rate	Min	Nor	Max	Min	Nor	Max	Min	Nor	Max	Nor	Max
lb.mol/hr	50	150	300	50	100	250	50	150	300	150	330
A.C.F.M.	*	*	*	*	*	*	*	*	*	*	*
lb/hr	615	2333	5640	735	1840	5525	530	2348	6210	4200	9240
SCFM @1 atm. 70°F ‡	322	967	1933	322	644	1611	322	967	1933	967	2127

$$*\text{A.C.F.M.} = \frac{(\text{Suction Flow, Lb-Mol/Hr})}{60} \times \frac{(10.73)\ (460 + \text{Suction T, °F})}{(\text{Suction Press, psia})}$$

‡386.68 SCF/lb-mol

T. R. Tsao
1/29/82

EXHIBIT 2.3.1-8

VENDOR:

HEAT EXCHANGER SPECIFICATION SHEET

		Job No.	37-7-1533
Customer	APCI/DOE LPMeOH PDU	Reference No.	
Address		Proposal No.	
Plant Location	LaPorte, TX	Date	3/22/82 Rev. 0
Service of Unit	Slurry Heat Exchanger	Item No.	21.20
Size	Type (Hor/Vert) Vertical	Connected In	Parallel Series
Surf/Unit (Gross/Eff.)	58 ft²* Sq Ft; Shells/Unit 1	Surf/Shell (Gross/Eff.)	58* Sq Ft

PERFORMANCE OF ONE UNIT

	Shell Side		Tube Side	
Fluid Allocation	Shell Side		Tube Side	
Fluid Name	Utility Oil		Oil/Catalyst Slurry	
Fluid Quantity, Total Lb/Hr	60220		75390	
Vapor (In/Out)	0	0	0	0
Liquid	60220	60220	75390	75390
Steam	-	-	-	-
Water	-	-	-	-
Noncondensable	-	-	-	-
Temperature (In/Out) °F	554.0	551.3	515.5	518.0
Density Lb/Ft³	39	39	47	47
Viscosity, Liquid Cp	0.65	0.65	0.80	0.80
Molecular Weight, Vapor	-	-	-	-
Molecular Weight, Liquid	250	250	-	-
Specific Heat Btu/Lb °F	0.77	0.77	0.65	0.65
Thermal Conductivity Btu Ft/Hr Sq Ft °F	0.048	0.048	0.050	0.050
Volume pct. solids	zero		1.5 (6.0 max.)	
Inlet Pressure (min/max.) Psig	40/100		450/950	
Velocity minimum (note 3) Ft/S	3		5 (10 max.)	
Pressure Drop, Allow. Calc. Psi	5 /		5 /	
Fouling Resistance (Min.) Hr. ft² °F/BTU	0.002		0.003	

Heat Exchanged	123,340 (see note 1) Btu/Hr	MTD (Corrected)	°F
Transfer Rate, Service		Clean 88*	Btu/Hr Sq Ft °F

CONSTRUCTION OF ONE SHELL

		Shell Side	Tube Side	Sketch (Bundle/Nozzle Orientation)
Design/Test Pressure Psig		140 /	1000 /	See sheet 4
Design Temperature °F		600	600	
No. Passes per Shell		1	1 max.	
Corrosion Allowance In.		by design	by design	
Connections Size & Rating	In	4"*	4"*	
	Out	4"*	4"*	
	Intermediate	-	-	

Tube No. 42* OD 3/4*In.; Thk (Min/Avg) 0.166*In.; Length 7* Ft; Pitch 15/16 In.	(30) 60 90 45		
Tube Type 14 BWG (design to verify)*	Material C. Steel		
Shell C. Steel Nom OD 10* In.	Shell Cover (Integ.) (Remov.)		
Channel or Bonnet Conical (see note 4)	Channel Cover		
Tubesheet-Stationary	Tubesheet-Floating		
Floating Head Cover	Impingement Protection		
Baffles-Cross Type by vendor	% Cut (Diam/Area)	Spacing: c/c	Inlet In.
Baffles-Long	Seal Type		
Supports-Tube	U-Bend	Type	
Bypass Seal Arrangement	Tube-Tubesheet Joint		
Expansion Joint	Type		
ρv²-Inlet Nozzle	Bundle Entrance	Bundle Exit	
Gaskets-Shell Side	Tube Side		
-Floating Head			
Code Requirements	TEMA Class		
Weight/Shell	Filled with Water	Bundle	Lb

Remarks

SEE REMARKS PAGE 3

Specified by: L. W. Bonnell 22 Mar 82
T. R. Tsao 22 Mar 82

FORM 8304 (REV. 12/80)

p

HEAT EXCHANGER SPECIFICATION SHEET
ADDITIONAL INFORMATION REQUIRED BY AIR PRODUCTS & CHEMICALS, INC.

ADDITIONAL PROCESS DATA

5.1 Service of Unit Condenser (Cooler or Heater) Reboiler Vaporizer

7.1 Number of Units Required one (1)

		Shell Side IN	Shell Side OUT	Tube Side IN	Tube Side OUT
17.1	[redacted]/Bubble Point °F	> 600°F		Saturated Liquid	
18.1	Density, V/L Lbs./Cu. Ft.				
19.1	Viscosity, V/L Cp				
20.1	Molecular Weight, V/L Lbs./Mole				
22.1	Specific Heat, V/L Btu/Lb. °F				
23.1	Thermal Conductivity, V/L Btu Ft./Hr. Sq. Ft. °F				
25.1	Highest Operating Pressure, psia	100		950	
26.1	Velocity, In/Out Ft./Sec.	3.1*		5.7*	
30.1	Heat Transfer Coeff Clean Btu/Hr. Sq. Ft. °F	150*		220*	

30.2 Transfer Rate Fouled, Btu/Hr. Sq. Ft. °F Nominal 60*

30.3 Transfer Rate Clean, Btu/Hr. Sq. Ft. °F Nominal 88*

30.4 Transfer Rate Service, Btu/Hr. Sq. Ft. °F (includes 40% Process Safety Factor) 43*

ADDITIONAL MECHANICAL DATA

39.1 Additional Connections Vents: Number Size & Rating

39.2 Drains: Number Size & Rating

39.3 Rupture Discs: Number Size & Rating

40.1 Finned or Extended Surface: Type Area Ratio Ao/Ai

40.2 Surface or Bundle Mfr. Model & Description

40.3 Fin Count FPI Fin Thick in Fin Mat'l. Coating

40.4 Bundle Length in Height in Depth in Face Area Ft.^{2}

40.5 Seal Type & Arrangement (Describe)

44.1 Tube Sheet:

44.2 Stationary Material Thickness in. Corrosion Allowance in.

Floating Material Thickness in. Corrosion Allowance in.

Baffle Thickness in. Method of Fastening (Describe)

Baffle Spacer Mat'l. Size Tie Rod Mat'l. Size

Diametrical Clearances:

Bundle to Shell in. Baffle to Shell in. Tube to Baffle Hole in.

Demister, Perforated Plate or Condensate Removal Device Type & Description:

Lifting Lugs Paint

Cleaning Requirements

Shipping Requirements

Exchanger Drawing Number

Detail Method & Rating Heat Transfer Coefficient

Detail Method of Calculating MTD

Remarks

SEE REMARKS PAGE 3

L. W. Bonnell 3/22/82
T. R. Tsao 3/22/82

p

L. W, Bonnell
19 March 1982

EXHIBIT 2.3.1-8

21.20 Slurry Heat Exchanger Remarks

87-7-1533

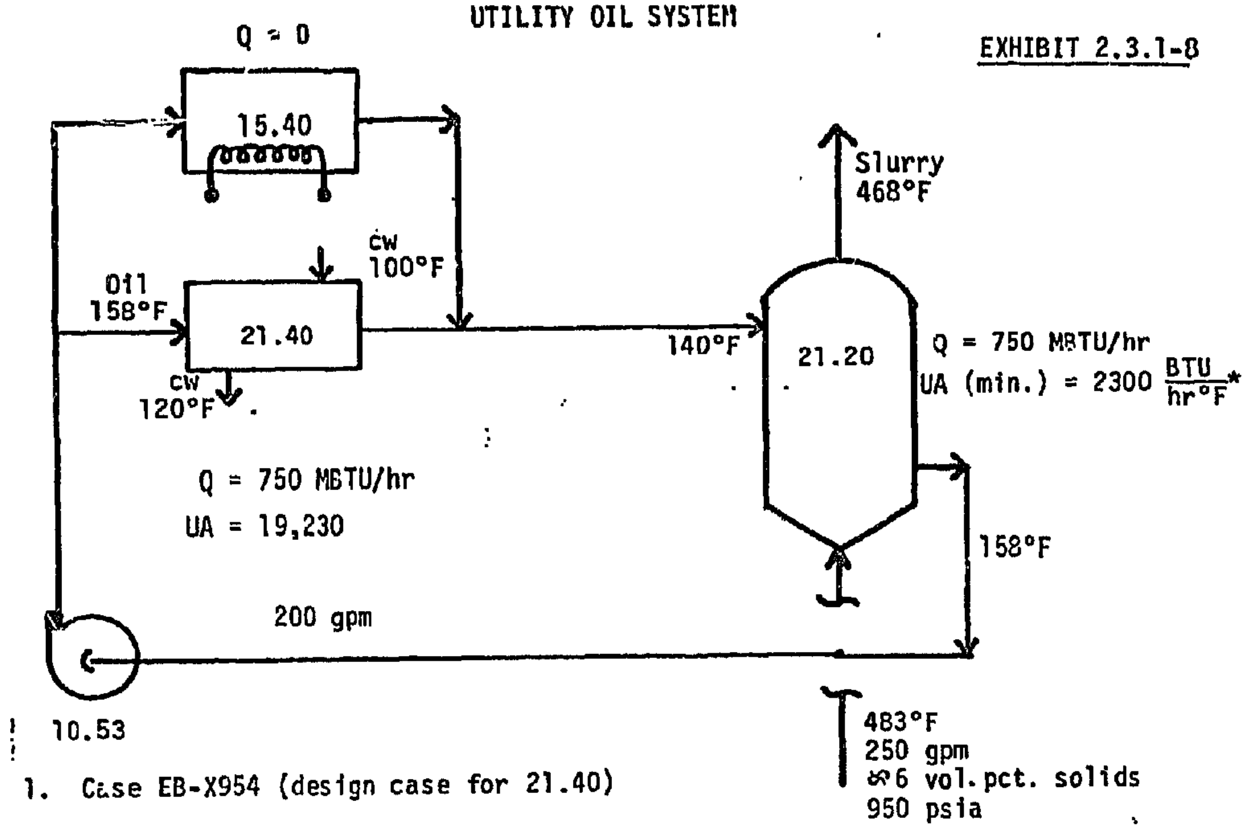
1. APCI Design Case: EK-2571 with 150 MBTU/hr. heat leak. 40 percent process duty safety factor has been applied.
2. Shell and Tube flowrate design ranges (gpm)

	Min.	Normal	Max.
Shell (oil)	100	200	210
Tube (slurry)	200	200	260

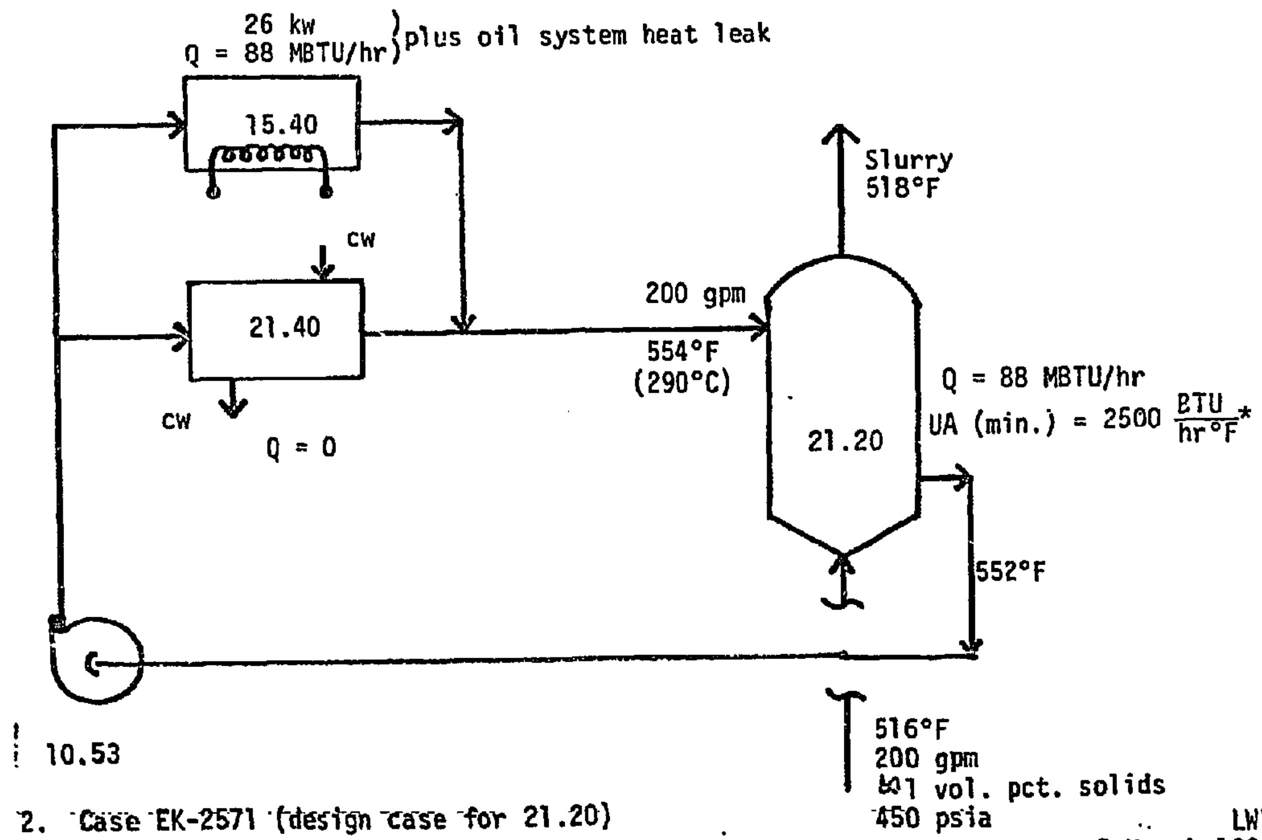
3. Minimum tubeside velocities must be maintained between 5 and 10 ft/sec for above flow range.
4. Due to slurry service and erosion concerns, one tube pass strongly recommended, with vertical upflow of slurry in normal operation. Inlet (front) head should be cone-shaped, to eliminate dead spaces where solids can gather.
5. Data marked with an asterisk ("*") on pp. 1 & 2 are given for estimate purposes only, and do not constrain the vendor's design.
6. See p. 4 for sketch of 21.20 and utility oil system. 21.20 will function as both heater and cooler. Design Eng. and the vendor to ensure that exchanger is designed to handle large shell-to-tube temperature differences.
7. Catalyst particle size (typical): 60 microns

UTILITY OIL SYSTEM

EXHIBIT 2.3.1-8



1. Case EB-X954 (design case for 21.40)

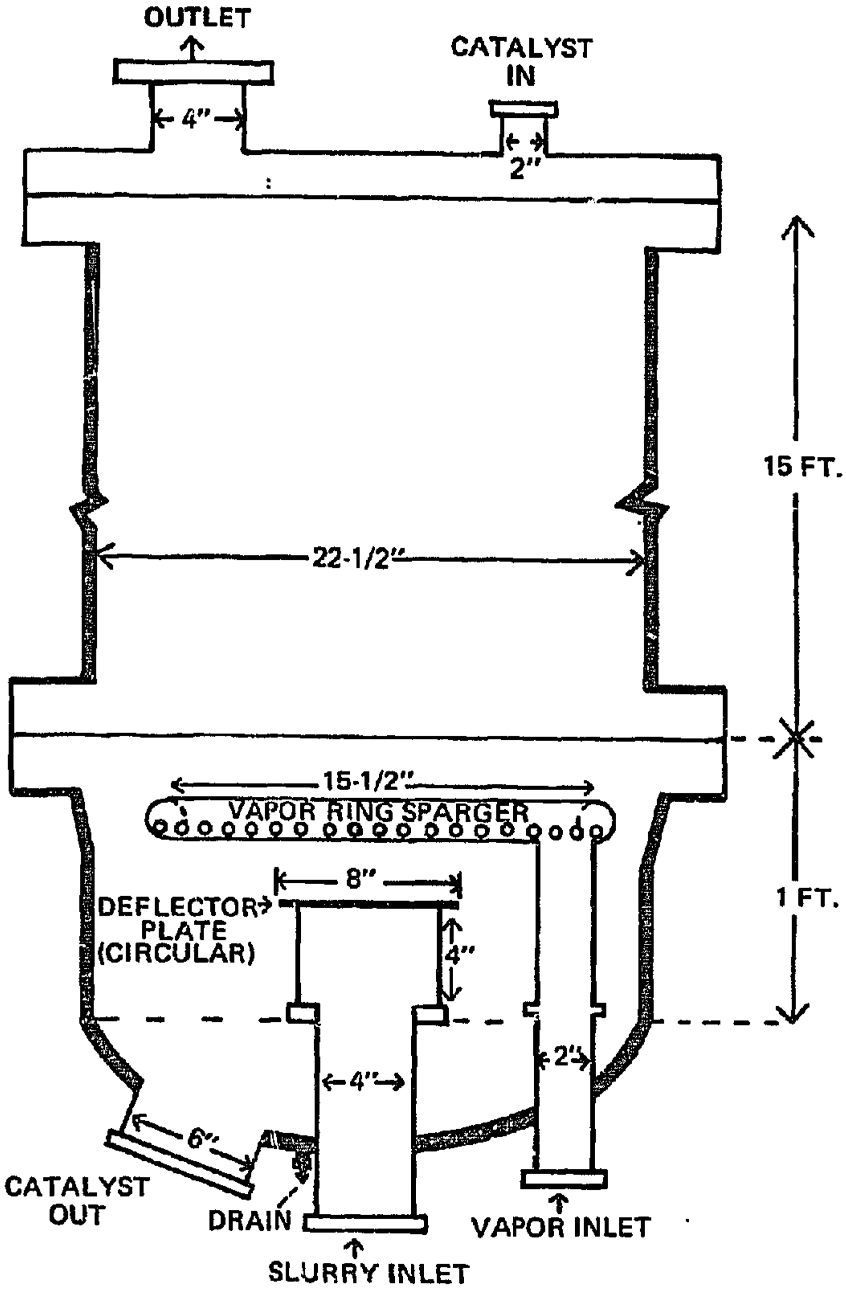


2. Case EK-2571 (design case for 21.20)

LWB
5 March 1982

EXHIBIT 2.3.1-9A

27.10 LPMeOH REACTOR (LIQUID-ENTRAINED OPERATING MODE)



LWB
12 MAR. 82

p

EXHIBIT 2.3.1-9B

LaPorte LPMeOH Reactor Operating Parameters

	Case EB-X954 (Max. Production, Liquid-Entrained)	Case FB-4930 (Max. Production Liquid Fluidized)
Superficial Vapor Velocity, ft/sec	0.39	0.26
Superficial Liquid Velocity, ft/sec	0.21	0.17
Space Velocity, acfh/ft^3*	93.6	62.4
Space Velocity, scfh/ft^3	3270	2300
Space Velocity, Std. liters/hr-kg cat oxide	9770	3975
Catalyst Loading, lb	909	1387
Catalyst Particle Size, inches	0.0024	0.107
Catalyst Particle Size, microns	60	2718

*ft^3 refers to reactor free volume.

LWB
16 April 1982

EXHIBIT 2.3.2-1

Engineering Specification Activity for Process Equipment/LaPorte LPMeOH PDU

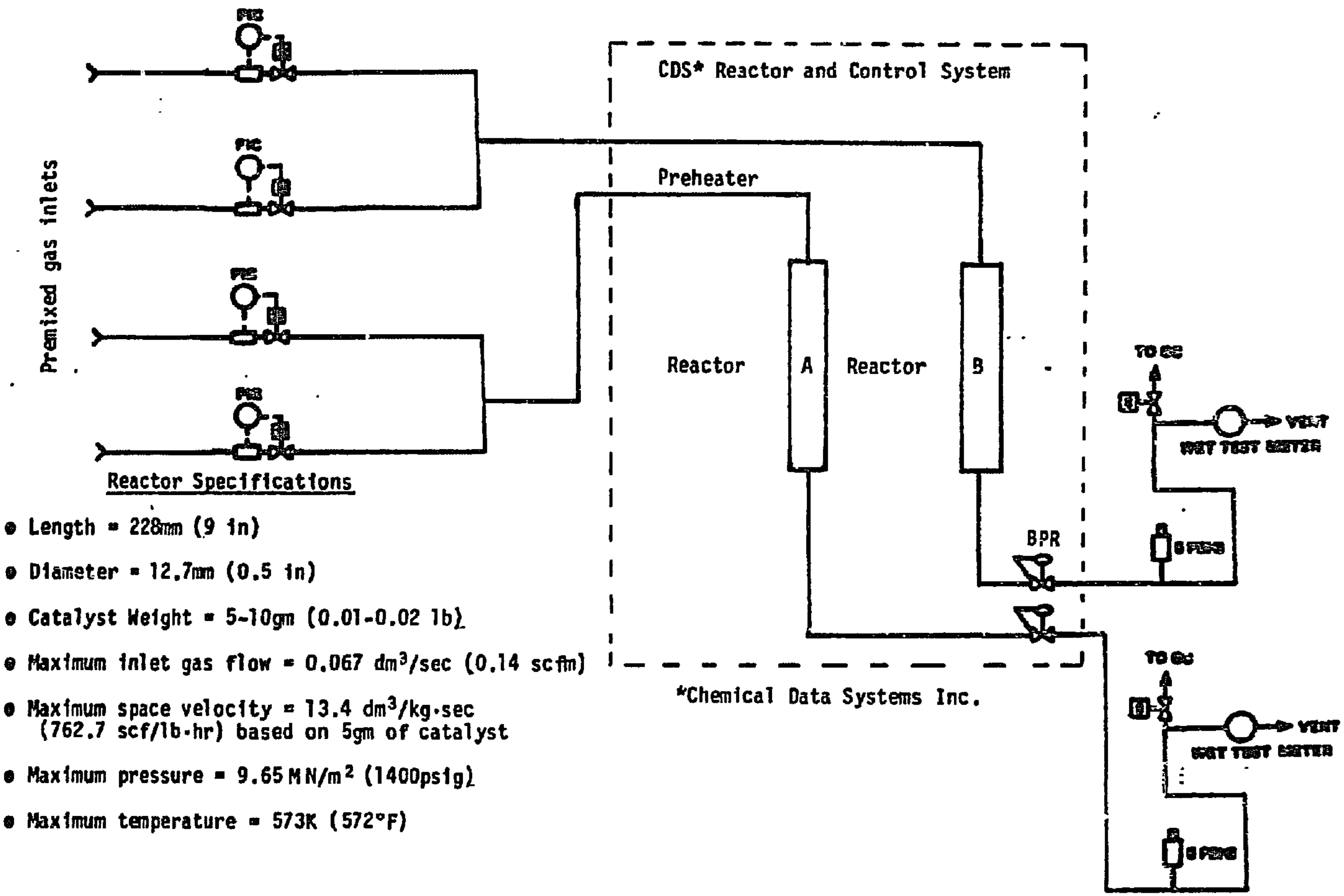
Equipment Item	Process Specification	Mechanical Specification	Quotations Received	Existing Equipment
01.10/01.20 Feed/Recycle	X (Note 1)			
Compressor	X	X	X	
01.13 Feed Surge Tank	X	X		
01.14 Feed Compressor Recycle Cooler	X	X		
01.24 Recycle Compressor Recycle Cooler	X	X		
02.50 Sulfur Trim Bed	X	X		
02.51 Sulfur Trim Bed Afterfilter	X	X		
02.81 Catalyst Reduction Vessel				
02.83 Reduction Gas Heater	X			X
02.91 A&B Water Pumps	X	X		
02.92 Water Feed Tank	X			X
10.50 A&B Slurry Circulation Pumps	X	X	X	
10.52 A&B Condensed Oil Pumps	X			X
10.53 A&B Hot Oil Pumps	X			X
10.54 Process Oil Make-up Pump	X			X
15.40 Oil Heater	X			X
21.10 Feed/Product Exchanger	X	X		
21.20 Slurry Heat Exchanger	X	X		
21.30 Product Gas Cooler	X			X
21.40 Oil Cooler	X	X		
21.53 Hop Seal Flush Cooler	X	X		
22.10 Three-phase Separator	X	X		X (Note 2)
22.11 Methanol Degasser	X			X
22.12 Demister	X			X
22.50 A&B Side Stream Filters	X			X
22.51 A&B Condensed Oil Filters	X			X
27.10 Reactor	(Note 3)			X
27.13 Primary V/L Separator	X	X		
27.14 Intermediate V/L Separator	X			X
28.10 Product Storage Tank	X	X		
28.20 Process Oil Storage Tank	X			X
28.30 Slurry Preparation Tank	(Note 4)			
28.40 Maintenance Dump Tank	X			
28.53 Oil Expansion Tank	X	X		
Total Items = 33	Total = 30	Total = 16	Total = 2	Total = 15

NOTES:
(1) Two process specifications issued, counted here as one for multiservice machine.
(2) Existing vessel D-101 considered marginally acceptable for use on LaPorte LPMeOH PDU. Evaluation of modification costs versus new equipment fabrication must be made.
(3) Process specification covering LaPorte LPMeOH reactor based on existing LPM vessel R-101, delayed pending determination of internals.
(4) Slurry Preparation Tank required for liquid-entrained modifications only. Process specifications scheduled for 25 June 1982.

APCI Lab Gas Phase Reactor

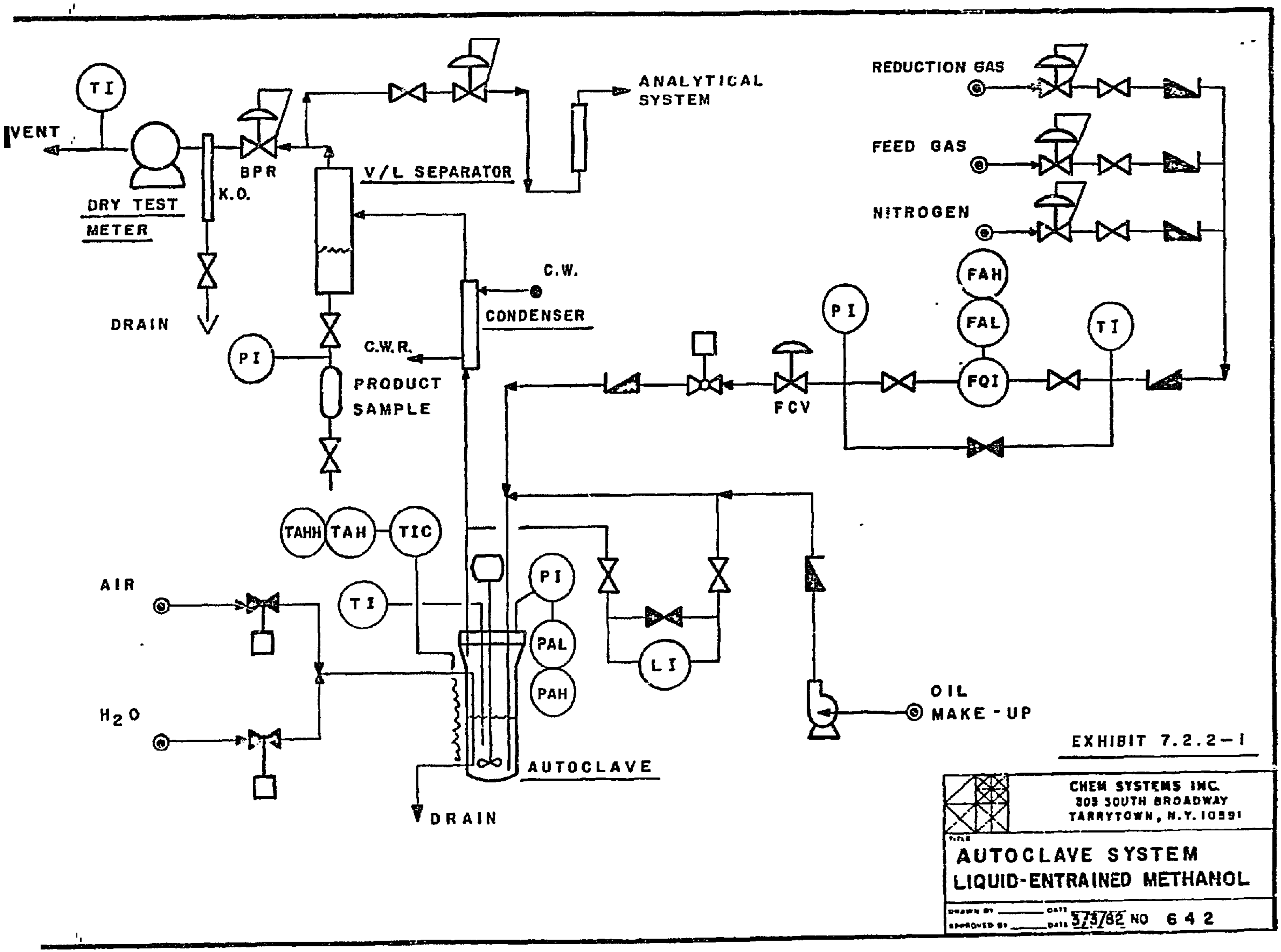
EXHIBIT 7.1.3-1

20 April 1982



Reactor Specifications

- Length = 228mm (9 in)
- Diameter = 12.7mm (0.5 in)
- Catalyst Weight = 5-10gm (0.01-0.02 lb)
- Maximum inlet gas flow = 0.067 dm^3/sec (0.14 scfm)
- Maximum space velocity = 13.4 dm^3/kg·sec (762.7 scf/lb·hr) based on 5gm of catalyst
- Maximum pressure = 9.65 MN/m^2 (1400psig)
- Maximum temperature = 573K (572°F)


VENT
TI
DRY TEST
METER
K.O.
BPR
DRAIN
V/L SEPARATOR
ANALYTICAL
SYSTEM
PI
C.W.R.
PRODUCT
SAMPLE
C.W.
CONDENSER
REDUCTION GAS
FEED GAS
NITROGEN
FAH
FAL
FQI
PI
TI
FCV
TAHH
TAH
TIC
TI
PI
PAL
PAH
LI
AIR
H2O
AUTOCLAVE
DRAIN
OIL
MAKE-UP
EXHIBIT 7.2.2-1
CHEM SYSTEMS INC.
303 SOUTH BROADWAY
TARRYTOWN, N.Y. 10591
AUTOCLAVE SYSTEM
LIQUID-ENTRAINED METHANOL
3/3/82
NO 642

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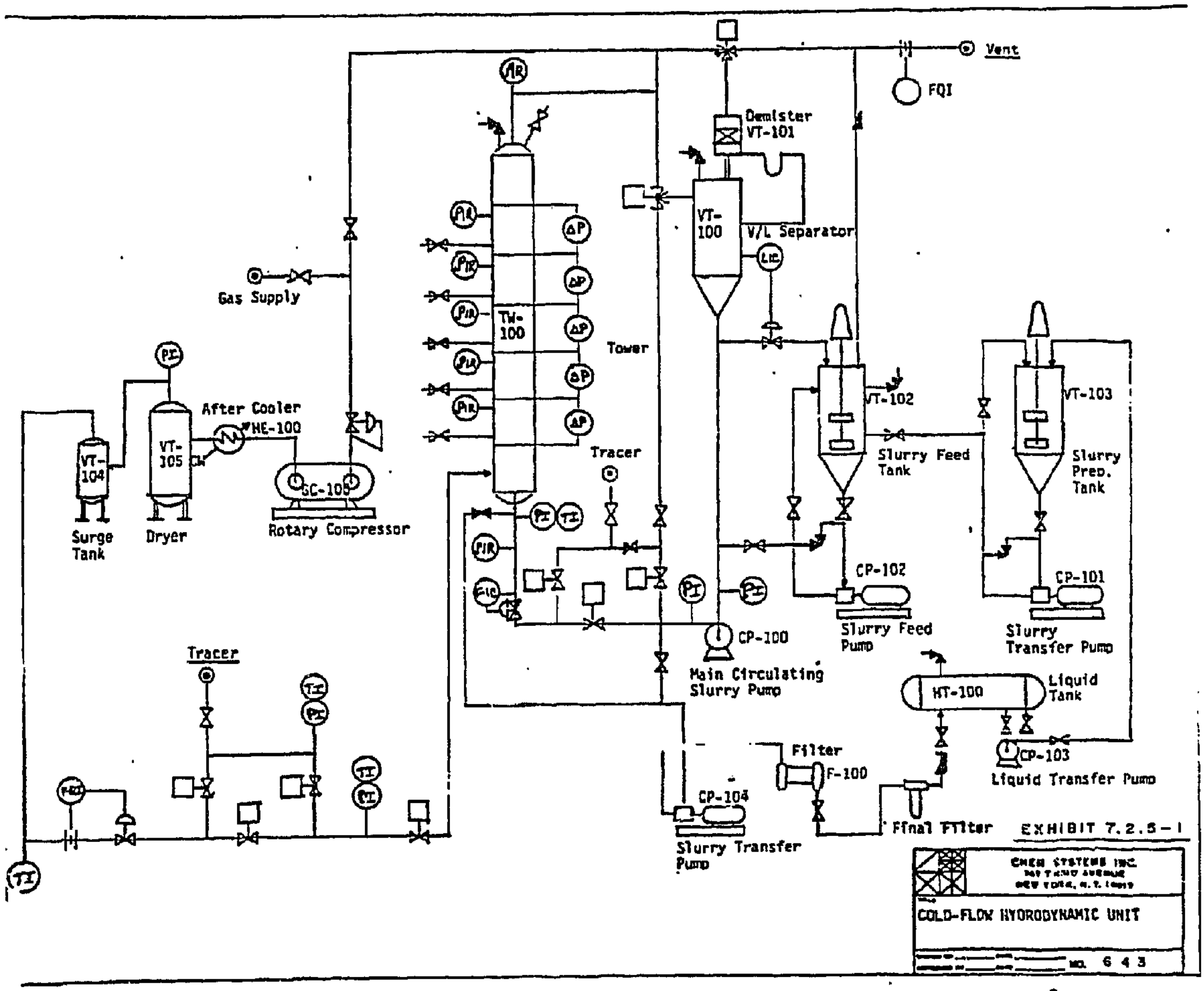
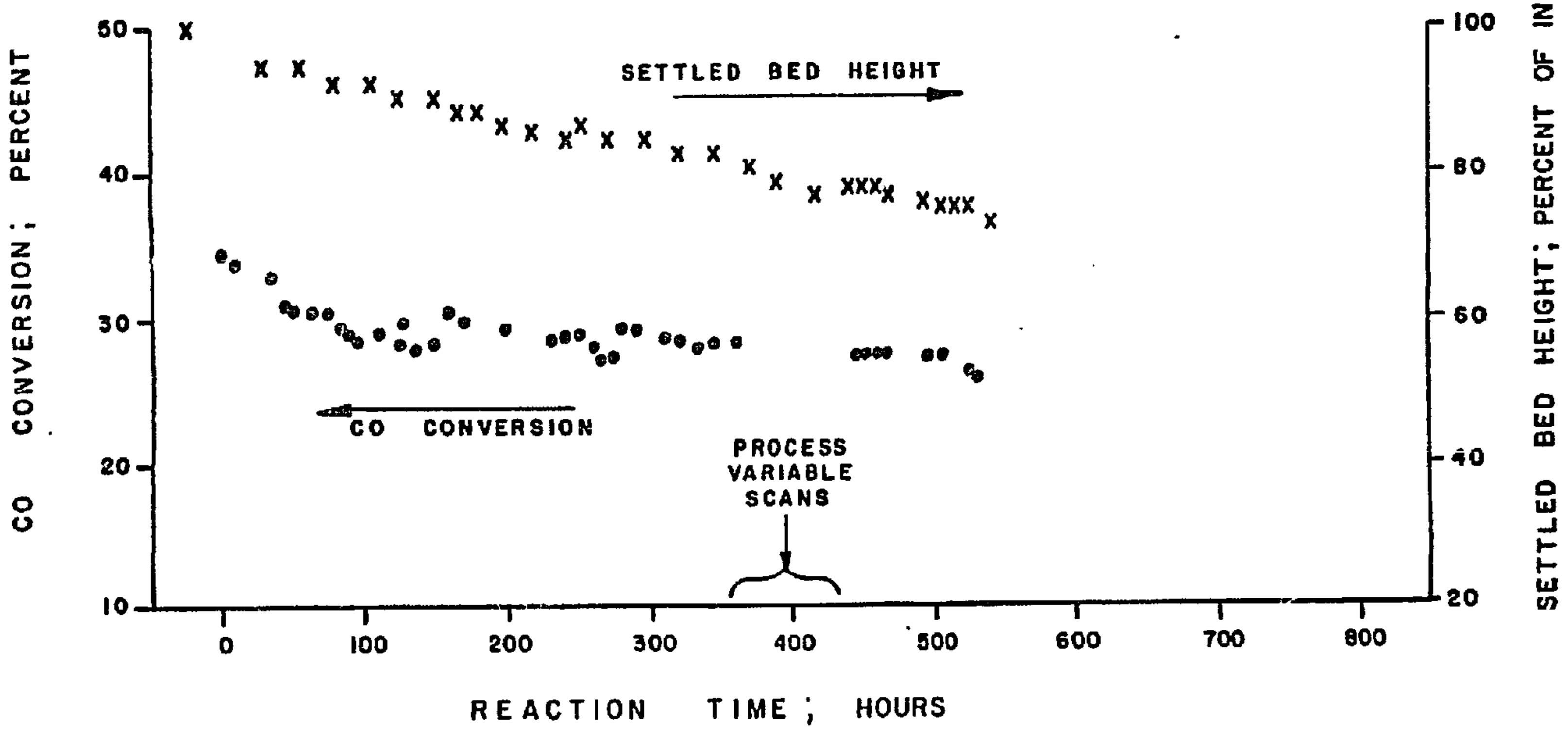


Vent
FQI
Demister VT-101
VT-100
V/L Separator
Gas Supply
TW-100
Tower
Tracer
After Cooler
HE-100
VT-104
VT-105
Surge Tank
Dryer
GC-105
Rotary Compressor
VT-102
Slurry Feed Tank
VT-103
Slurry Prep. Tank
CP-102
Slurry Feed Pump
CP-101
Slurry Transfer Pump
CP-100
Main Circulating Slurry Pump
HT-100
Liquid Tank
CP-103
Liquid Transfer Pump
Filter
F-100
CP-104
Slurry Transfer Pump
Final Filter
EXHIBIT 7.2.5-1
CHEM SYSTEMS INC.
COLD-FLOW HYDRODYNAMIC UNIT
NO. 6 4 3

EXHIBIT 7.2.8-1

CATALYST ACTIVITY AND ATTRITION IN CSI LIQUID-FLUIDIZED LAB PDU WITH CATALYST R7 1/0F12 – 02

2/1 H_2/CO FEED GAS
250 °C, 7000 kPa
3000 L/HR.–Kg CAT



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CHEM SYSTEMS INC.

EXHIBIT 7.2.8-2

CSI LIQUID-FLUIDIZED PDU RUN CHRONOLOGY

WITH CATALYST R71/OF12-02

Date	Time	Cumulative Reaction Time (Hours)	Milestone
2/16/82	0900	0	4.4 Kg oxided catalyst (R71/OF12-02) loaded into reactor.
	1600	0	2% H_2/N_2 reduction gas in; catalyst heating to 180°C.
2/17/82	--	0	Reduction continuing
2/18/82		0	Two Al_2O_3-filled guard chambers put on-line.
2/19/82	0300	0	First sight of H_2 break through; a total of 45.0 gmol H_2 has passed over catalyst at this point.
	0400	0	Begin heating catalyst @ 10°C per hour to 240°C.
	1100	0	Catalyst at 240°C.
	1200	0	Catalyst cooling to 200°C.
	1300	0	Oil circulating on reactor by-pass; heating to 200°C; pressurizing system to 3500 kPa with nitrogen.
	1630	0	Reactor filled w/Witco 40 oil.
	1830	0	Oil flow started through reactor; filters placed in-service.
2/20/82	0600	0	Oil through reactor @ 15 liters/min.
	1000	0	Fluidization tests at various oil flow rates at 7000 kPa and 250°C.
	1630	0	Gas flow started through reactor.
	1745	0	Fluidization tests @ 15 liters/min oil and various gas flows started at 7000 kPa and 250°C.
	2100	0	Gas fluidization tests complete and establishment of run conditions.
2/21/82	0800	11	At steady-state conditions of 3000 VHSV, 7000 kPa, 250°C; draining 2L methanol product each hour; fluidized bed height taken every 4 hrs, and settled bed height taken every 24 hrs.
2/22/82	1800	45	Change filter.
2/23/82	1400	65	Change filter.
2/26/82	0230	125	Change filter.
2/28/82	0230	173	Change filter.
3/2/82	1400	233	Change filter.
3/5/82	0100	292	Change filter.
3/8/82	0500	368	Change filter.

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CHEM SYSTEMS INC.

EXHIBIT 7.2.8-2 (Continued)

CSI LIQUID-FLUIDIZED PDU RUN CHRONOLOGY

WITH CATALYST R71/OF12-02

Date	Time	Cumulative Reaction Time (Hours)	Milestone
3/8/82	1315	376	Switch oil pumps due to excessive leaking.
	1330	376	Begin process variables scan.
	1400	377	7000 kPa, 250°C, 2000 VHSV, 2/1 H_2/CO feed gas.
	1900	382	7000 kPa, 230°C, 2000 VHSV, 2/1 H_2/CO feed gas.
3/9/82	0100	388	7000 kPa, 270°C, 2000 VHSV, 2/1 H_2/CO feed gas.
	0700	394	7000 kPa, 270°C, 4000 VHSV, 2/1 H_2/CO feed gas.
	1300	399	Change filter.
	1400	400	7000 kPa, 250°C, 4000 VHSV, 2/1 H_2/CO feed gas.
	1800	404	7000 kPa, 230°C, 4000 VHSV, 2/1 H_2/CO feed gas.
3/10/82	0100	411	3500 kPa, 230°C, 4000 VHSV, 2/1 H_2/CO feed gas.
	0600	416	3500 kPa, 250°C, 4000 VHSV, 2/1 H_2/CO feed gas.
	1100	421	3500 kPa, 270°C, 4000 VHSV, 2/1 H_2/CO feed gas.
	1700	427	3500 kPa, 270°C, 2000 VHSV, 2/1 H_2/CO feed gas.
	2200	432	3500 kPa, 230°C, 2000 VHSV, 2/1 H_2/CO feed gas.
3/11/82	0600	440	3500 kPa, 250°C, 1000 VHSV, 2/1 H_2/CO feed gas.
	1400	448	Change filter.
	1500	449	3500 kPa, 250°C, 3000 VHSV, 2/1 H_2/CO feed gas.
	2000	454	Back to original conditions of 7000 kPa, 250°C, 3000 VHSV, 2/1 H_2/CO feed gas.
3/12/82	1130	469	Start low CO_2-content 2/1 H_2/CO feed gas @ 7000 kPa, 250°C, 3000 VHSV.
	1800	476	7000 kPa, 270°C, 3000 VHSV, low CO_2 2/1 H_2/CO feed gas.
3/13/82	0200	484	7000 kPa, 270°C, 4000 VHSV, low CO_2 2/1 H_2/CO feed gas.
	0800	490	Change filter.
	1200	494	7000 kPa, 250°C, 4000 VHSV, low CO_2 2/1 H_2/CO feed gas.
	1800	500	Back to original with 2/1 H_2/CO feed gas at 7000 kPa, 250°C, 3000 VHSV.
3/14/82	0500	511	Change filter.
3/15/82	1000	540	2/1 H_2/CO feed off, K/T gas on-line.
	1100	541	Start K/T run; 7000 kPa, 250°C, 3000 VHSV.
	1700	547	End K/T run.
	1800	548	Shutdown; feed gas switched to N_2; all heats off; circulating through oil cooler on reactor bypass; depressurize system and seal flush over 2 hr period; pump off when oil at 200°F; cooling water left on overnight. overnight.

EXHIBIT 7.2.8-3

CSI LIQUID-FLUIDIZED

PDU VARIABLE SCANS: PRELIMINARY RESULTS

H_2/CO Feed Gas	P, kPa	Temp., °C	VHSV* L/Hr·Kg	Conversion, % CO	Conversion, % H_2	Conversion, % CO_2
2/1	7000	250	2000	33.1	34.6	3.3
2/1	7000	230	2000	31.1	33.6	6.1
2/1	7000	270	2000	29.8	30.0	1.5
2/1	7000	270	4000	23.8	24.2	4.5
2/1	7000	250	4000	24.1	24.6	5.3
2/1	7000	230	4000	20.3	21.4	6.8
2/1	3500	230	4000	9.4	10.3	1.9
2/1	3500	250	4000	10.2	10.5	1.7
2/1	3500	270	4000	8.7	9.7	2.3
2/1	3500	270	2000	12.8	13.2	2.3
2/1	3500	230	2000	17.3	21.5	5.2
2/1	3500	250	1000	17.4	18.2	0.7
2/1	3500	250	3000	11.9	13.2	3.0

*Based on weight of oxided catalyst (R71/OF12-02) charged at start of run