Piping and Instrumentation Drawings

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Contents

Introduction

This book contains piping and instrumentation drawings (P&IDs) representing Aspen Icarus Volumetric Models. Volumetric Models develop material quantities and are based on recognized design methods and construction standards. Volumetric Models are the key components behind Aspen Icarus' unique method of designing and estimating.

Volumetric Models determine the field materials (type, quantity, weights, and sizes) required to install an equipment item. Volumetric Models generate the material takeoff for equipment handling and setting, piping, civil, structural steel, instrumentation, electrical, insulation and paint materials. For example, a tower's pipe diameter and length is determined by the diameter, height, pressure, temperature, number of trays, and estimated flow rates. Each run of pipe is consistent with the tower materials, and of a specific length, diameter, schedule, valve, and fitting count, etc., to fulfill the functionality assigned to that line of pipe. Thus, the Volumetric Models create materials to be installed.

P&IDs come in either a standard (STD) or a more fully instrumented (FULL) configuration that may be specified at the Project and Area levels. Both the standard and full versions are shown in this book. The 600 series drawings represent the full versions.

How Project Instrumentation is Developed

Aspen Icarus systems develop the cost of project instrumentation based upon the direct costs of materials and manpower for the following major items:

- Primary element hook-up
- Signal transmission
- Field/panel hook-up
- Final element hook-up
- Control Center
- Operator Center

Primary Element Hook-Up

The primary element is a field-mounted component with all the necessary accessories for process connection and signal transmission to a centrally located field junction box. For pneumatic systems, it includes all the piping, tubing, fittings, valves, and filter-regulators necessary for connecting the impulse piping and air supply to the transmitter, and the process signal tubing to the field junction box. Aspen Icarus systems group this process signal tubing into one or more field junction boxes. For electronic systems, the system assumes a two-wire control loop where power for the transmitter is taken from a power supply in the Control Center. A 4-20 ma DC signal is assumed. Aspen Icarus systems calculate material and manpower costs for fabricating and installing all pipe, valves, and fittings for the impulse piping connection to the transmitter, and all wiring and electrical fittings to the field junction box. Single or multiple twisted pairs of insulated

stranded copper wire are used for the control system. You may specify the type of wiring in the Area date. If "IM" is selected, the complete control wiring system is costed using control wire and multi-conductor cable. The twisted pair consists of stranded copper wire with a mylar tape separator and an extruded PVC jacket.

Signal Transmission

At each junction box, the system differentiates between Control and Indicating function for grouping into multi-tube bundles to be sent to the Control Building for connection to the back of the control panel. For example, two tubes are required for the transmission signal of a control loop from a junction box: one tube for the process transmitter signal to the control and another tube for the control signal from the controller to the final element, as opposed to an indicating loop that is "deadended" at the indicating instrument in the control panel and requires only one tube for signal transmission. Pneumatic transmission tubing is 0.25 INCHES [8 MM] OD, singly or bundled. If the transmission distance between Control Center and the field junction box exceeds 300 FEET [90 M], the system provides a WARNing message. In such an instance, you should consider using an electronic system rather than a pneumatic control system to improve dynamic response. The type of control system, electronic or pneumatic, is specified in the Area data.

Like pneumatic systems, electronic systems differentiate between the different types of instrumentation loops. For example, in control loops, two pairs of signal transmission wire are required: one pair for the transmitter signal and the other pair for the control signal. Both pairs tie-in in the junction box back of the control panel to the field junction box located in the Area. At the field junction box, the transmission wires are collected and sent to the control room in multi-conductor cable in conduit or on cable trays. Aspen Icarus systems allow the user to select three different types of cables for transmission: multi-conductor wire; cable with interlocked armor; and cable pulled in rigid conduit.

Field/Panel Hook-Up

Aspen Icarus systems calculate the material and man-power cost for connecting each tube from the multi-tube bundle to the bulkhead plate in back of the control panel in the main control building. For an electronic control system, the system calculates the cost of material and manpower to connect all signal wiring to and from the field junction box to the field tie-in terminal blocks on the back of the panel.

Final Element Hook-Up

For pneumatic systems, system calculates the material and manpower cost to fabricate and assemble the piping, valves, and fittings required for the air supply and control signal from the junction box.

Aspen Icarus systems make the same calculations for electronic systems, with the exception that the control signal is wired from the junction box to an electopneumatic transducer mounted on the valve positioner valve.

Analog Control Center

The cost of the control panel is developed from:

- The list of instruments, either electronic, pneumatic, or a combination of these control systems.
- The type of display: conventional, semi-graphic, or full graphic type.

Aspen Icarus systems assume straight type panels and conventional miniature instruments with an instrument density of 4.75 per linear foot [15.6 per meter] for conventional displays, 3.75 per linear foot [12.3 per meter] for semi-graphic displays, and 2.5 per linear foot [8.2 per meter] for full graphic displays. The total number and cost of panel-mounted instruments is reported apart from the size and cost of the control panel. The cost of the control panel includes the hardware cost of all switches, relays, alarms, power supplies, etc., required for all designated Areas in the facility, It also includes the cost of sheet metal fabrication, piping and/or wiring, and the cost of shipping and installation at the job site.

Local Equipment Panels

Aspen Icarus systems calculate the cost of material and manpower for the fabrication and installation of each local equipment panel and any wiring or pneumatic piping connections for alarms, switches, indicators, etc., to the main control panel.

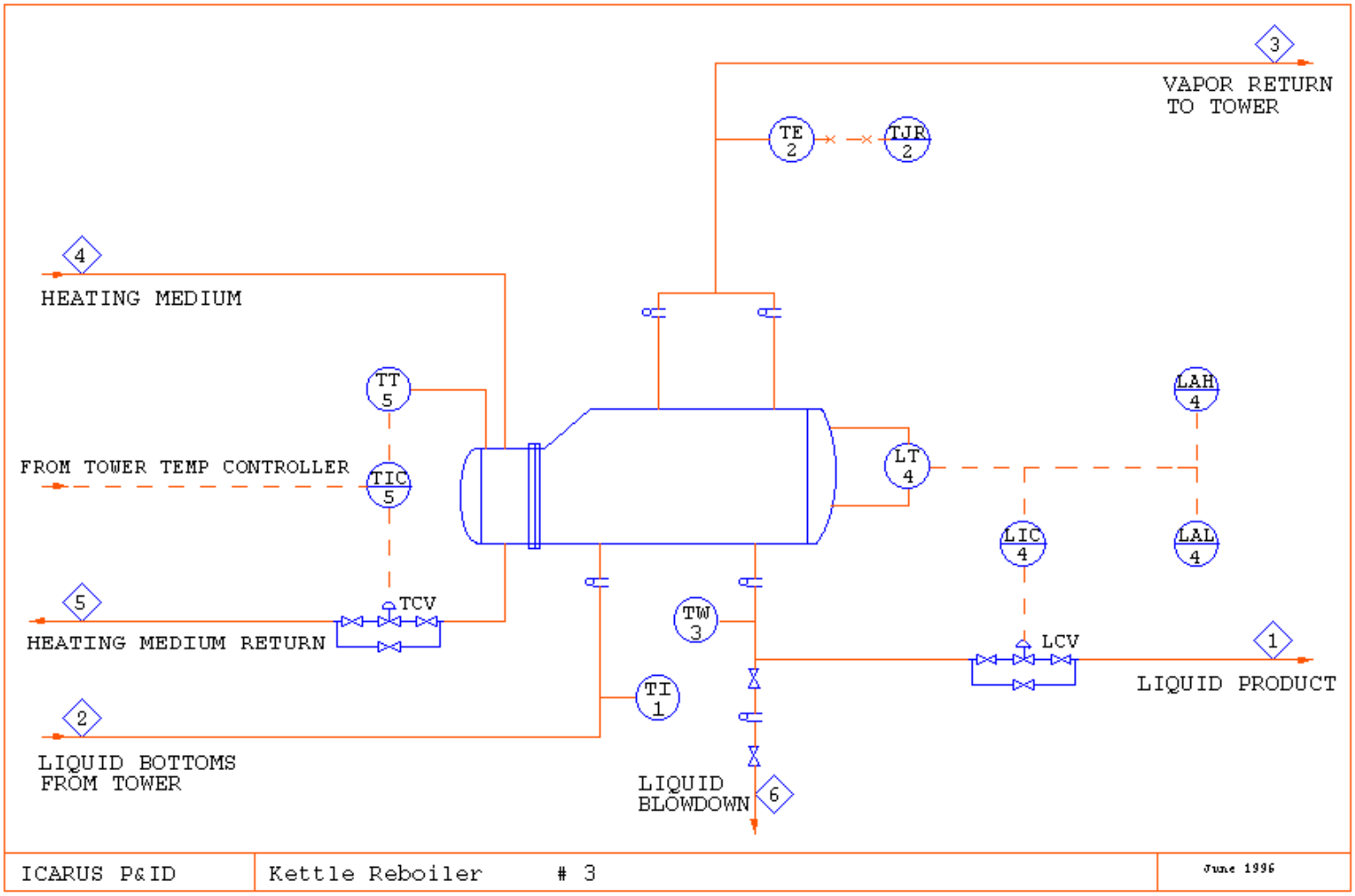
Thermocouple Wiring

On temperature control loops where thermocouples are used as sensing devices, the transmitter is assumed to be mounted on the thermocouple head.

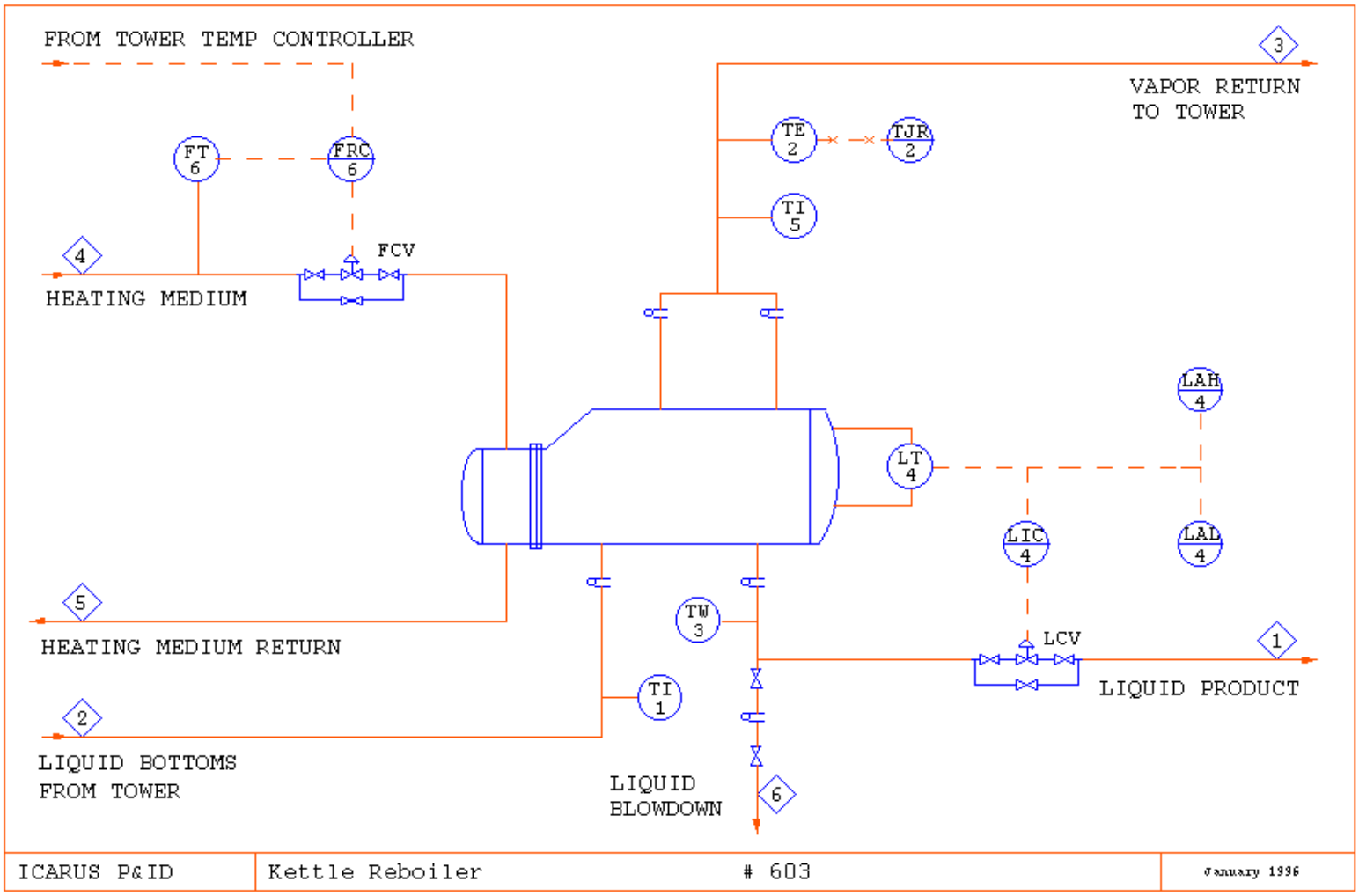
Drawings

The piping and instrumentation drawings that follow are arranged in numeric order. For easy reference, the 600 series drawings, representing fully instrumented models, immediately follow the corresponding standard models. For example, Drawing 603 immediately follows Drawing 3.

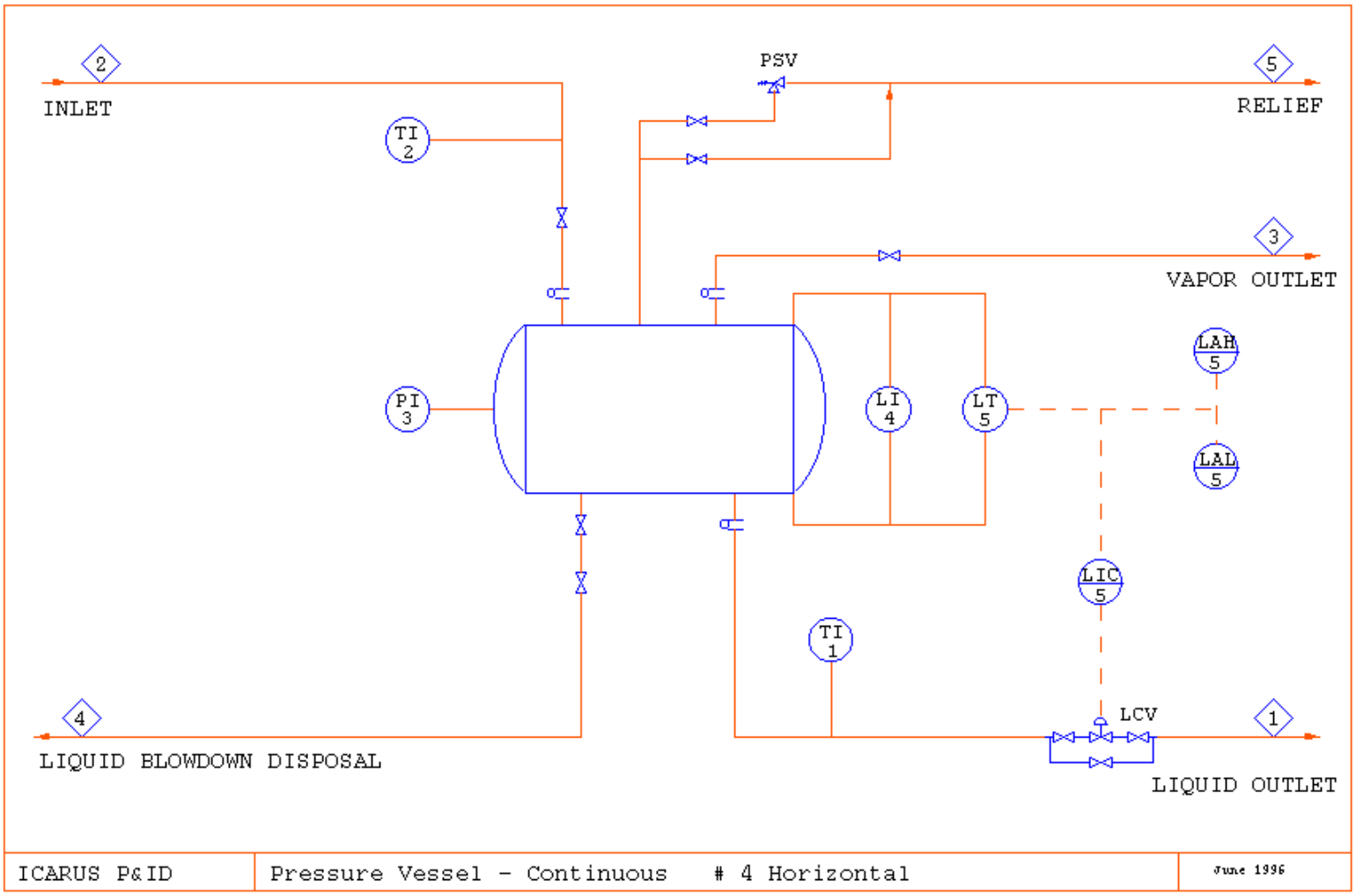
3 Kettle Reboiler



603 Kettle Reboiler



4 Horizontal Pressure Vessel – Continuous



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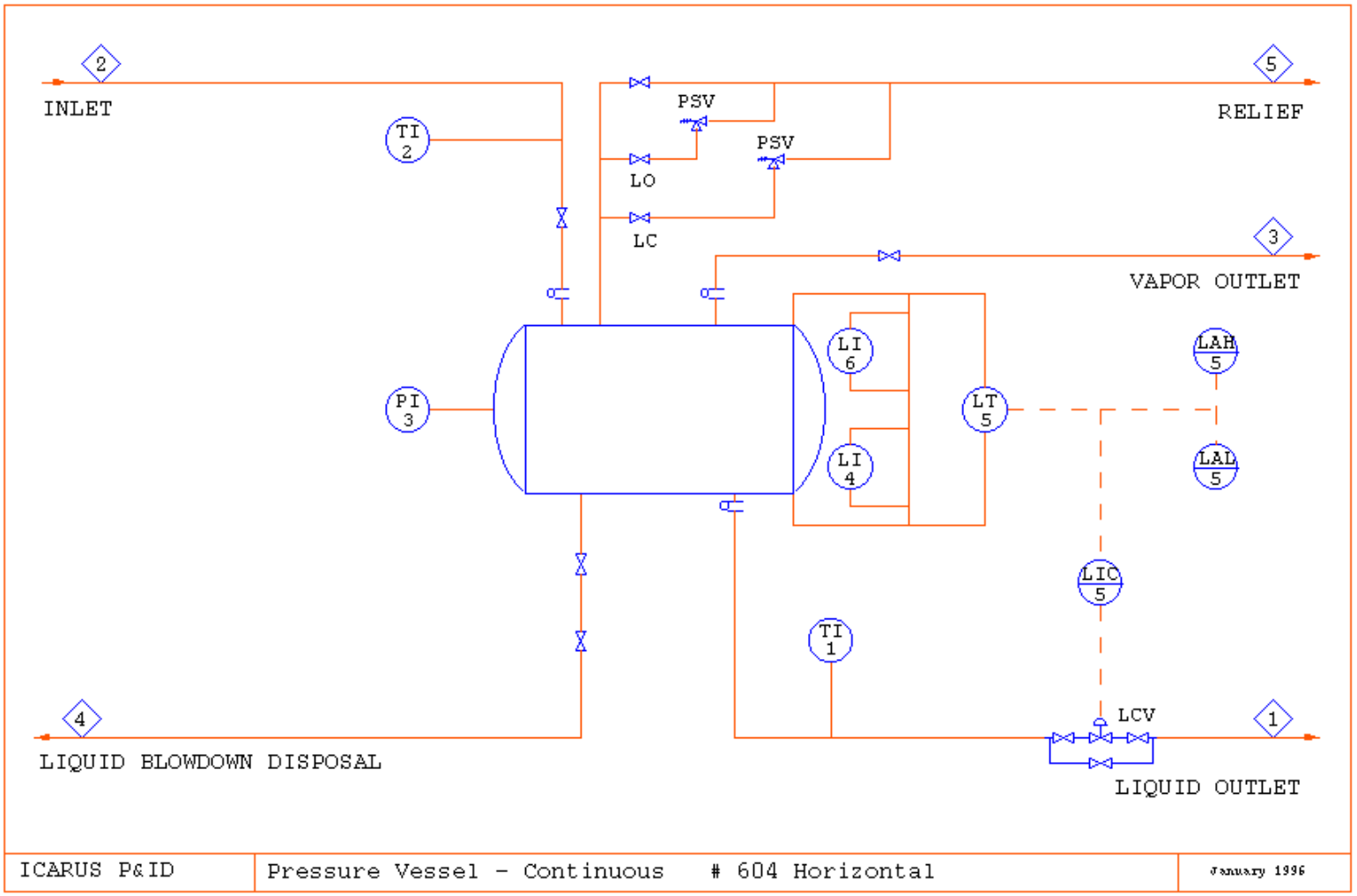
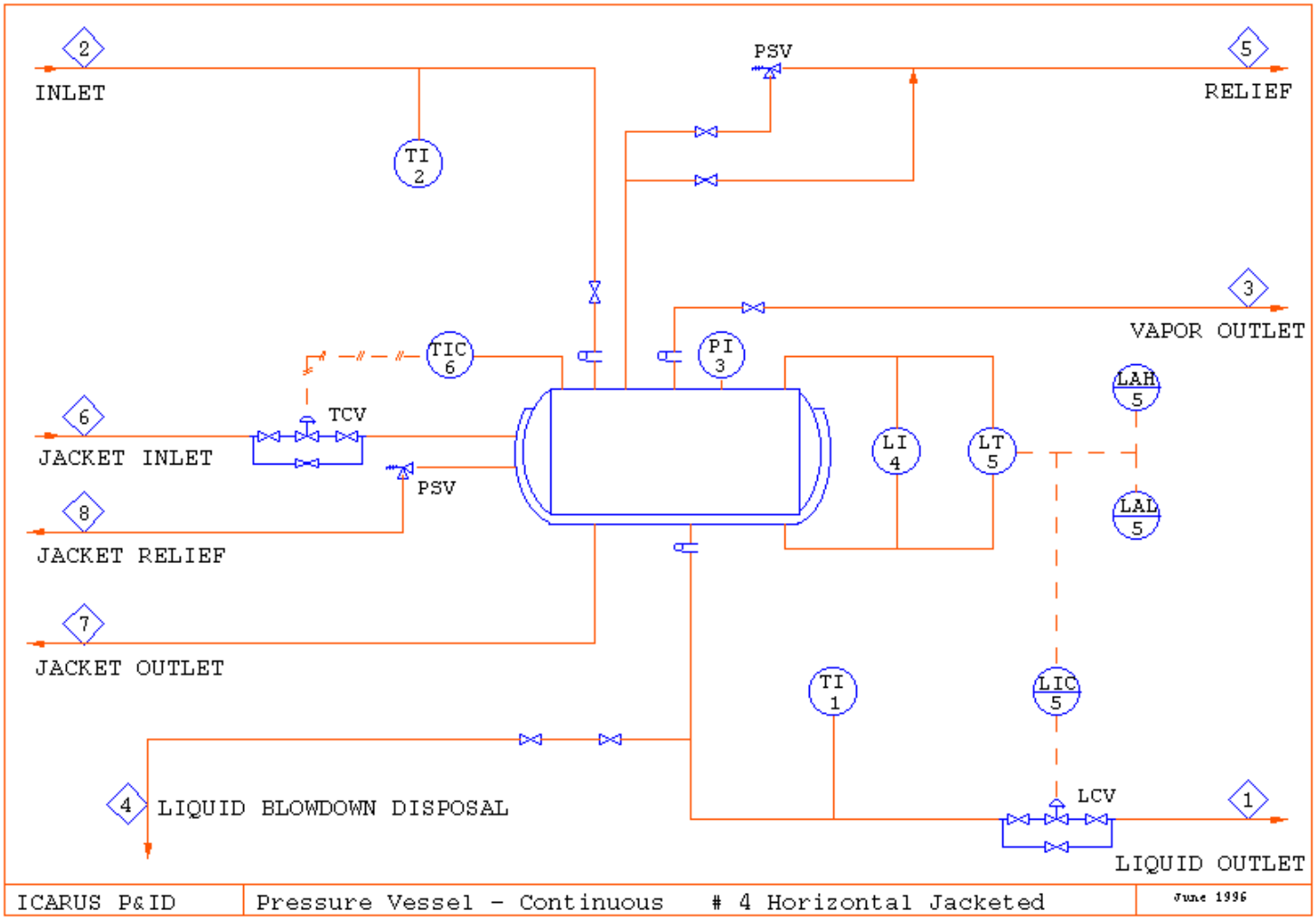
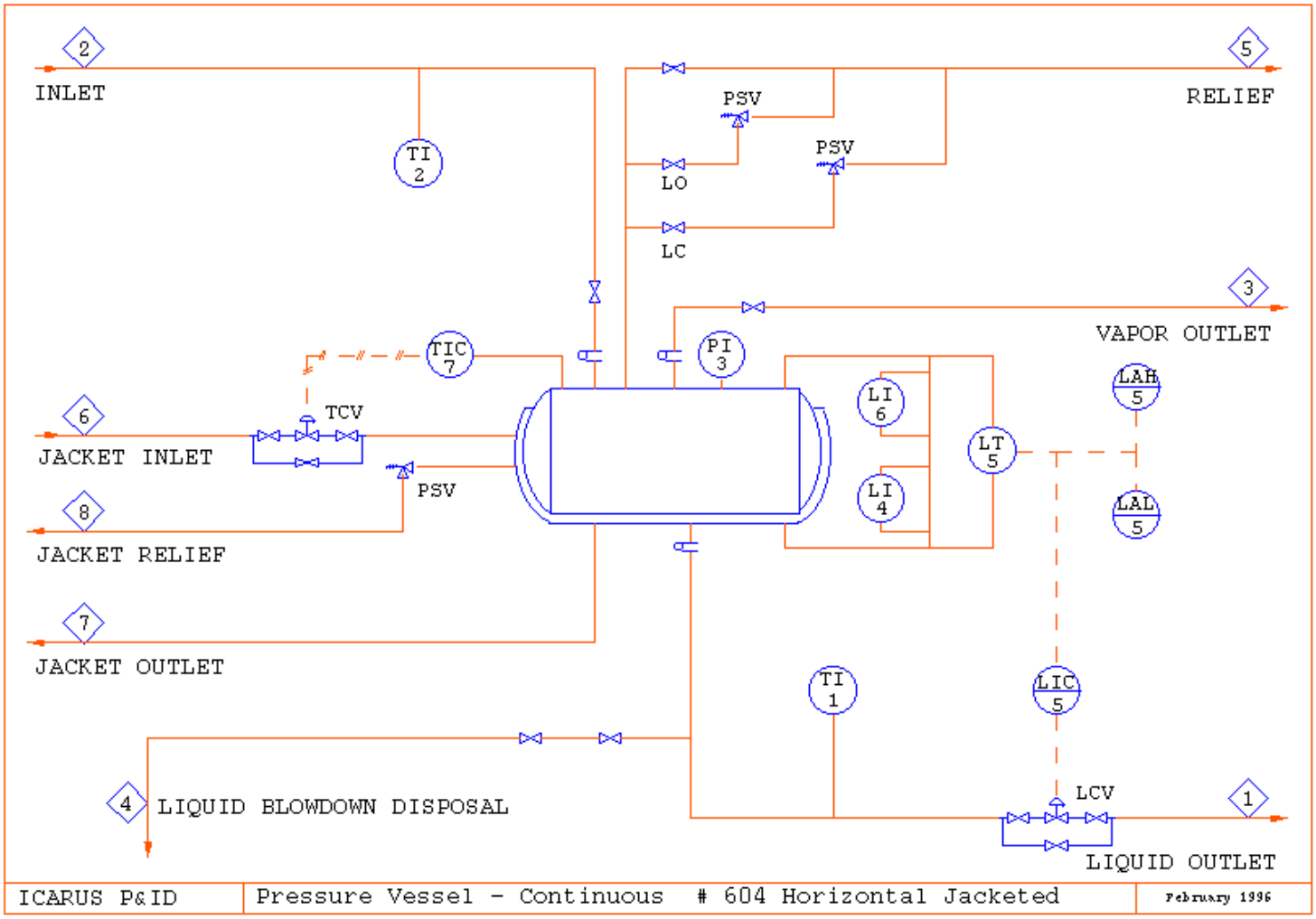


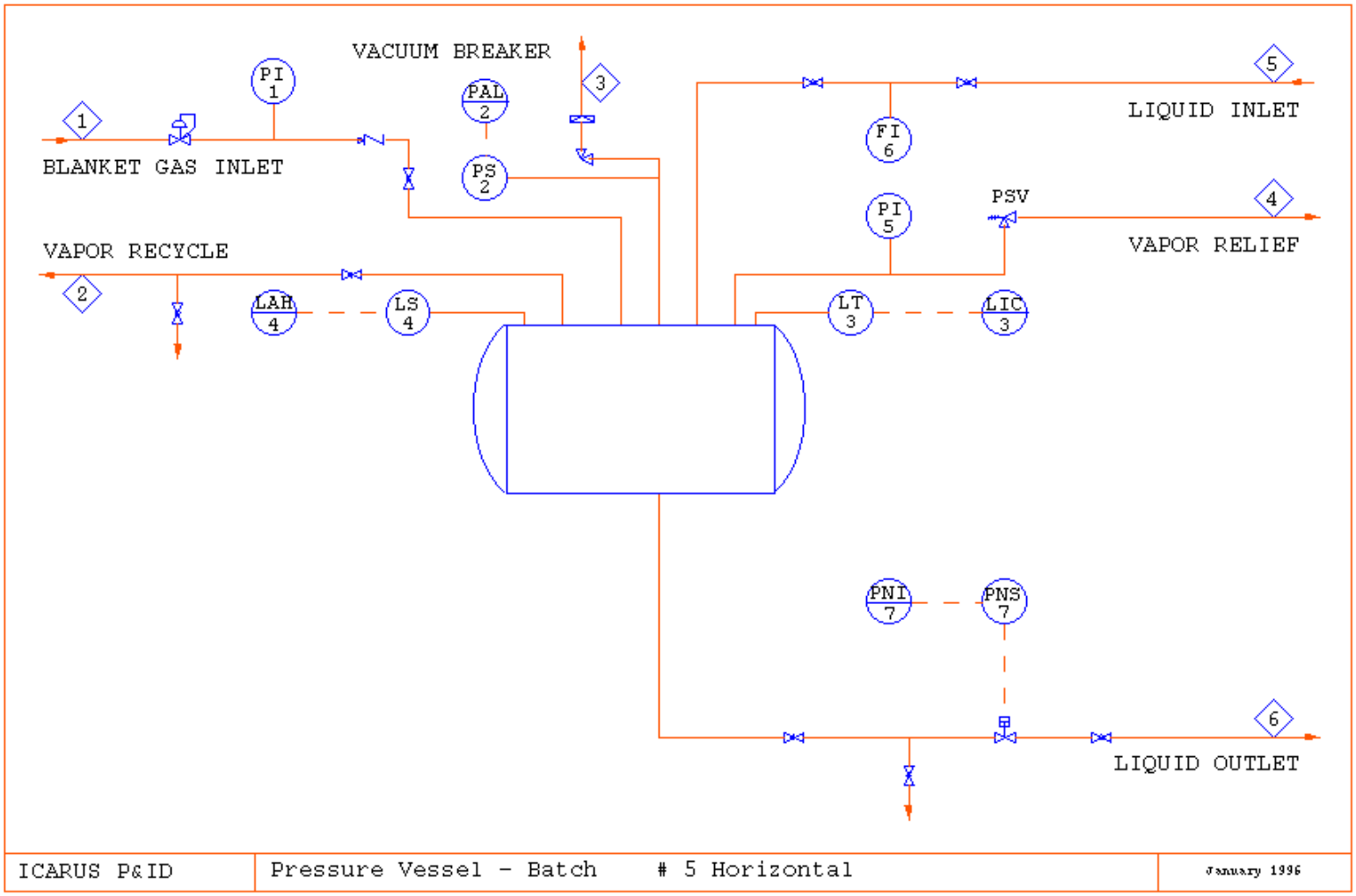
4 Horizontal Jacketed Pressure Vessel - Continuous



604 Horizontal Jacketed Pressure Vessel – Continuous



5 Horizontal Pressure Vessel – Batch



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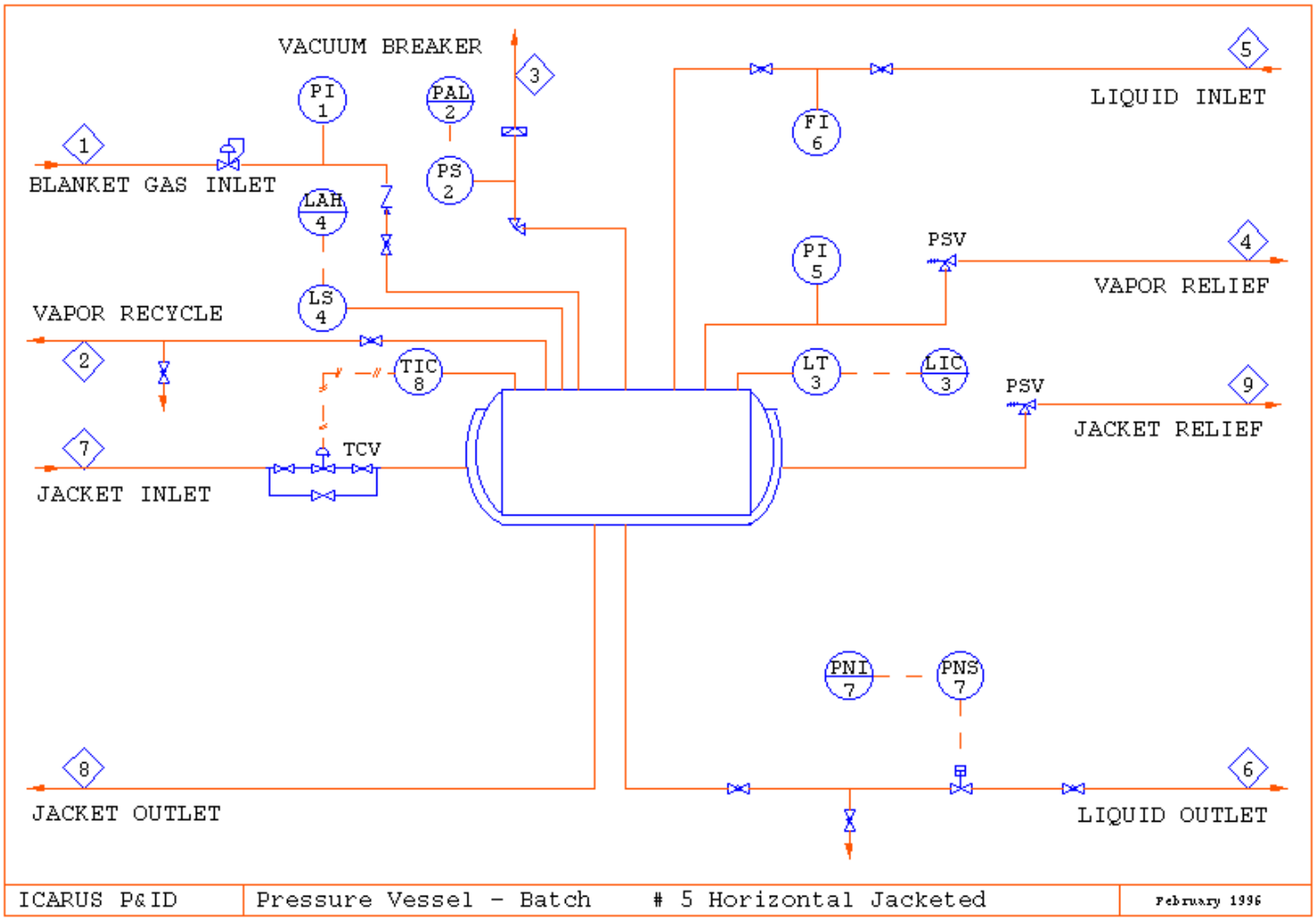

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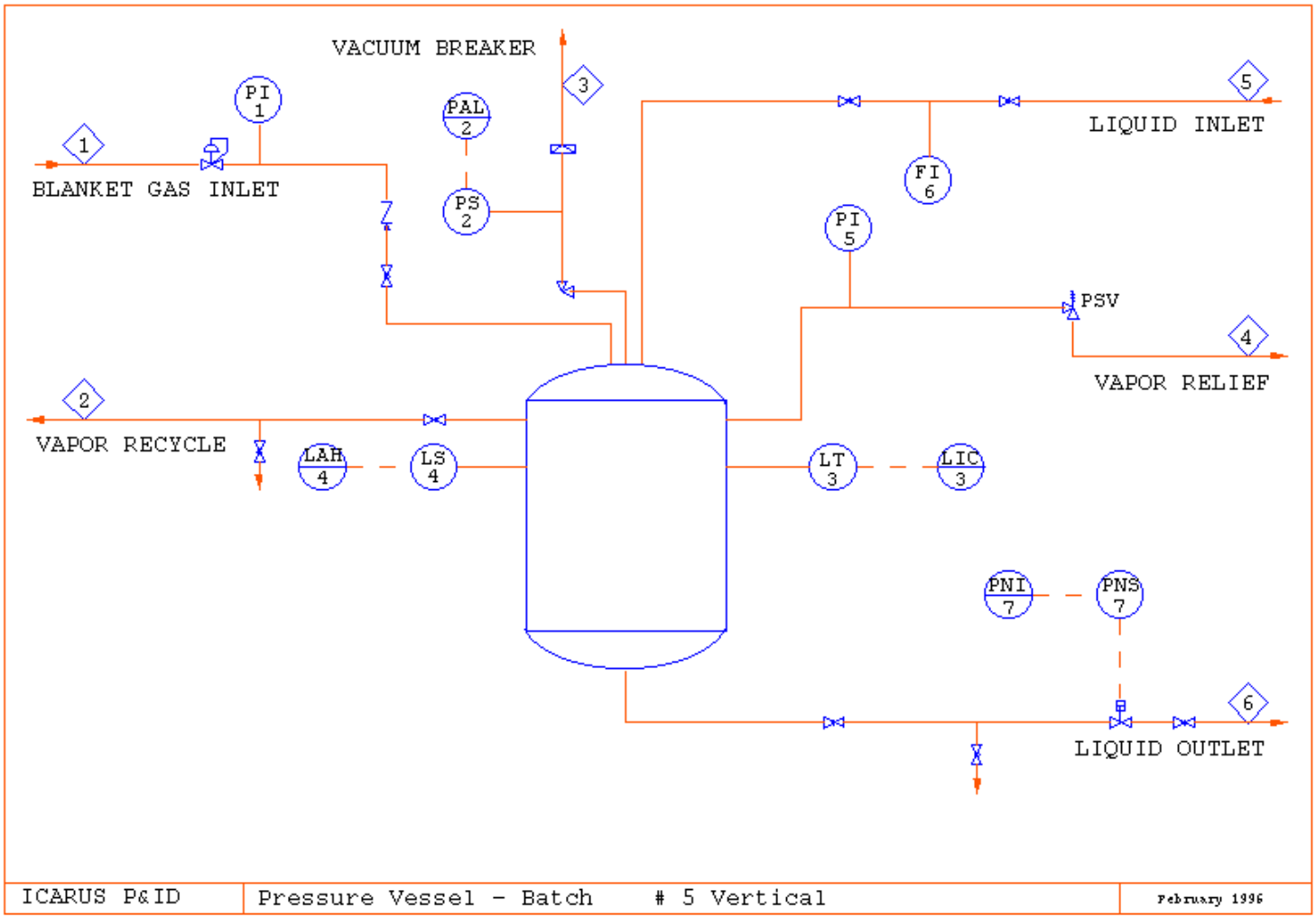

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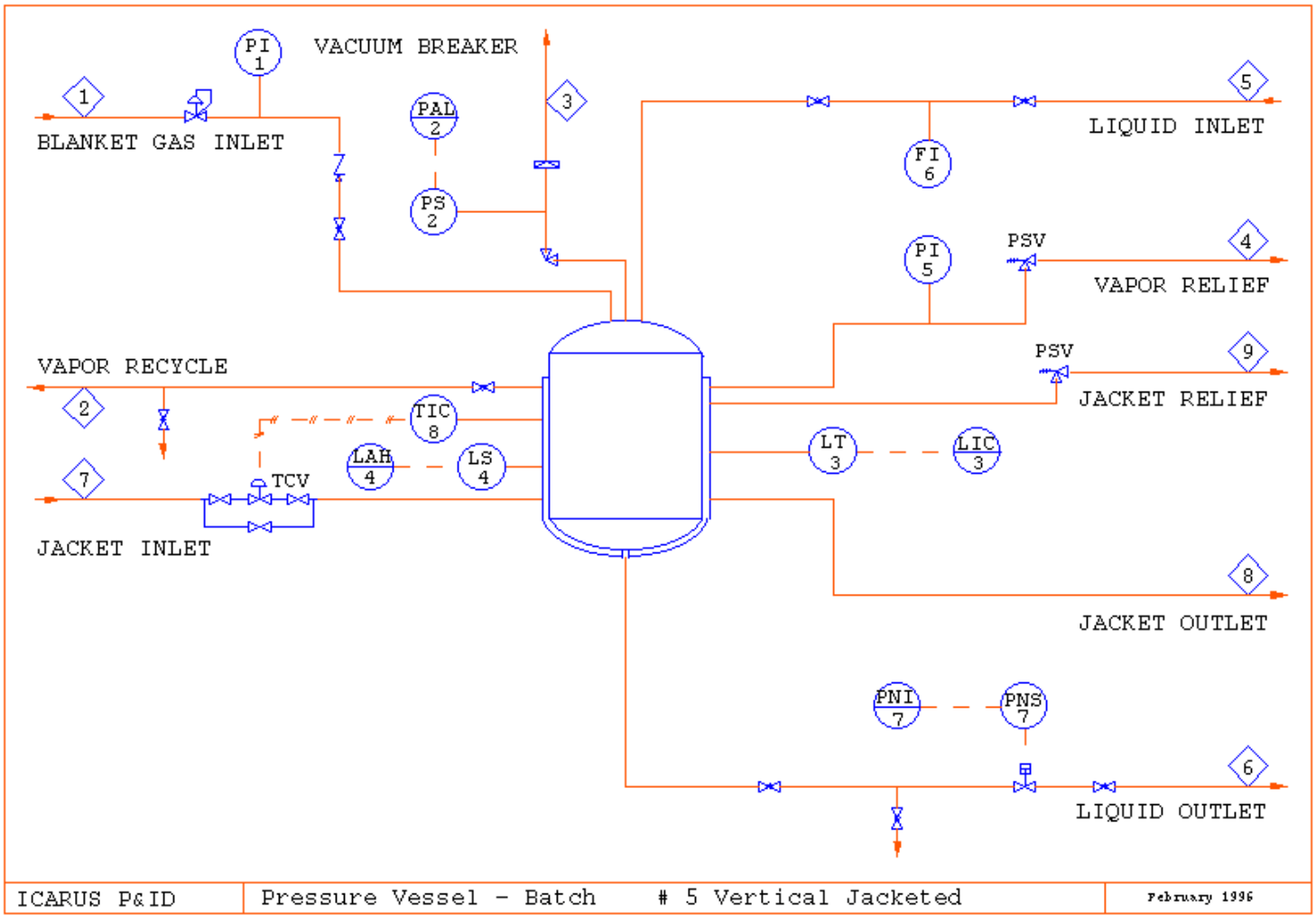

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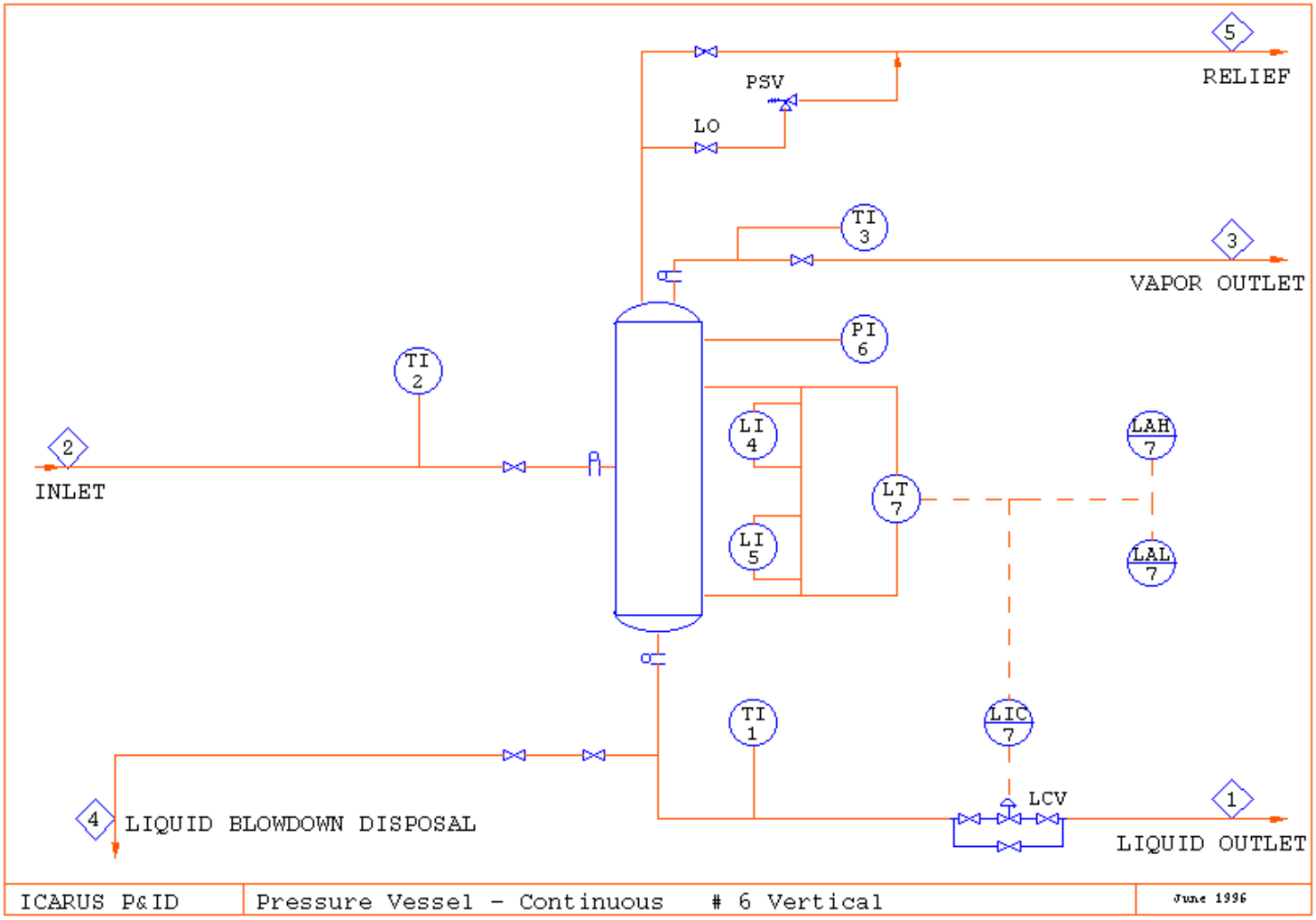
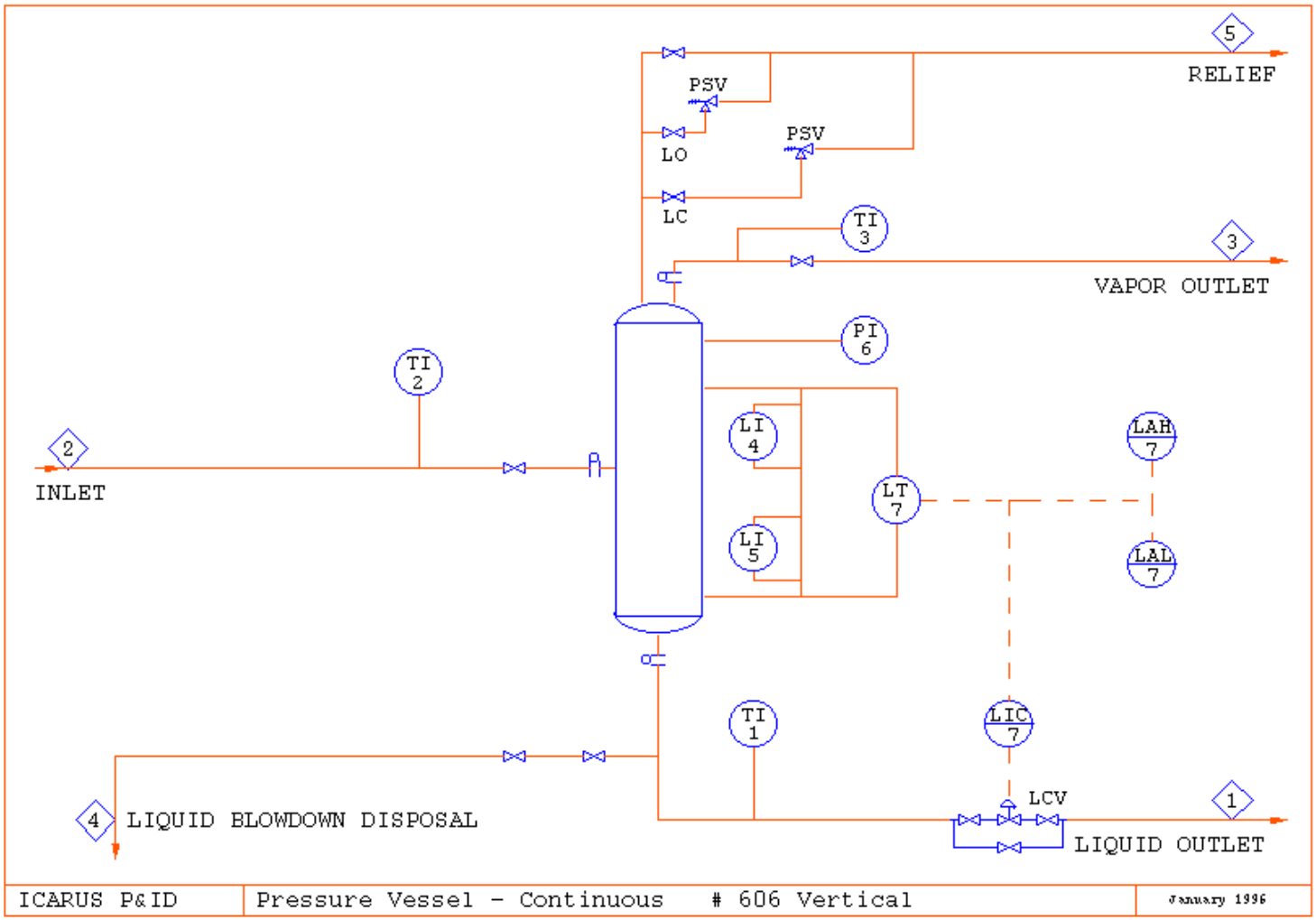
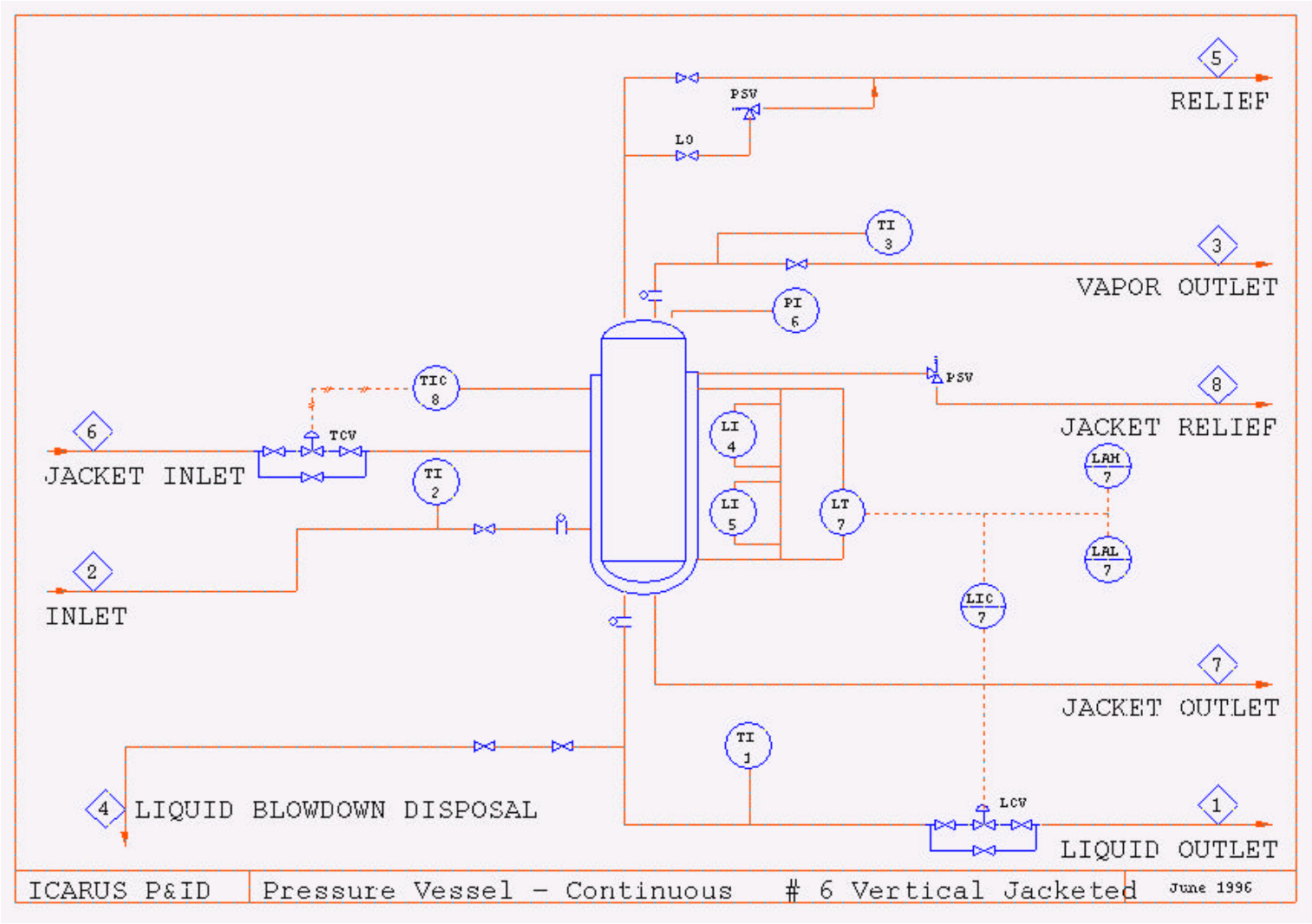


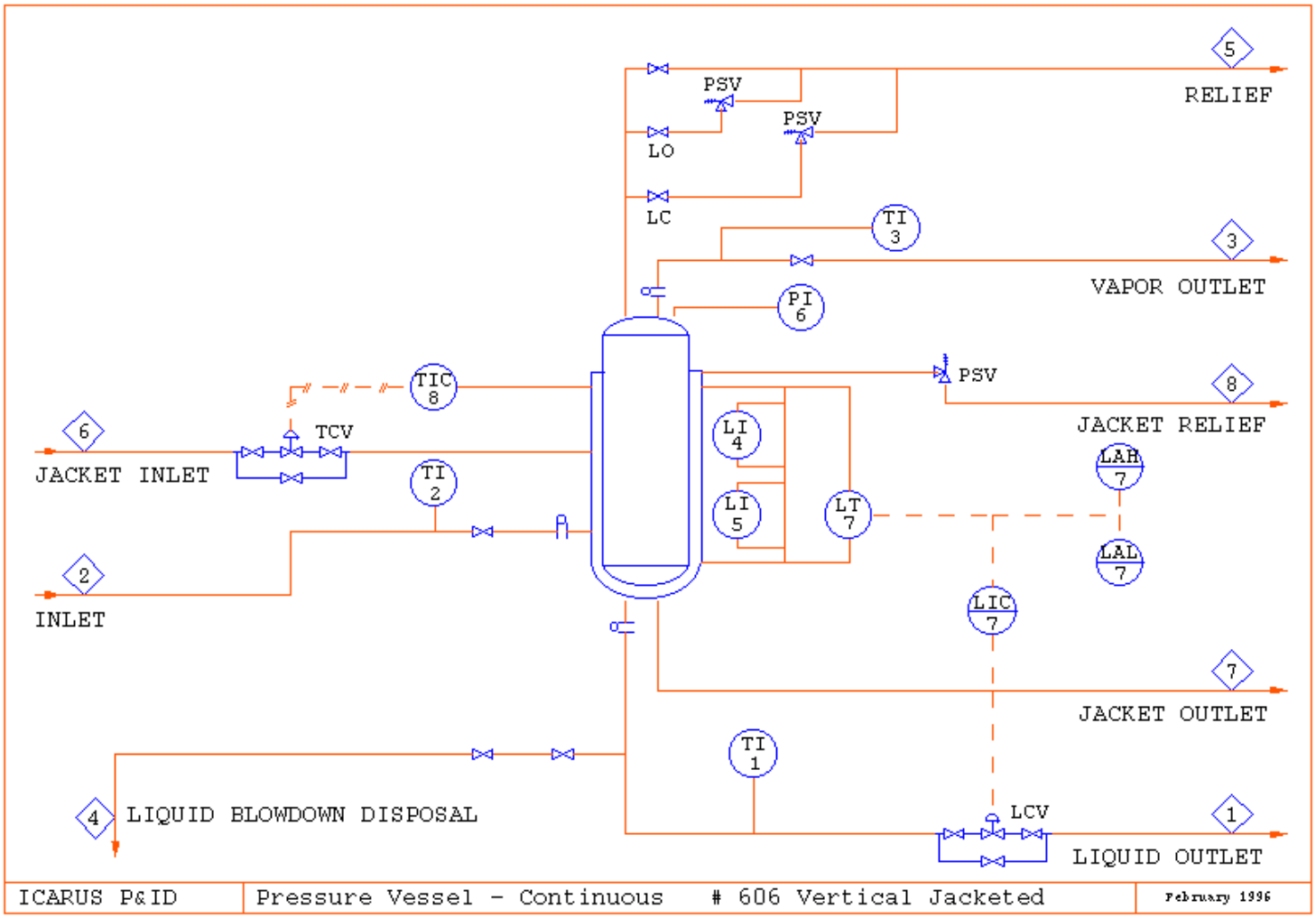
606 Vertical Pressure Vessel – Continuous



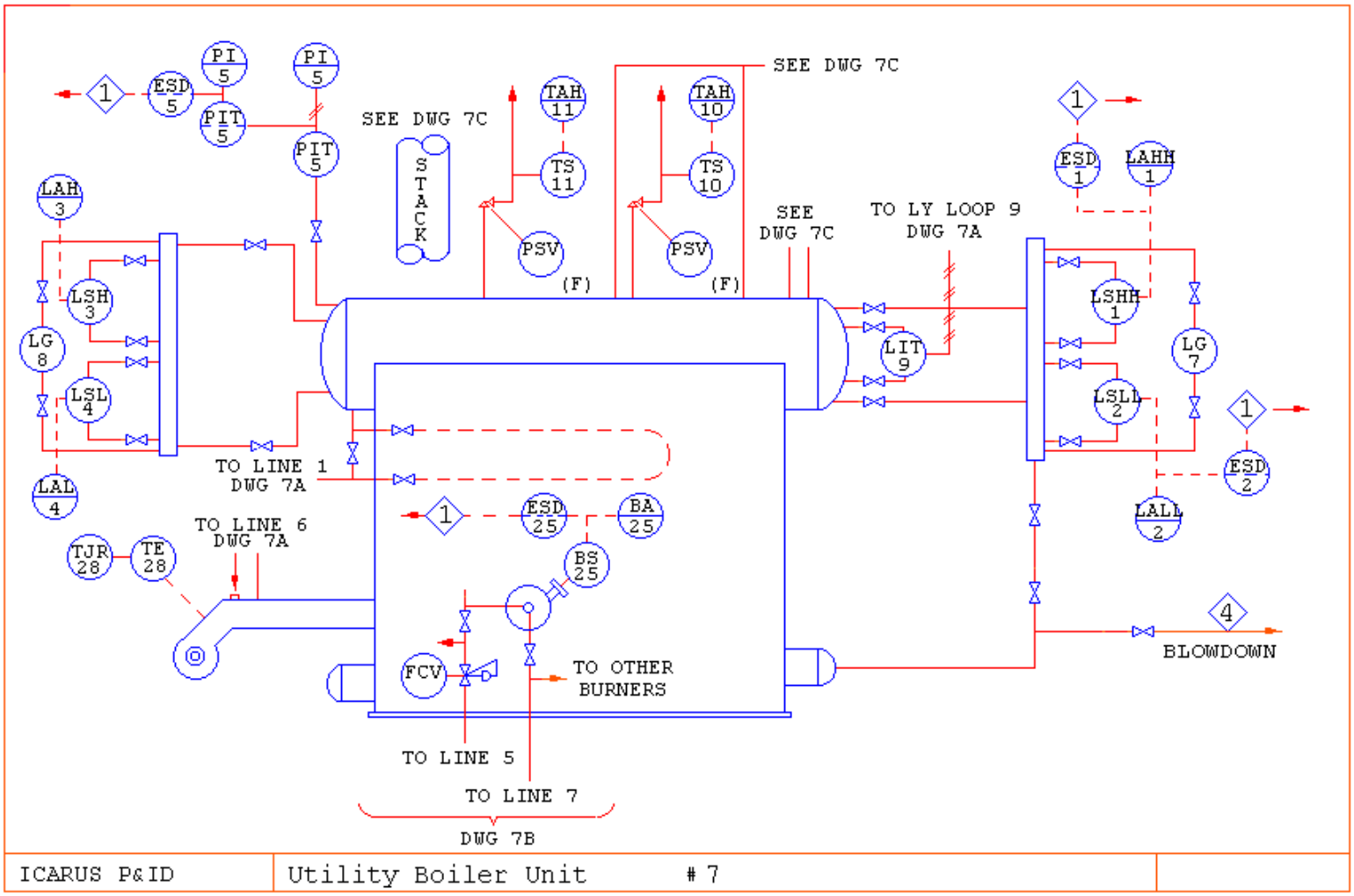
6 Vertical Jacketed Pressure Vessel – Continuous



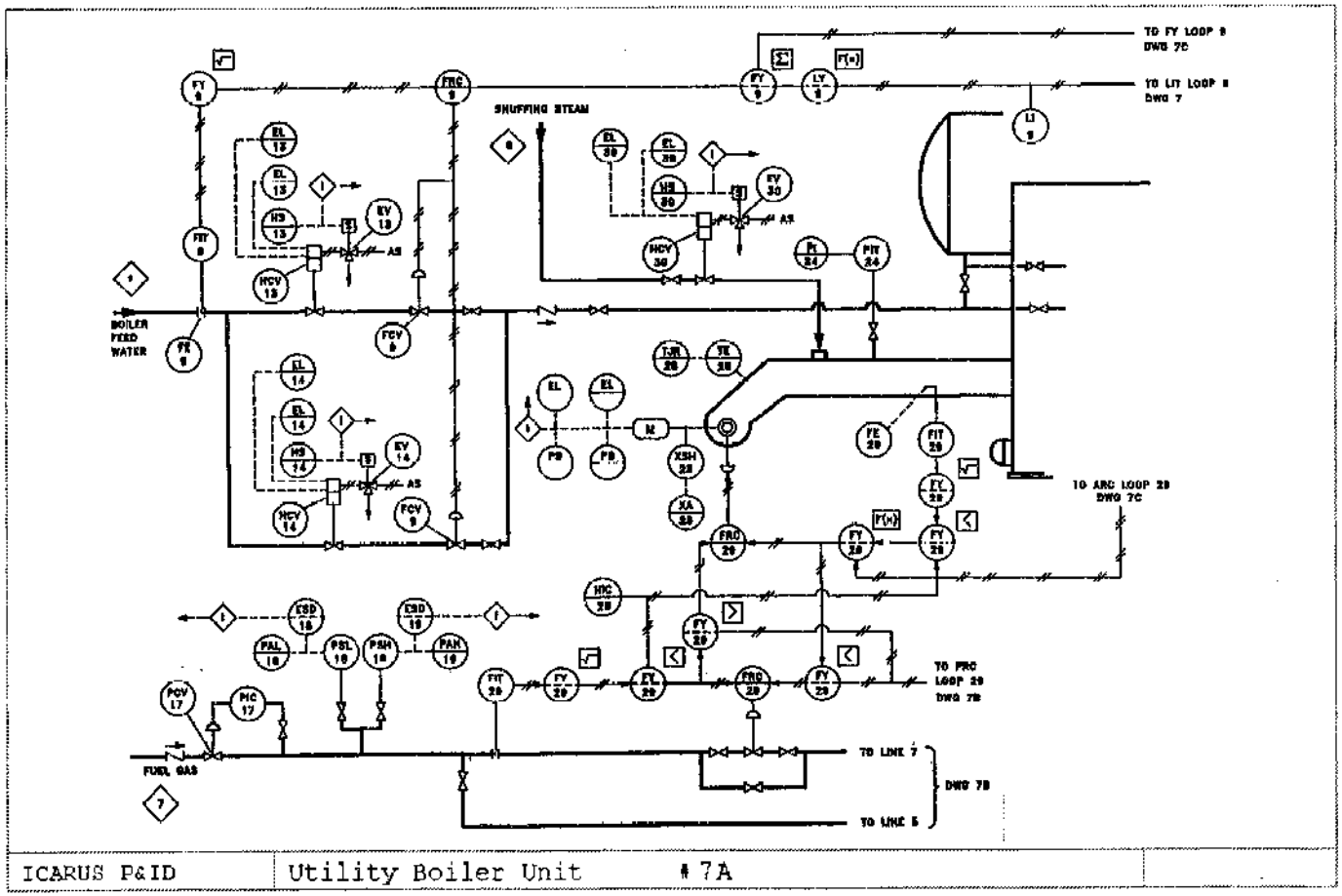
606 Vertical Jacketed Pressure Vessel – Continuous



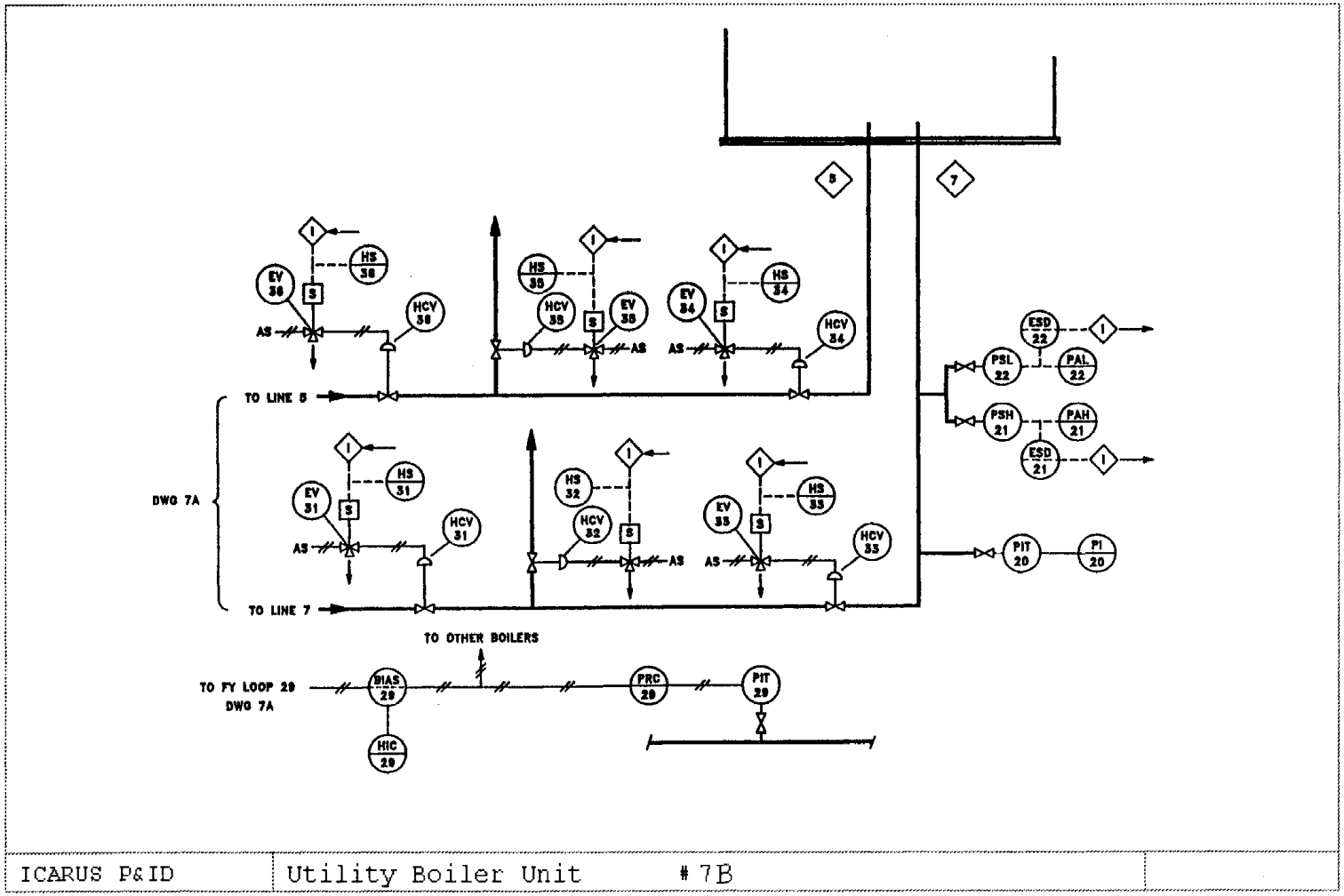
7 Utility Boiler Unit



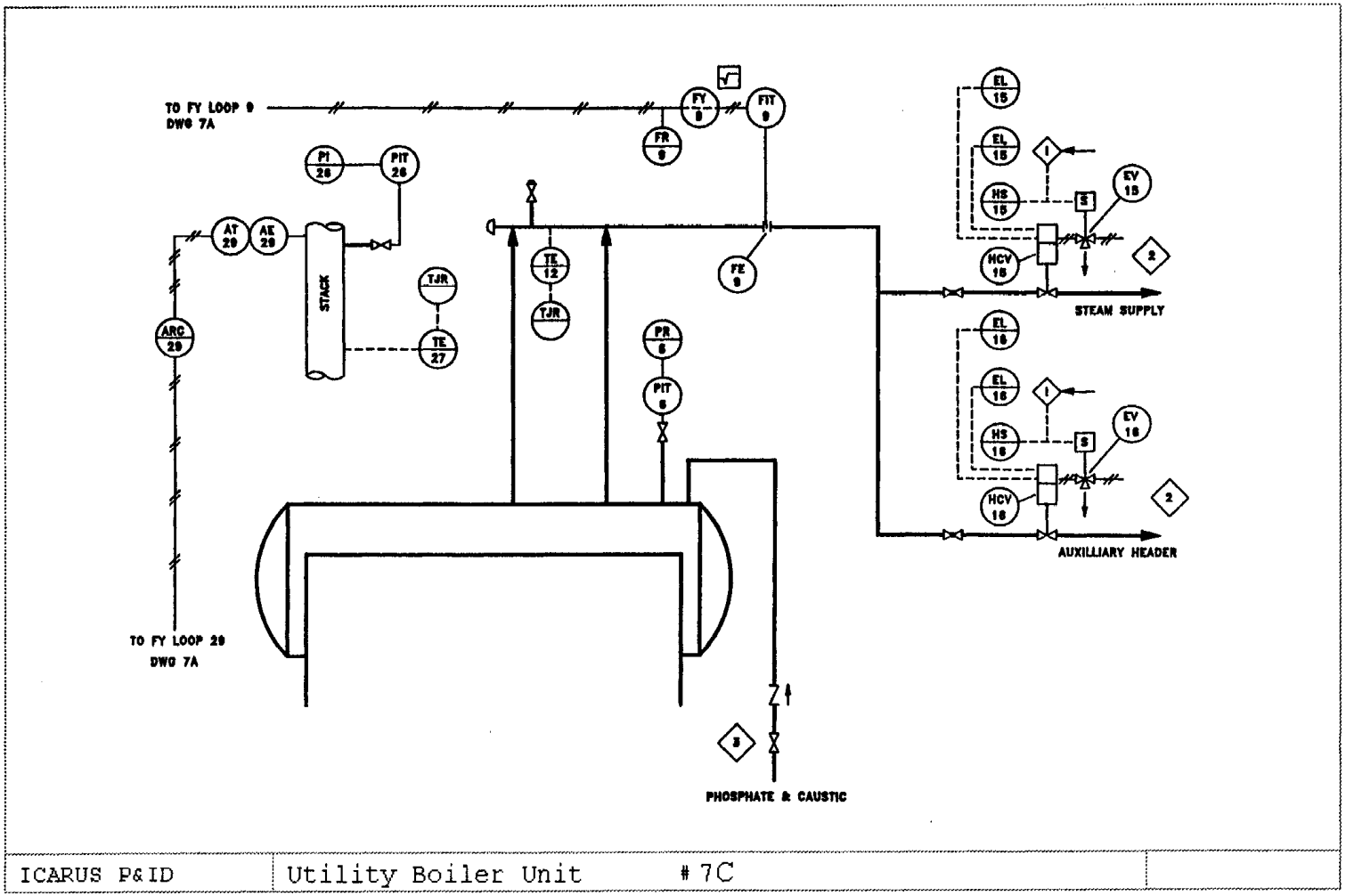
7A Utility Boiler Unit



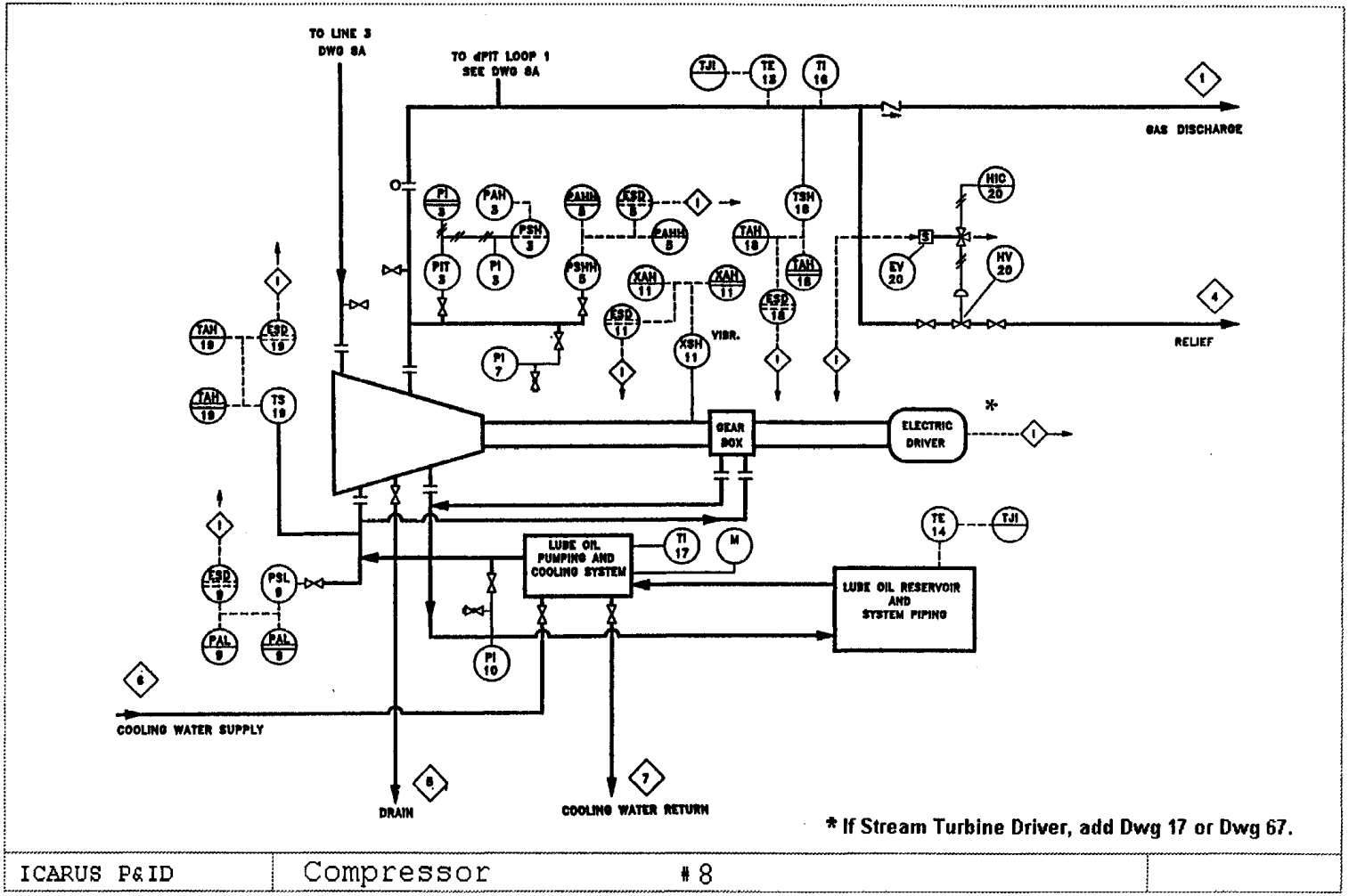
7B Utility Boiler Unit



7C Utility Boiler Unit



8 Compressor



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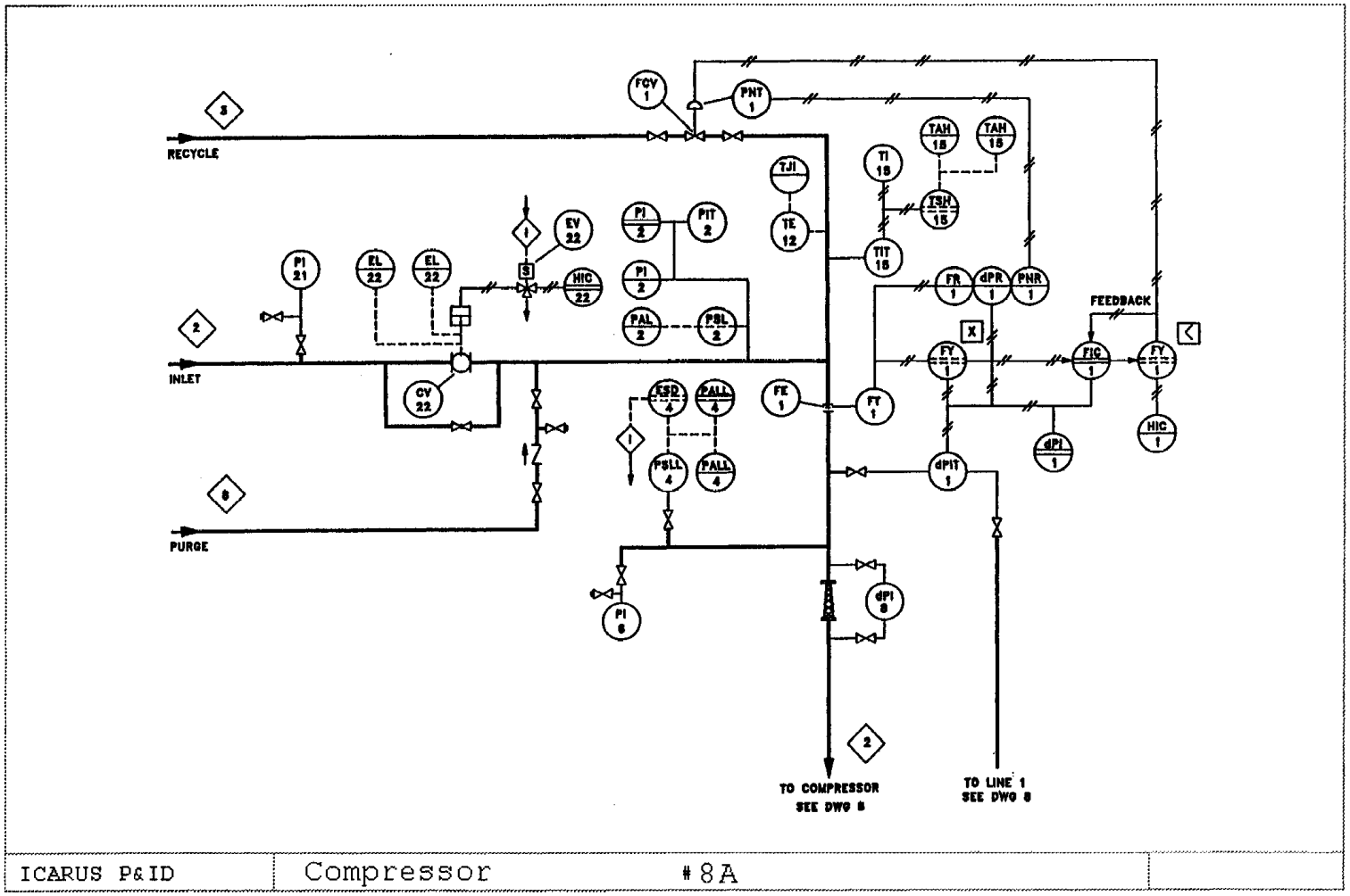
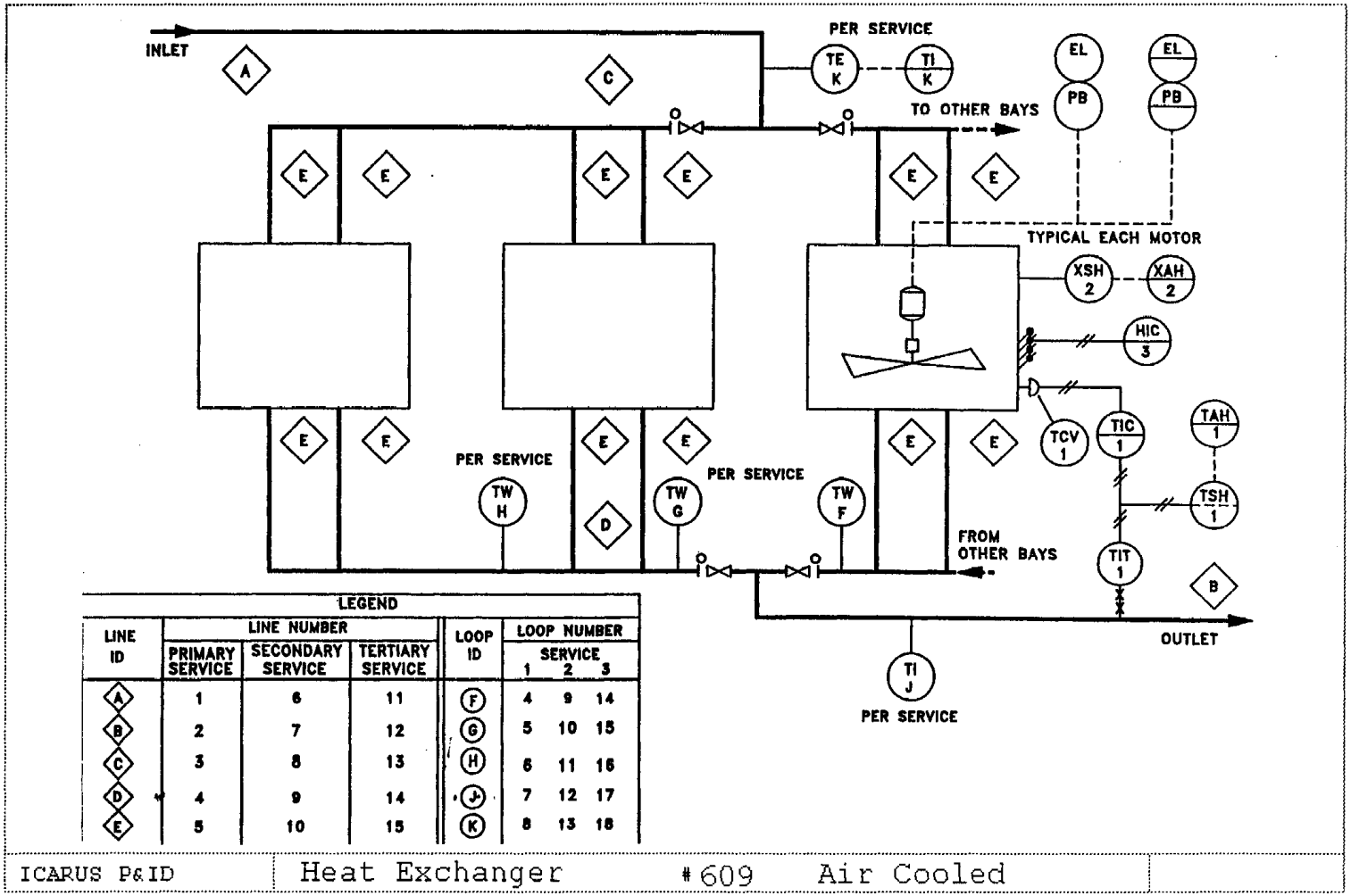


9 Air Cooled Heat Exchanger

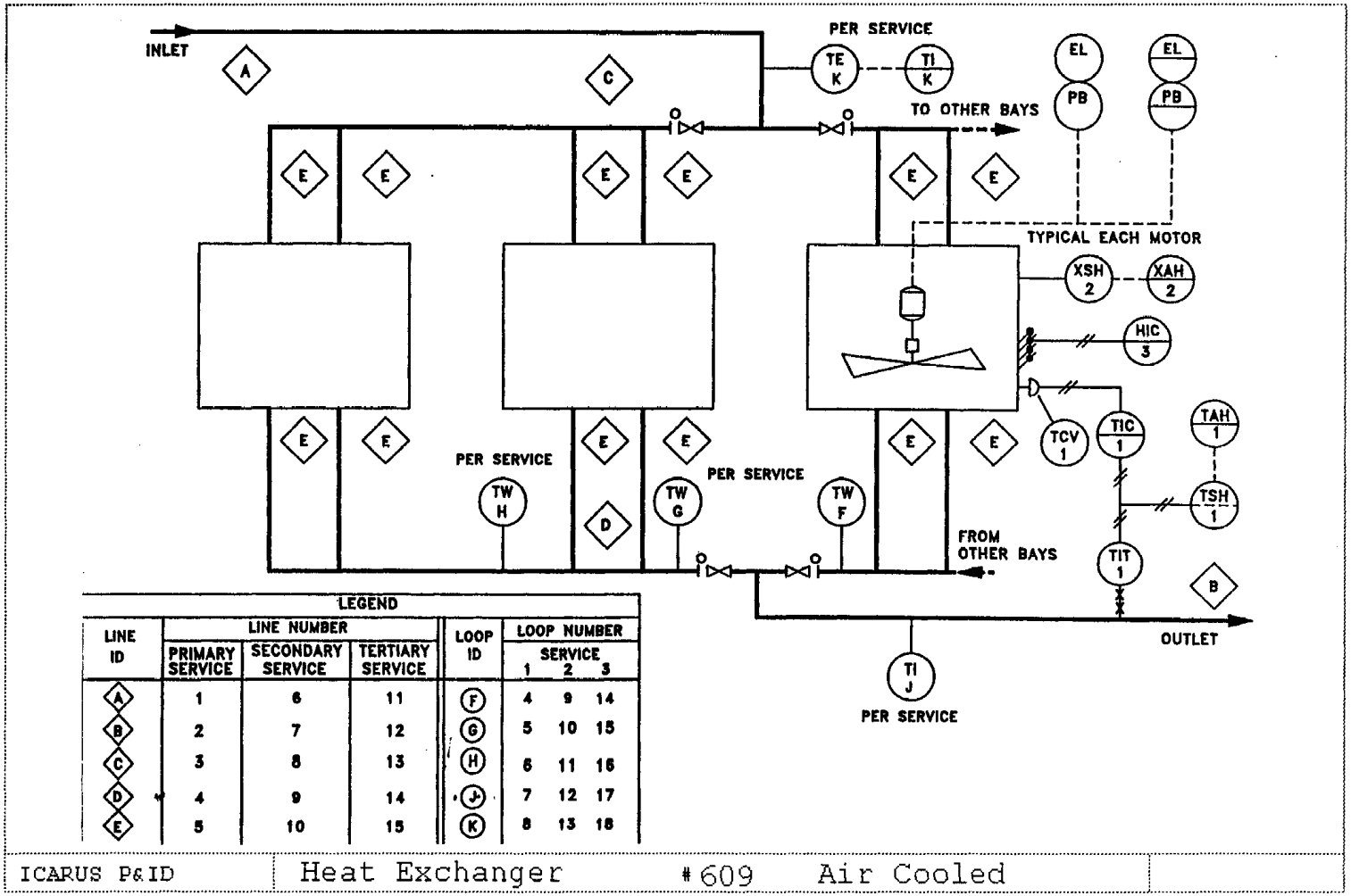


LEGEND

LINE ID	LINE NUMBER			LOOP ID	LOOP NUMBER		
	PRIMARY SERVICE	SECONDARY SERVICE	TERTIARY SERVICE		SERVICE 1	SERVICE 2	SERVICE 3
A	1	6	11	F	4	9	14
B	2	7	12	G	5	10	15
C	3	8	13	H	6	11	16
D	4	9	14	J	7	12	17
E	5	10	15	K	8	13	18

ICARUS P&ID | Heat Exchanger #609 Air Cooled

609 Air Cooled Heat Exchanger



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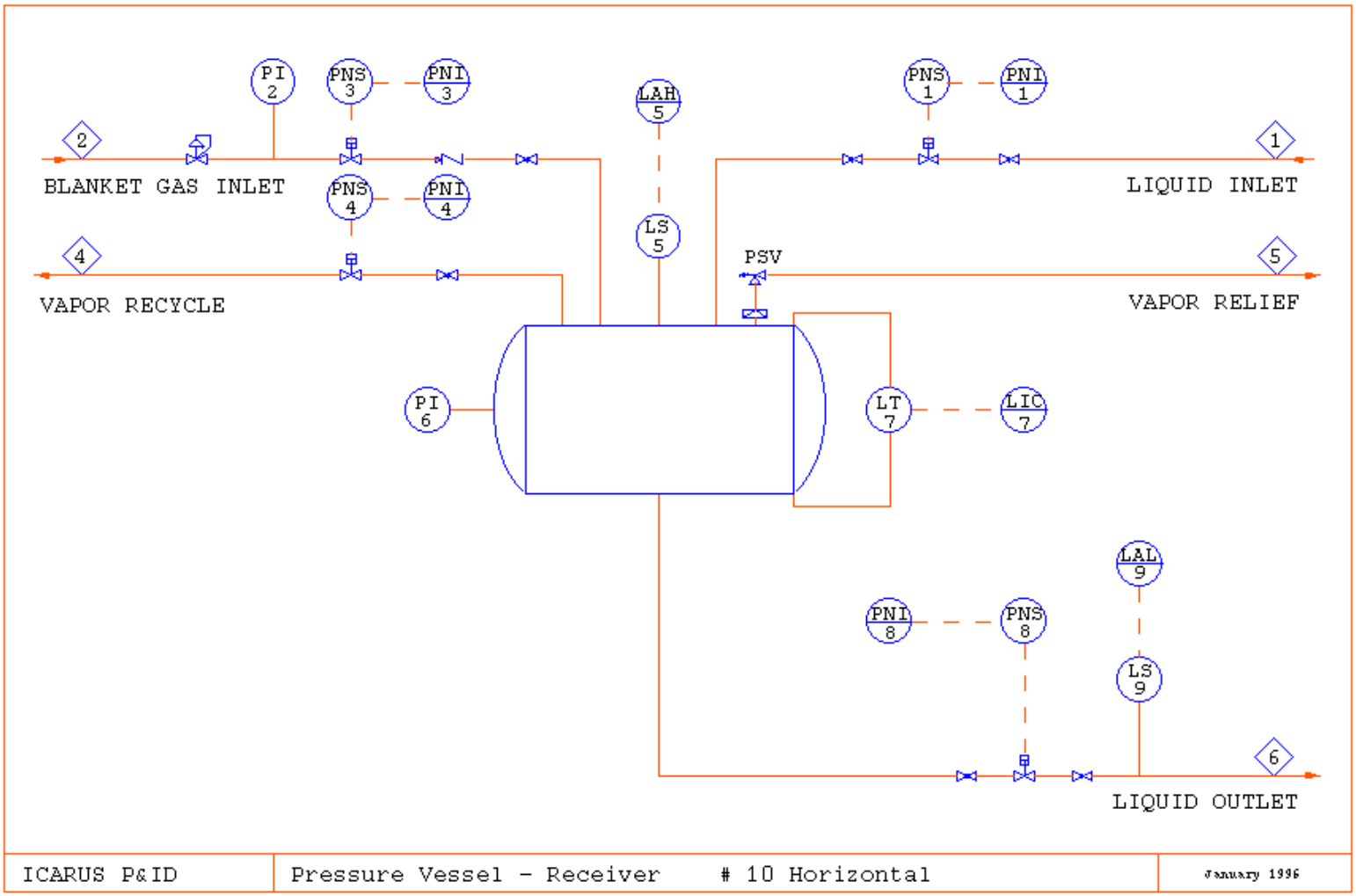
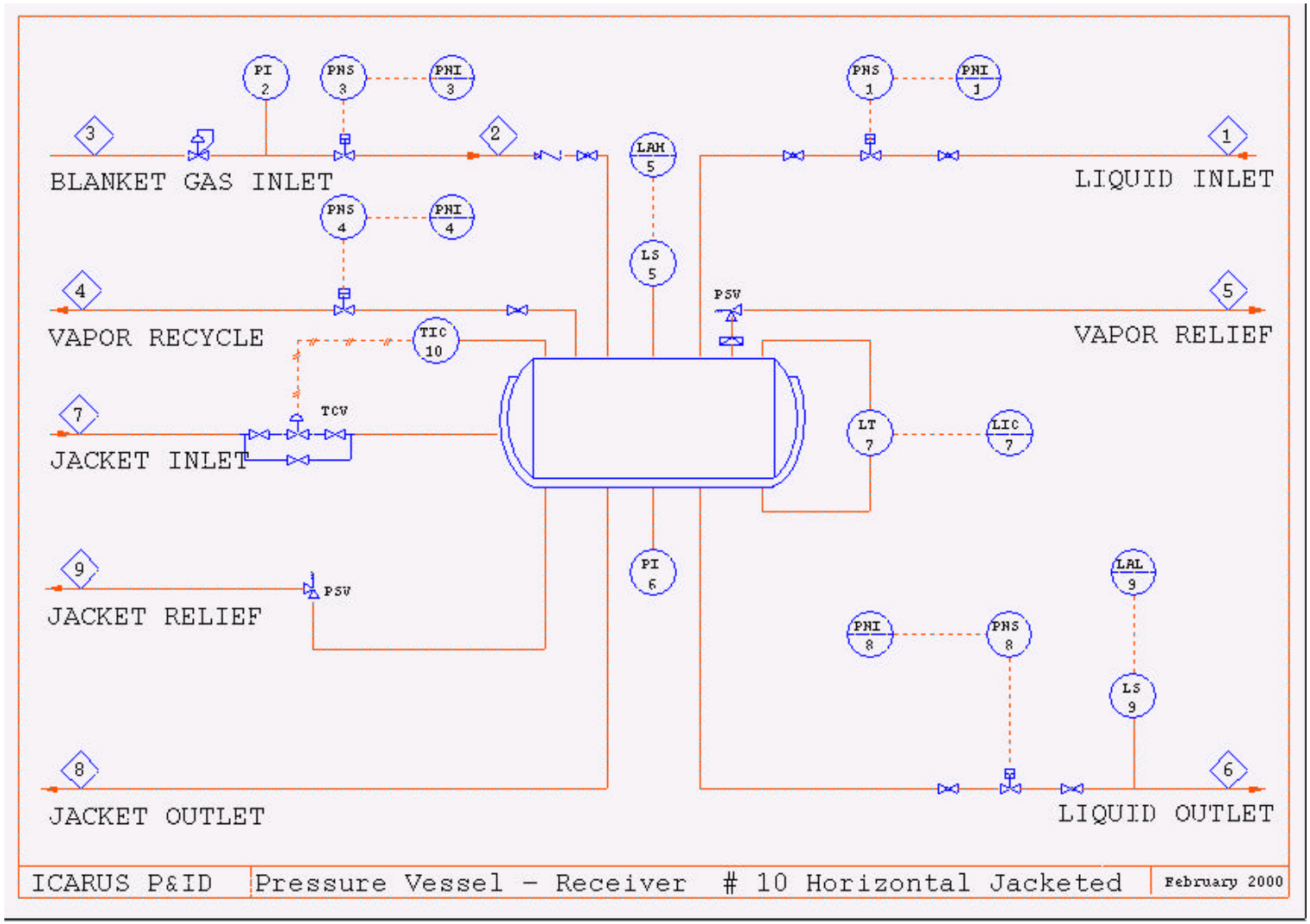
E	5	10	15	K	8	13	18

ICARUS P&ID | Heat Exchanger #609 Air Cooled

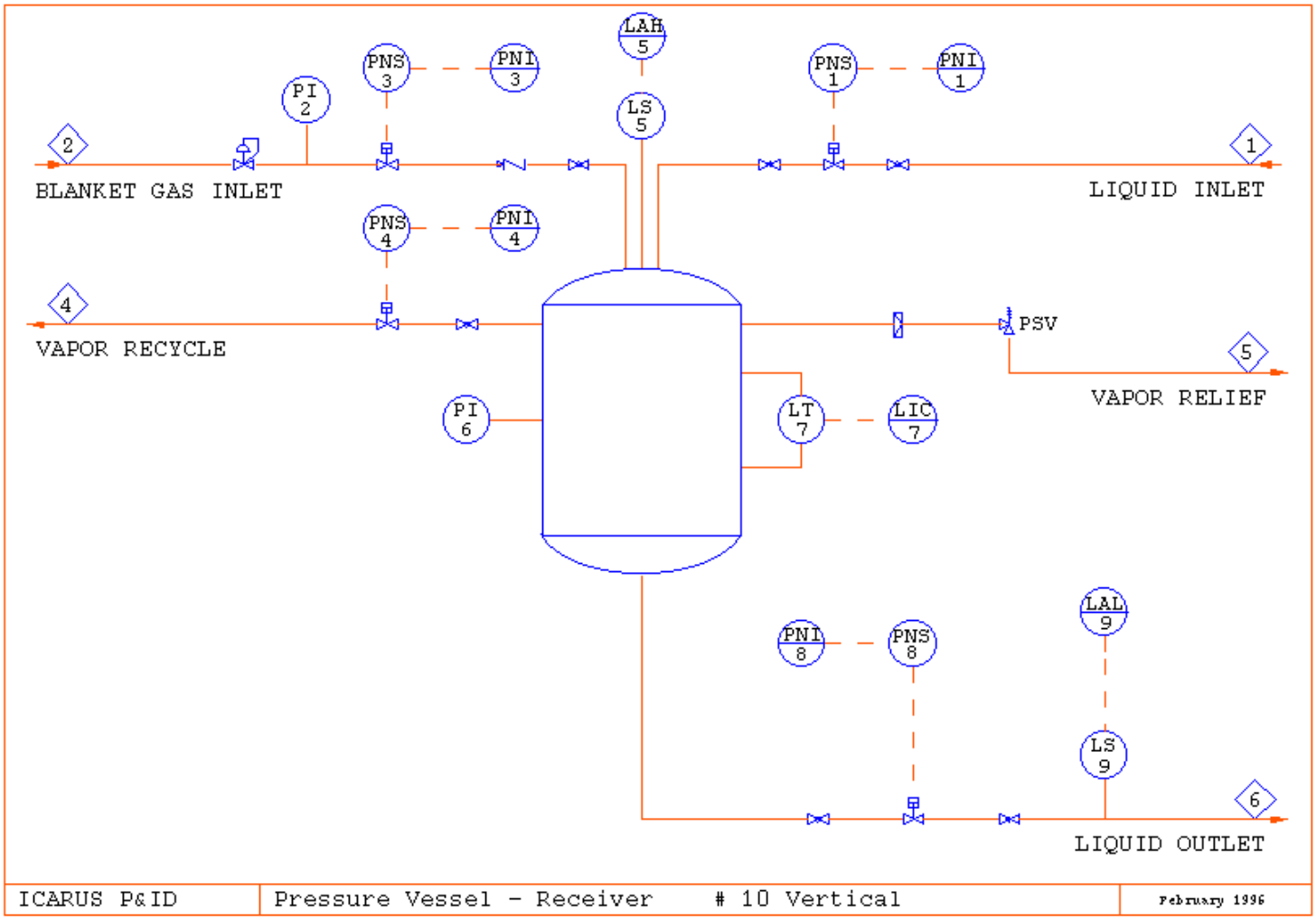
10 Horizontal Pressure Vessel – Receiver



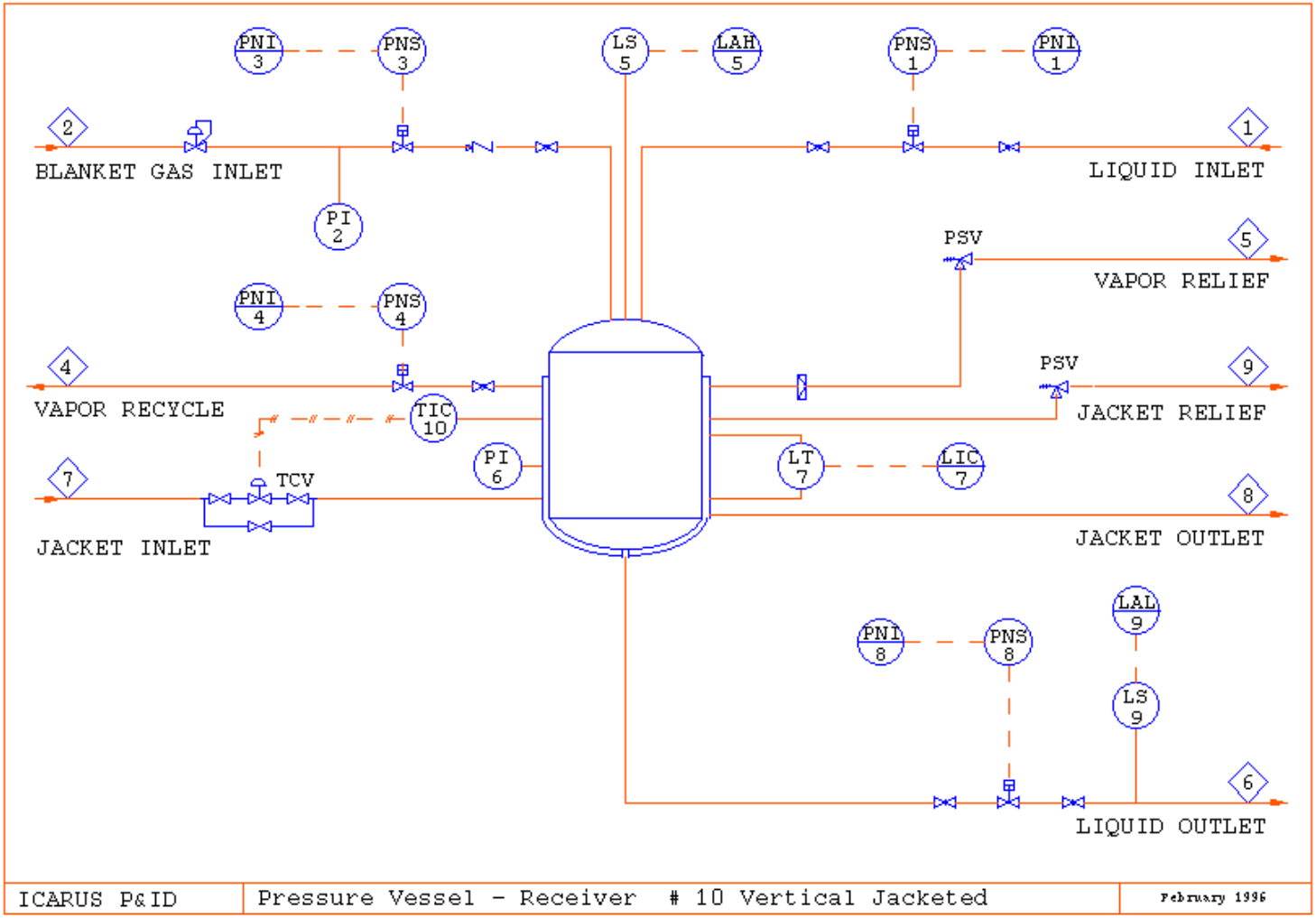
10 Horizontal Jacketed Pressure Vessel – Receiver



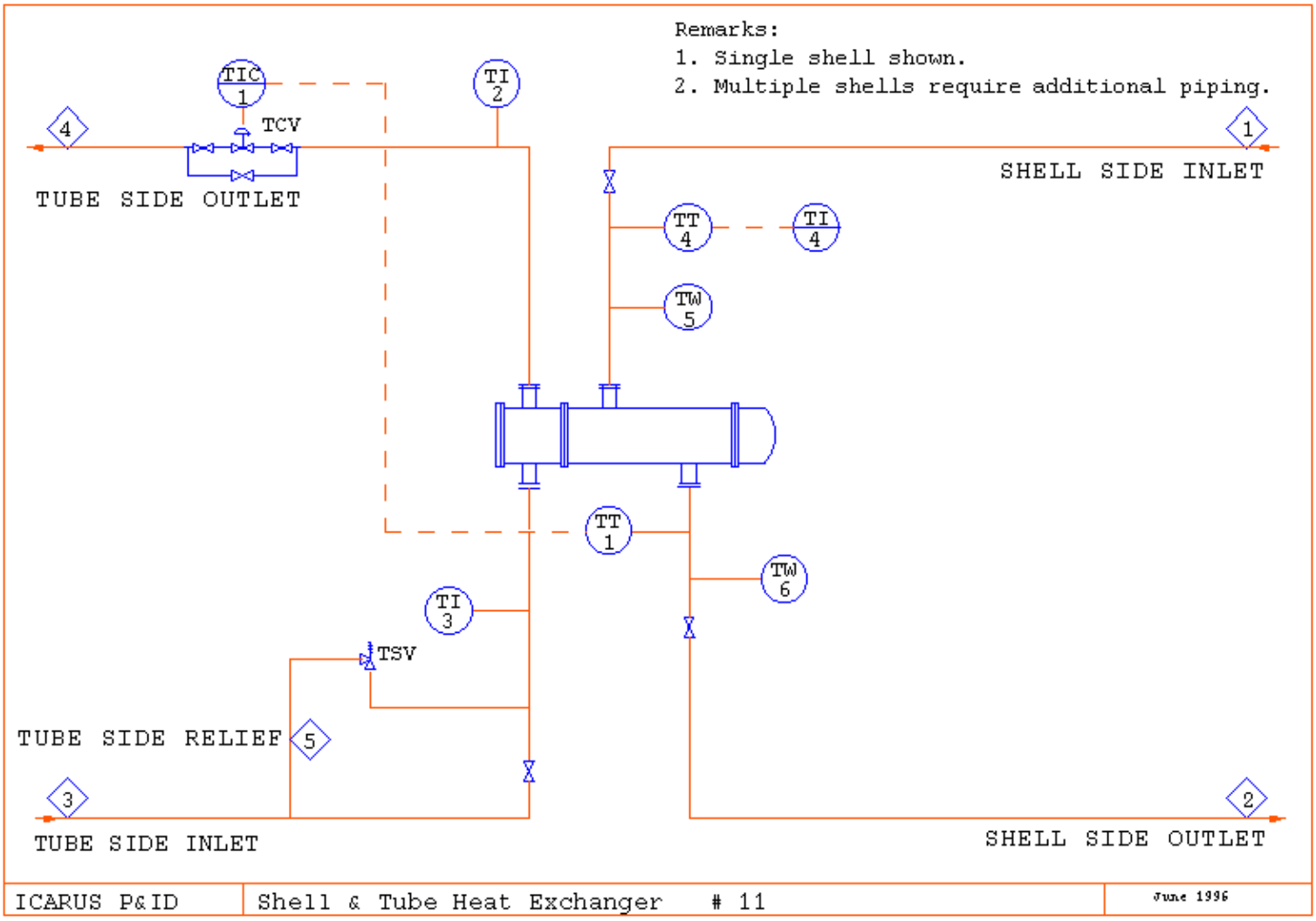
10 Vertical Pressure Vessel – Receiver



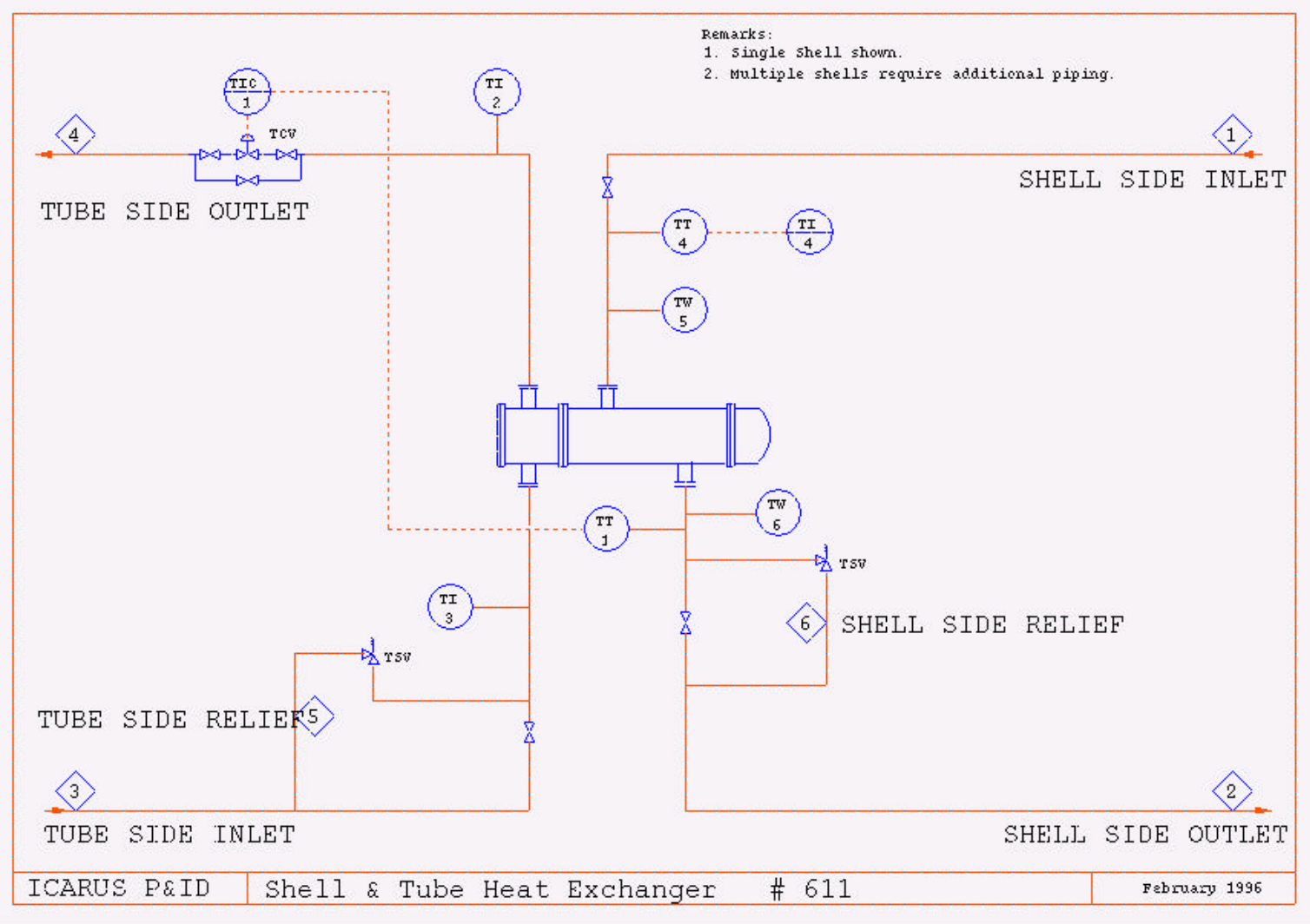
10 Vertical Jacketed Pressure Vessel – Receiver



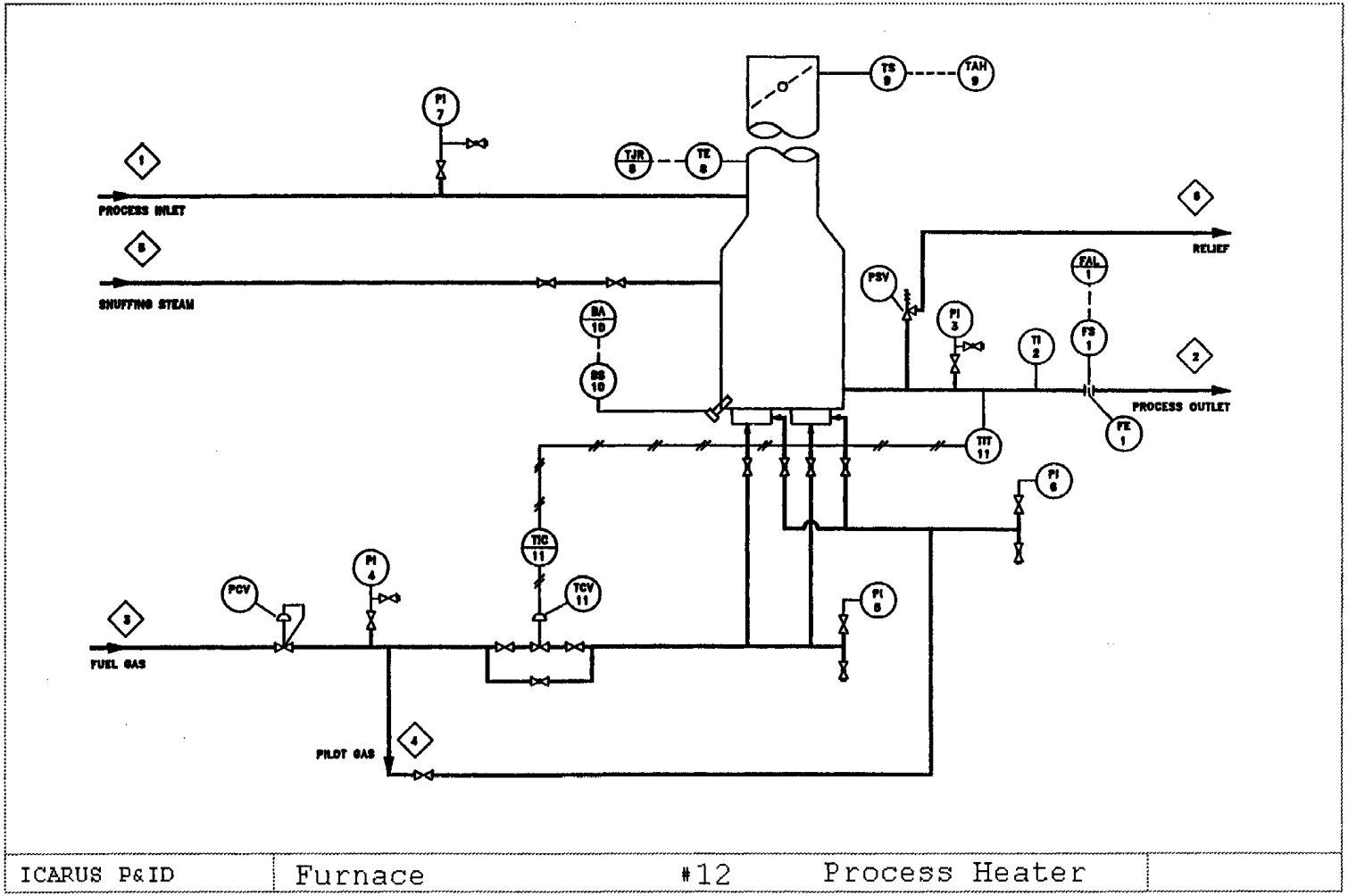
11 Shell & Tube Heat Exchanger



611 Shell & Tube Heat Exchanger

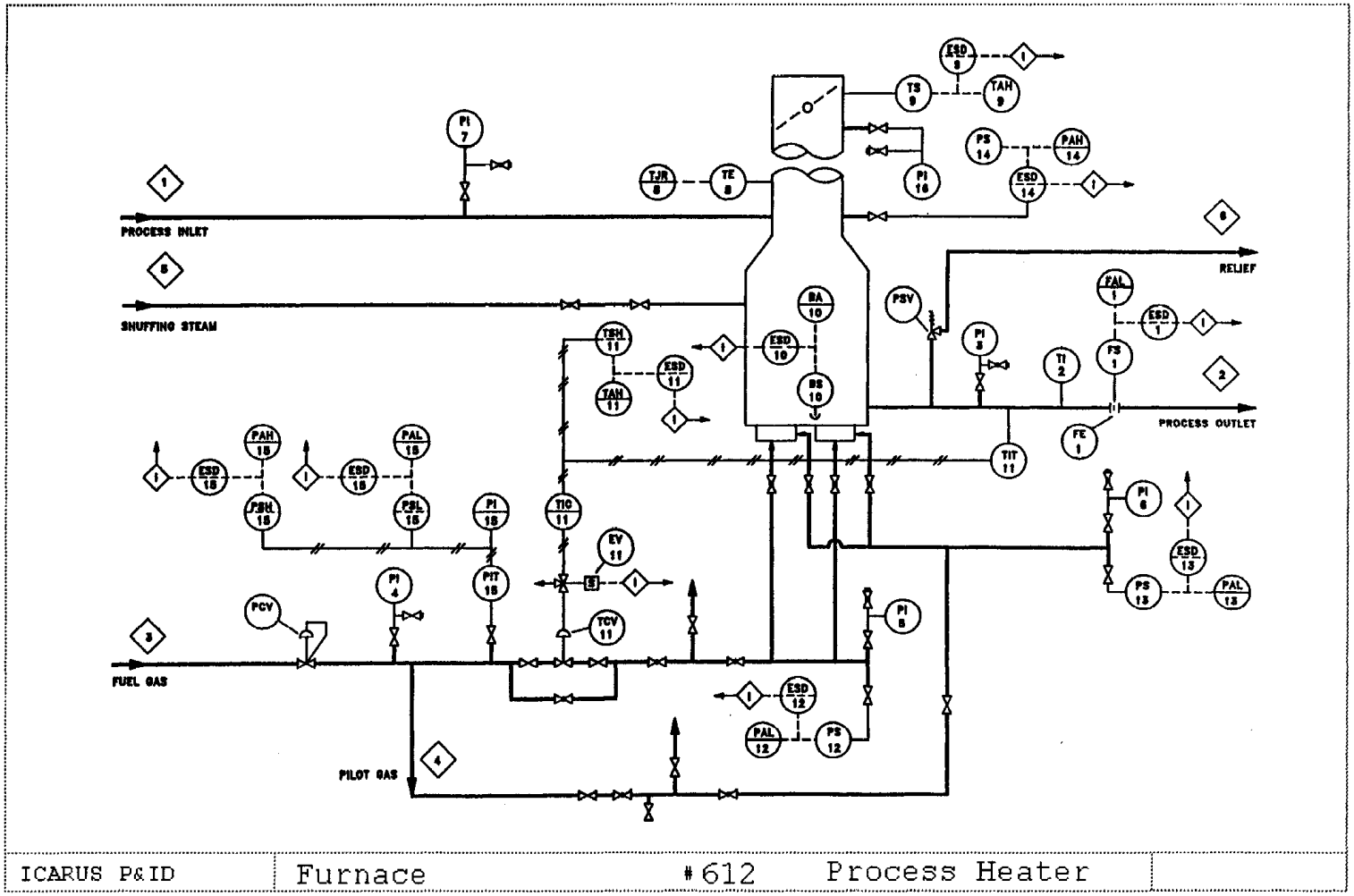


12 Process Heater Furnace

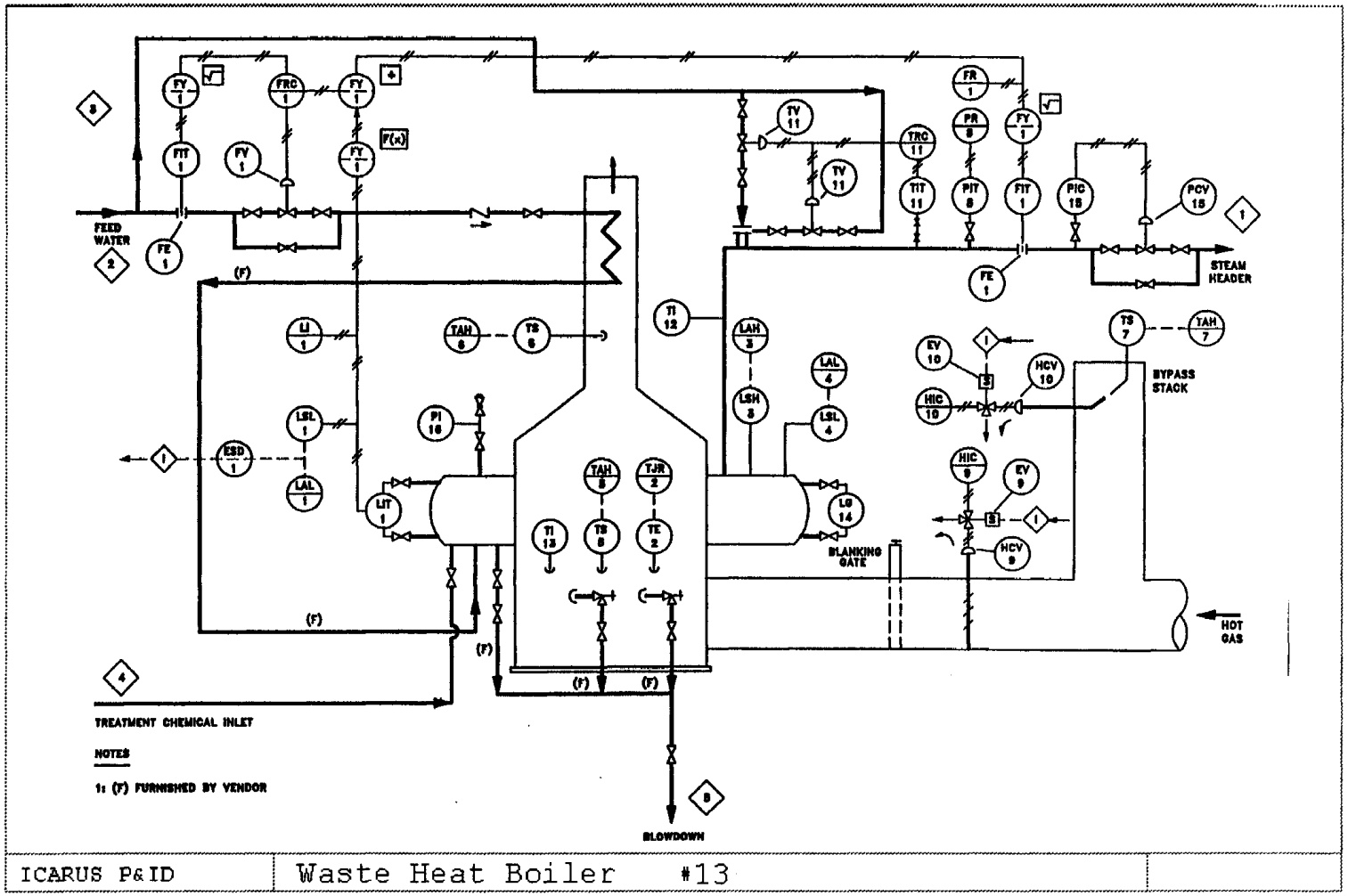


ICARUS P&ID	Furnace	#12	Process Heater	

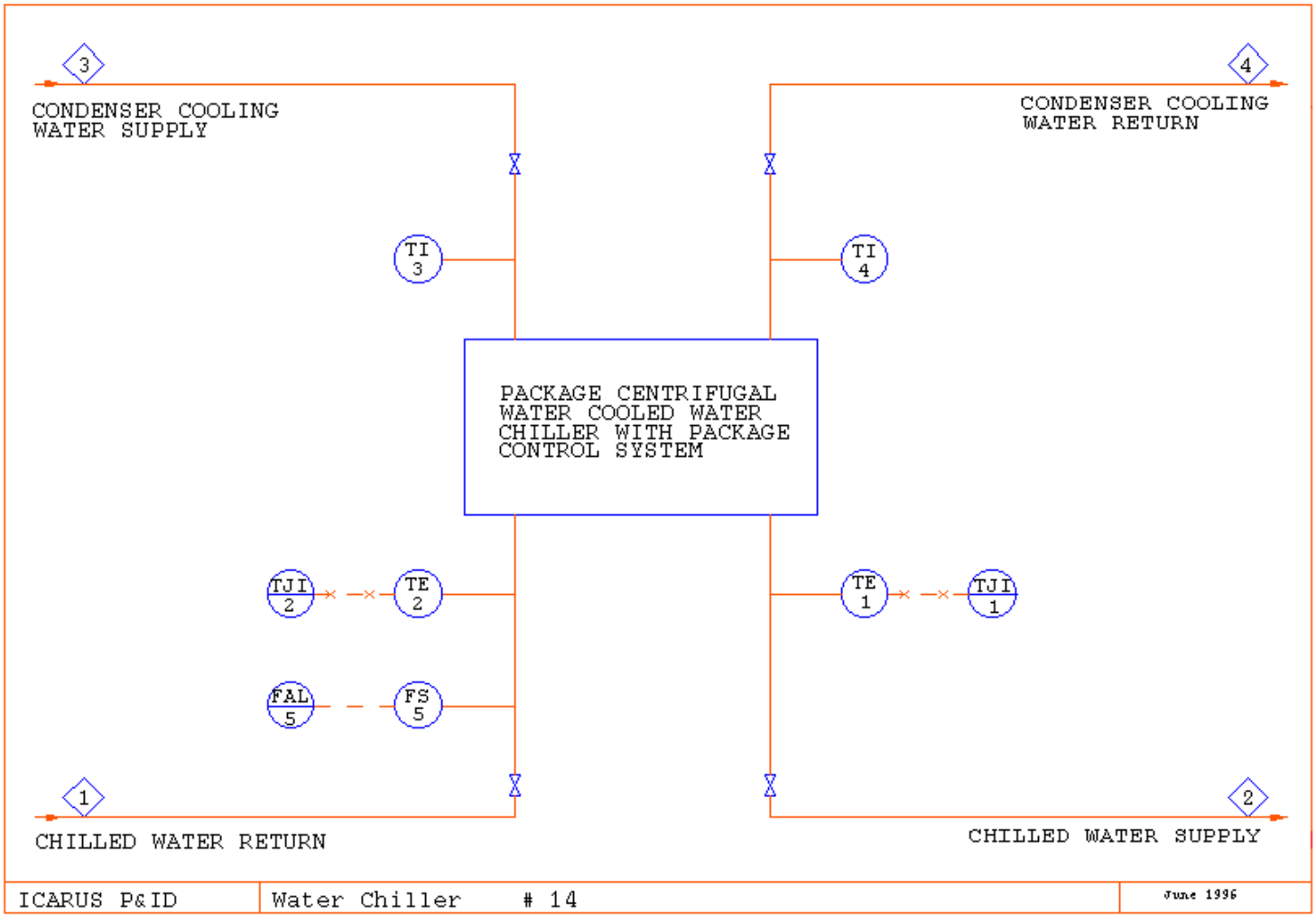
612 Process Heater Furnace



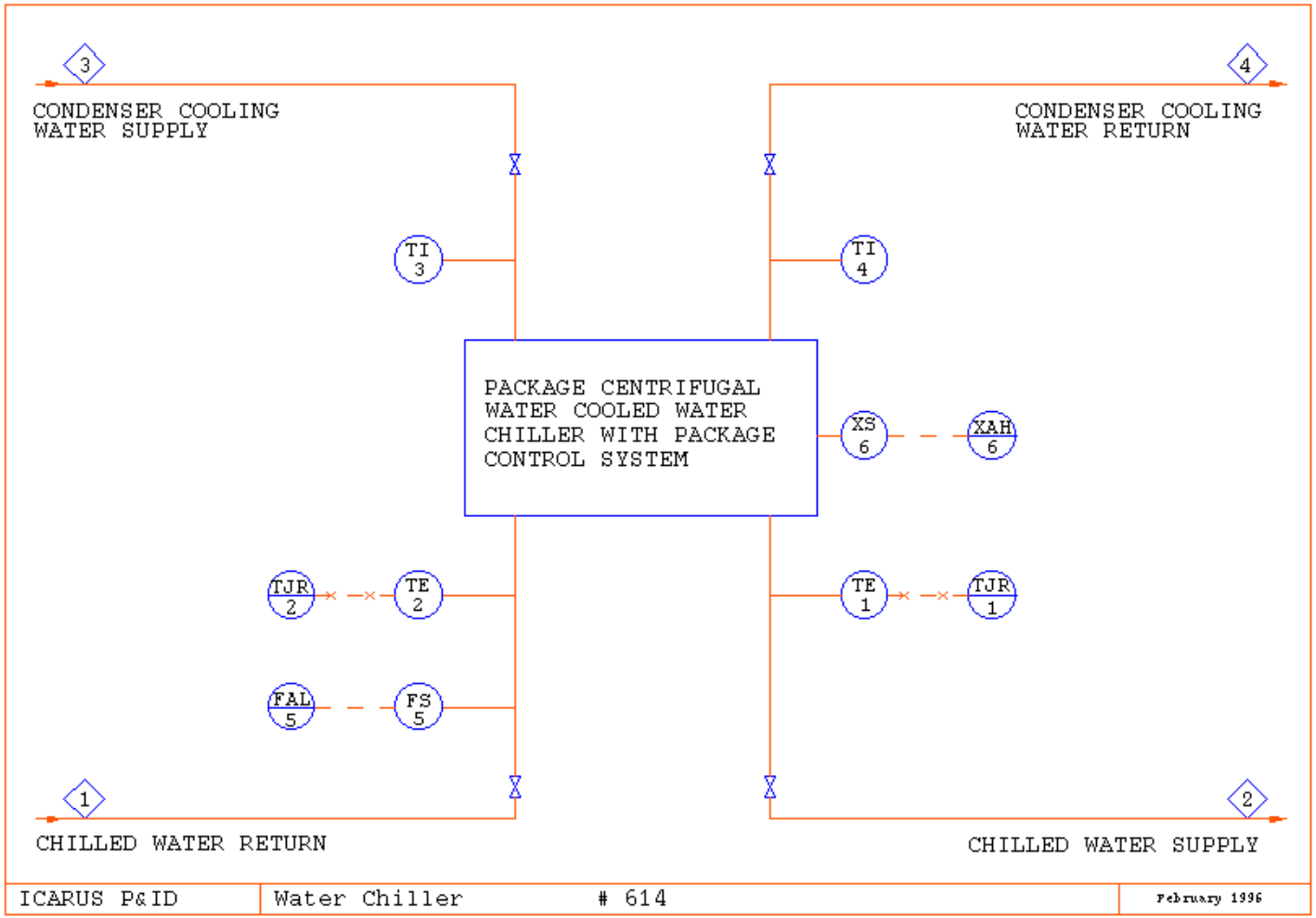
13 Waste Heat Boiler



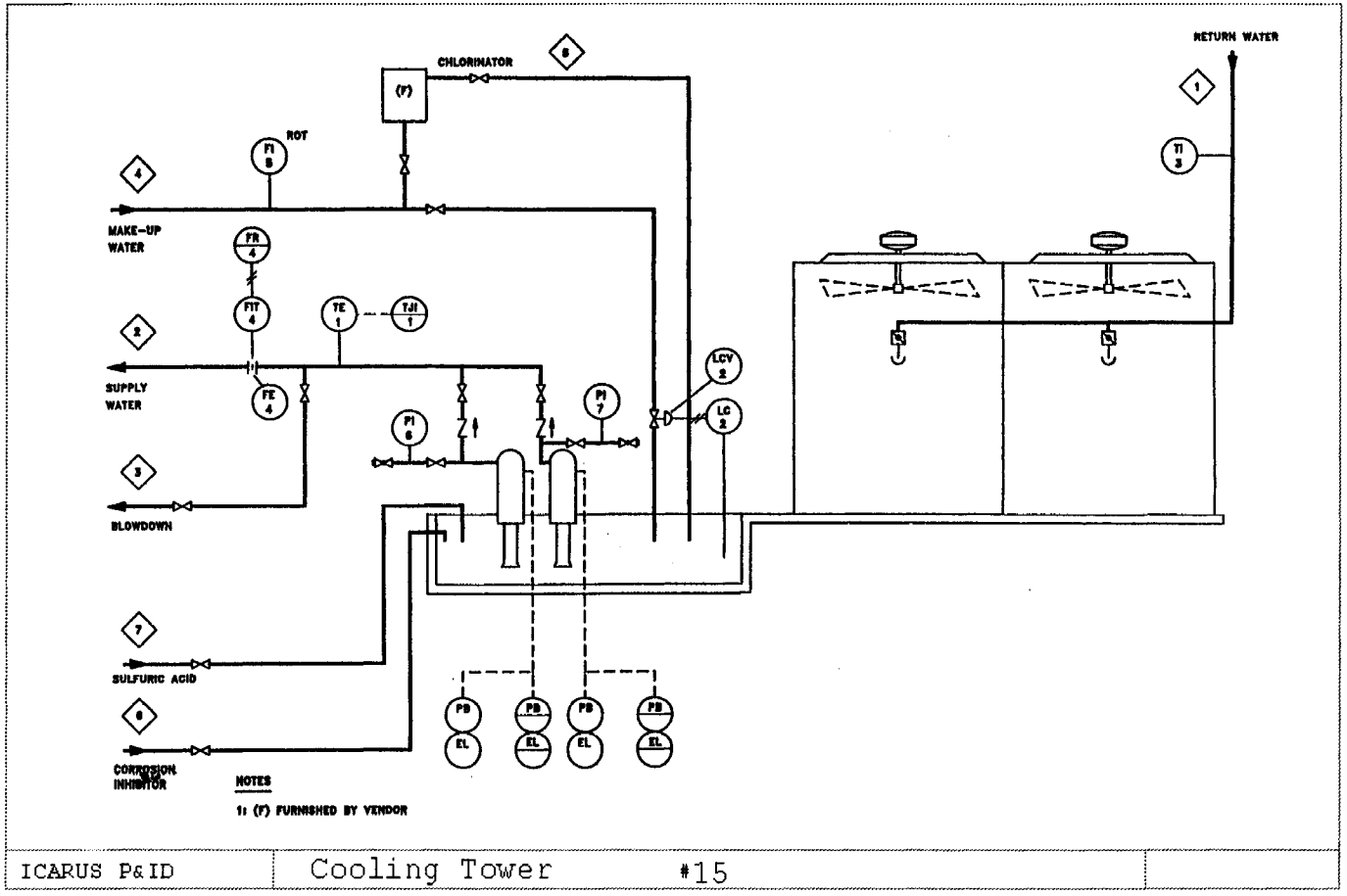
14 Water Chiller



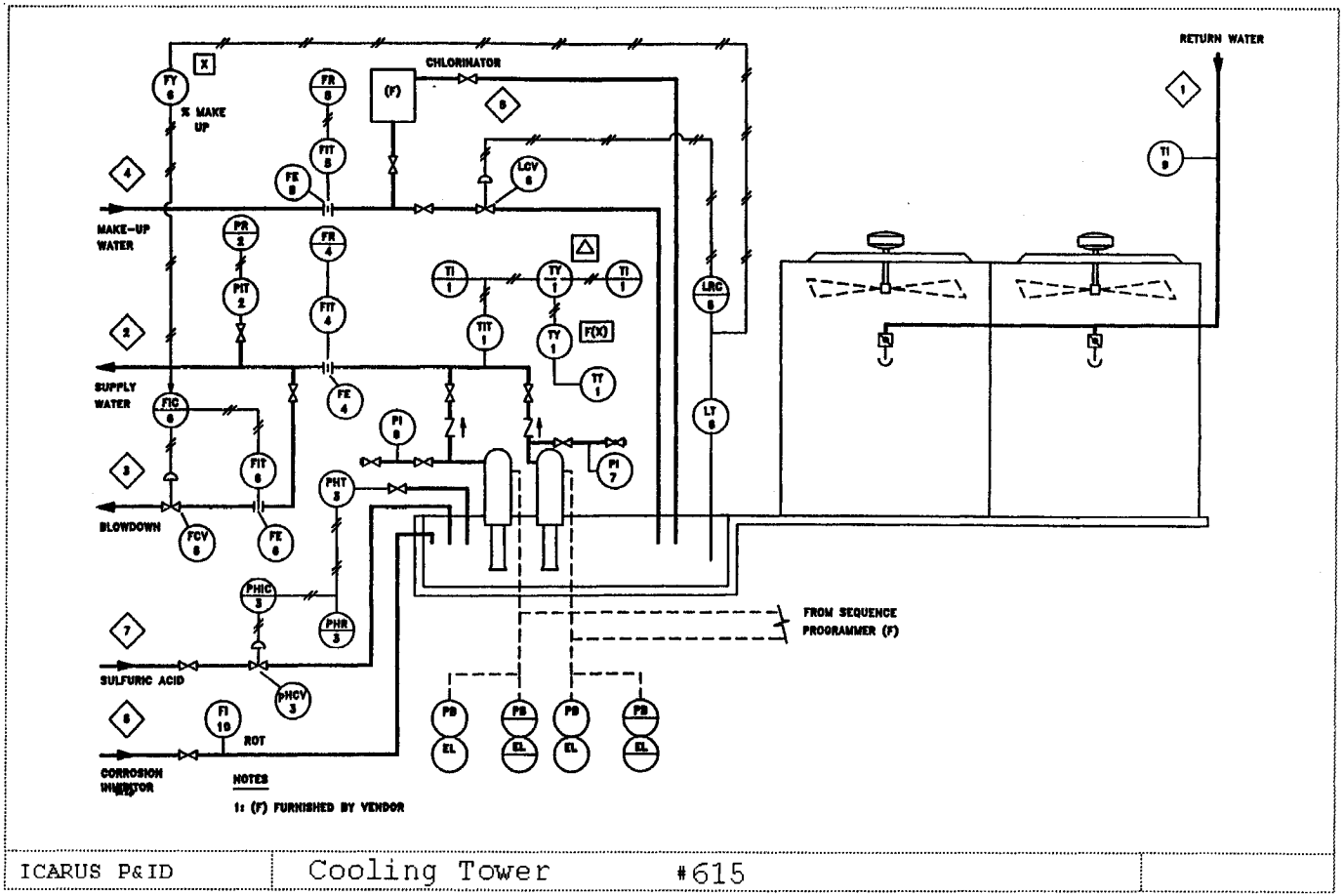
614 Water Chiller



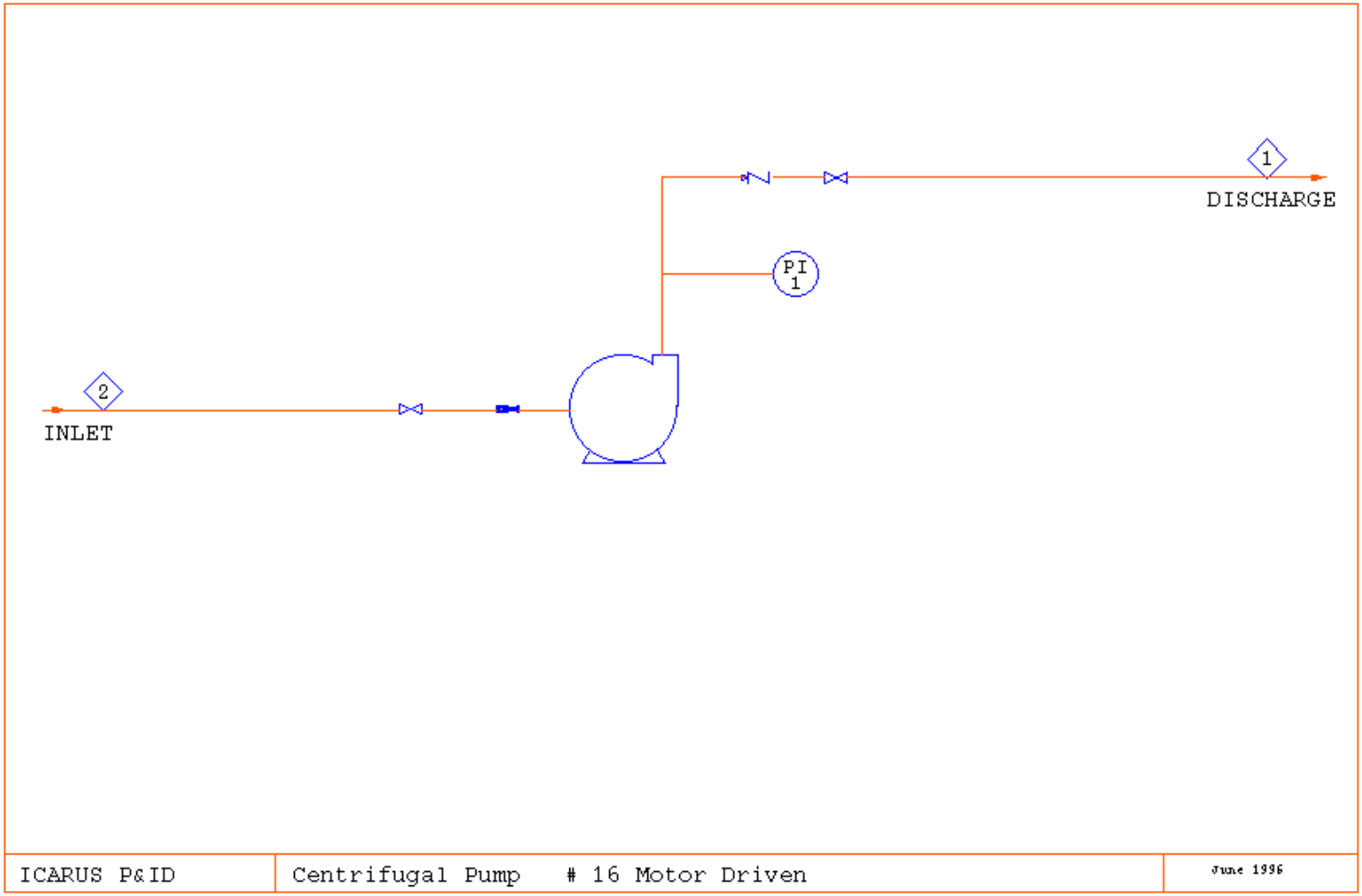
15 Cooling Tower



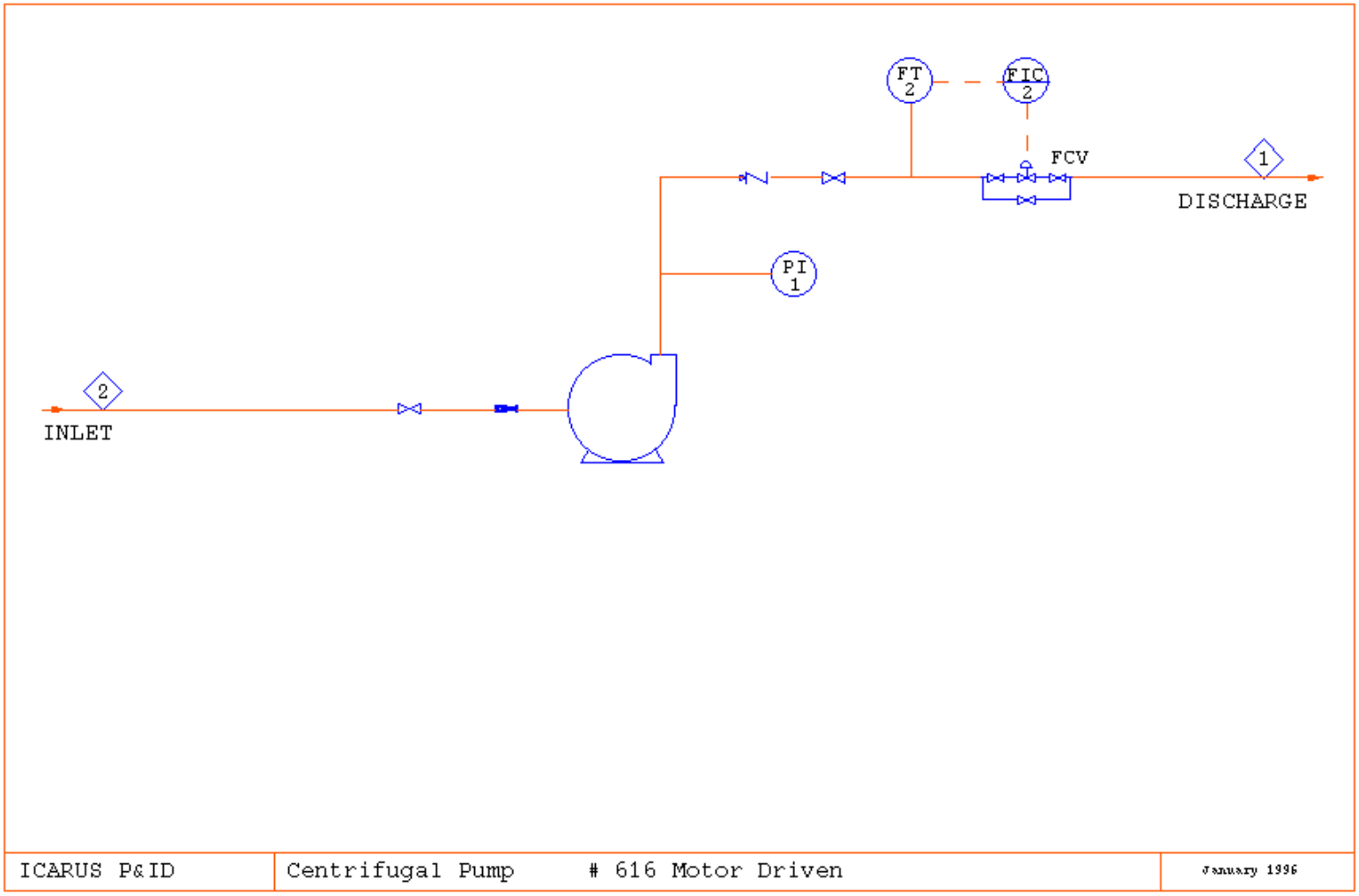
615 Cooling Tower



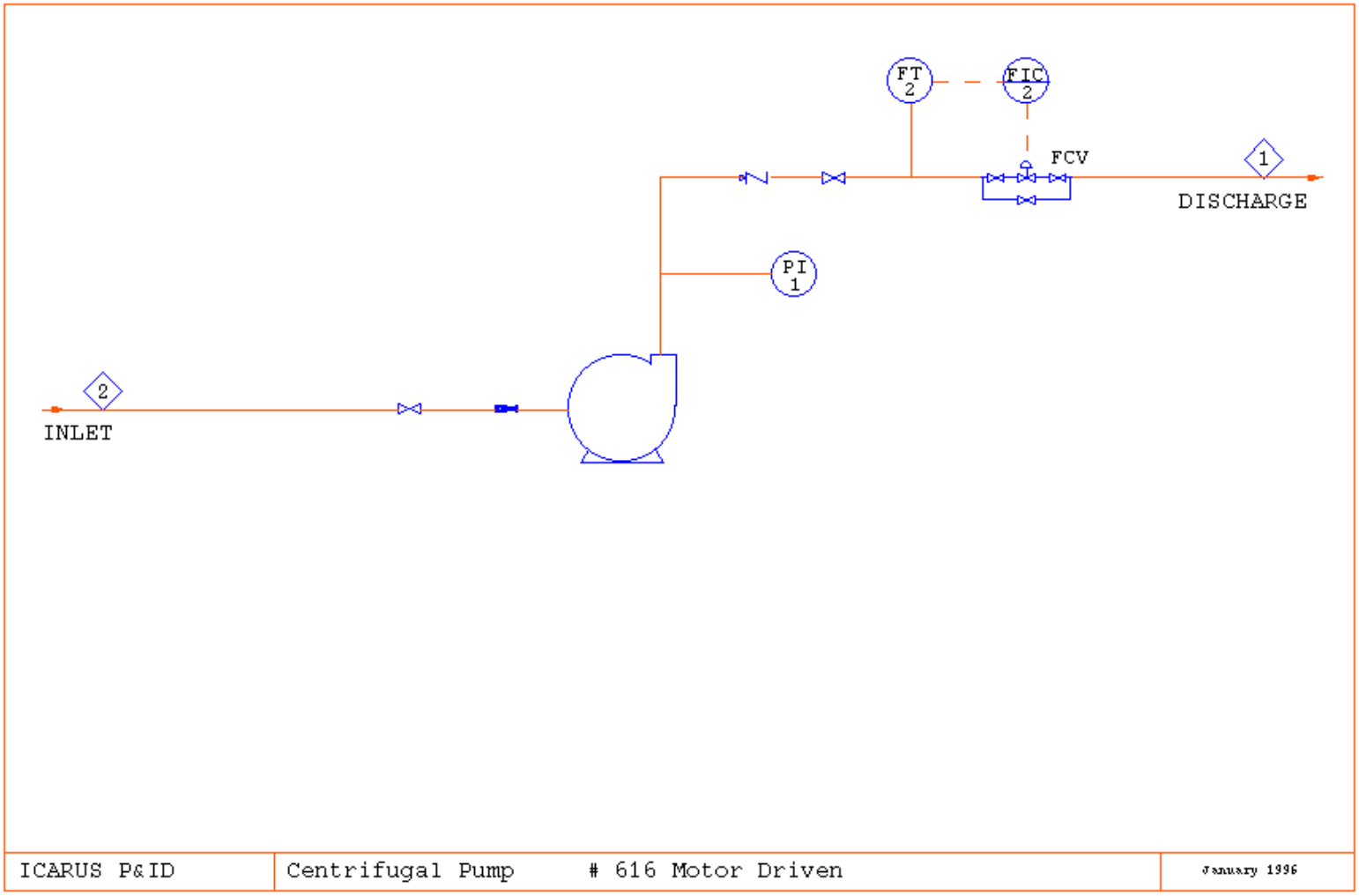
16 Motor Driven Centrifugal Pump



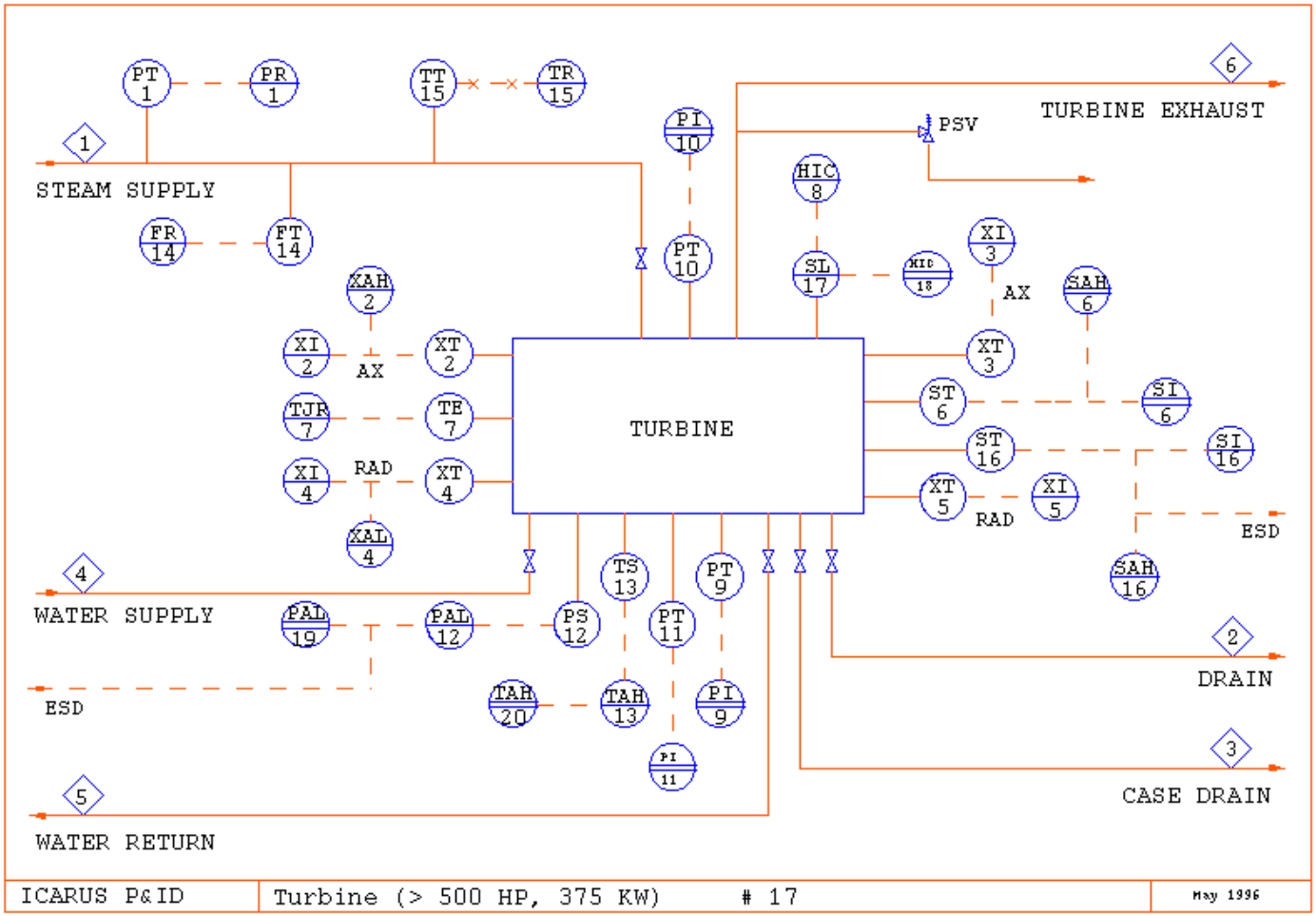
616 Motor Driven Centrifugal Pump



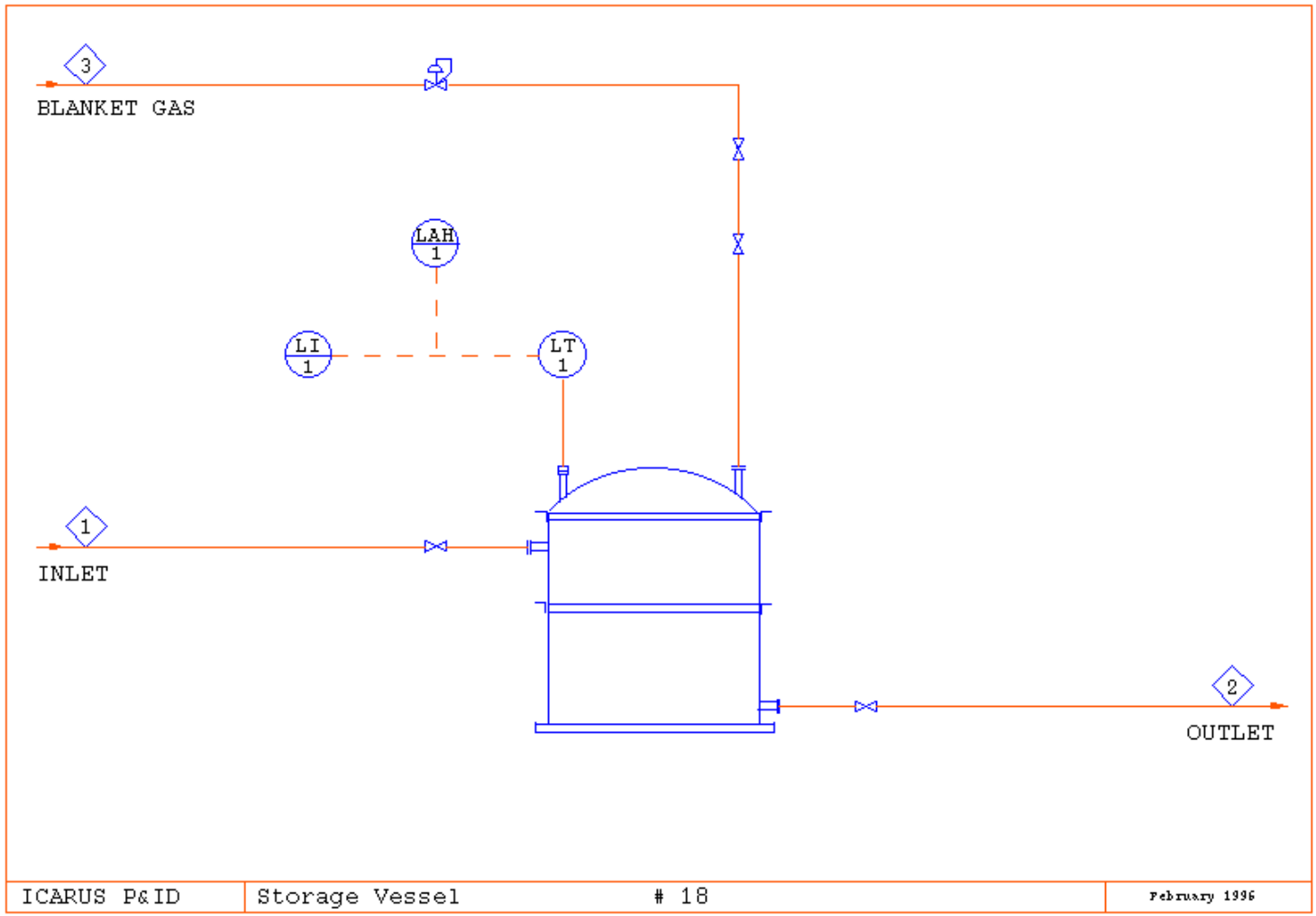
616 Motor Driven Spare Centrifugal Pump



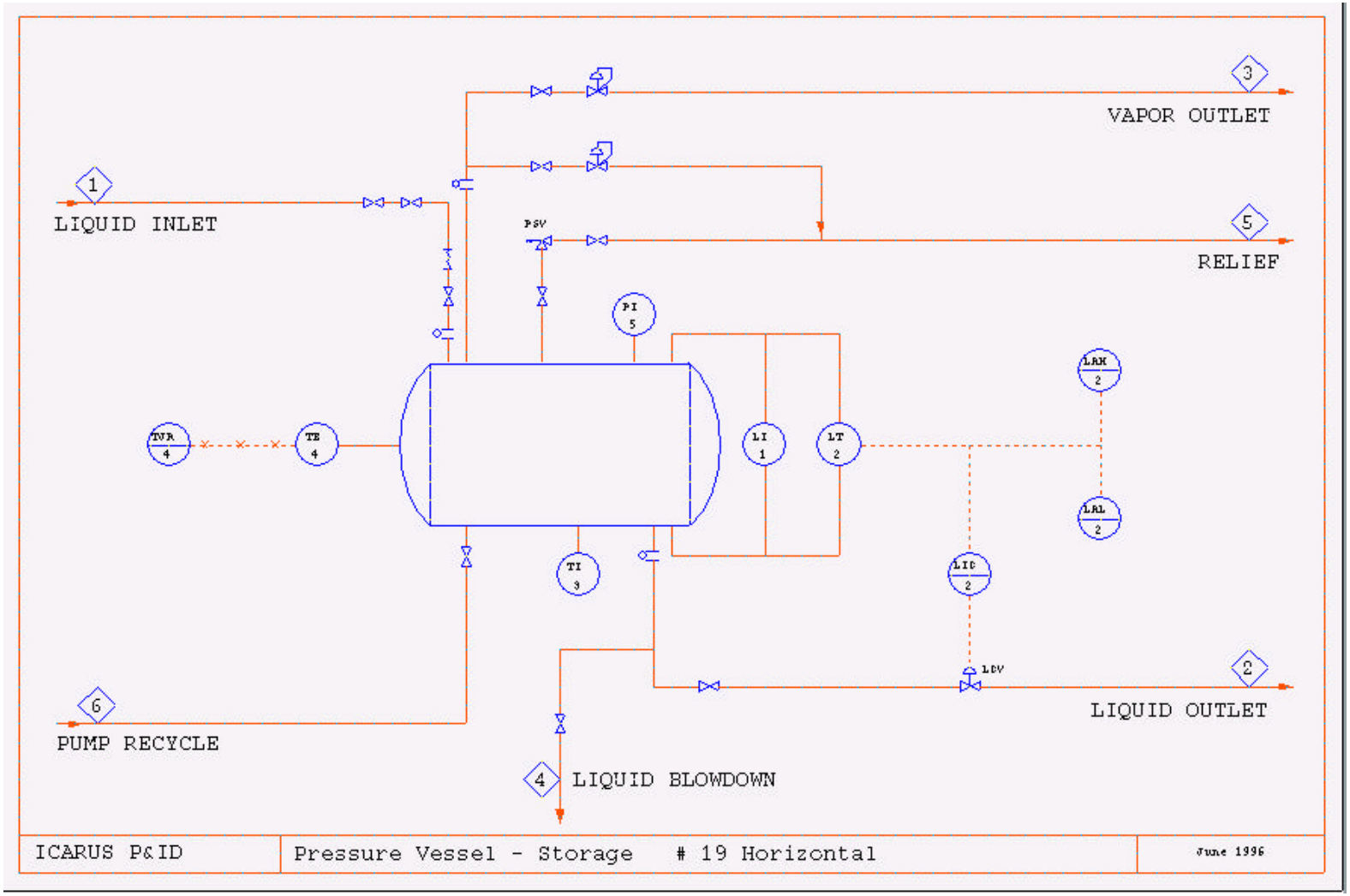
17 Turbine (>500 HP, 375 KW)



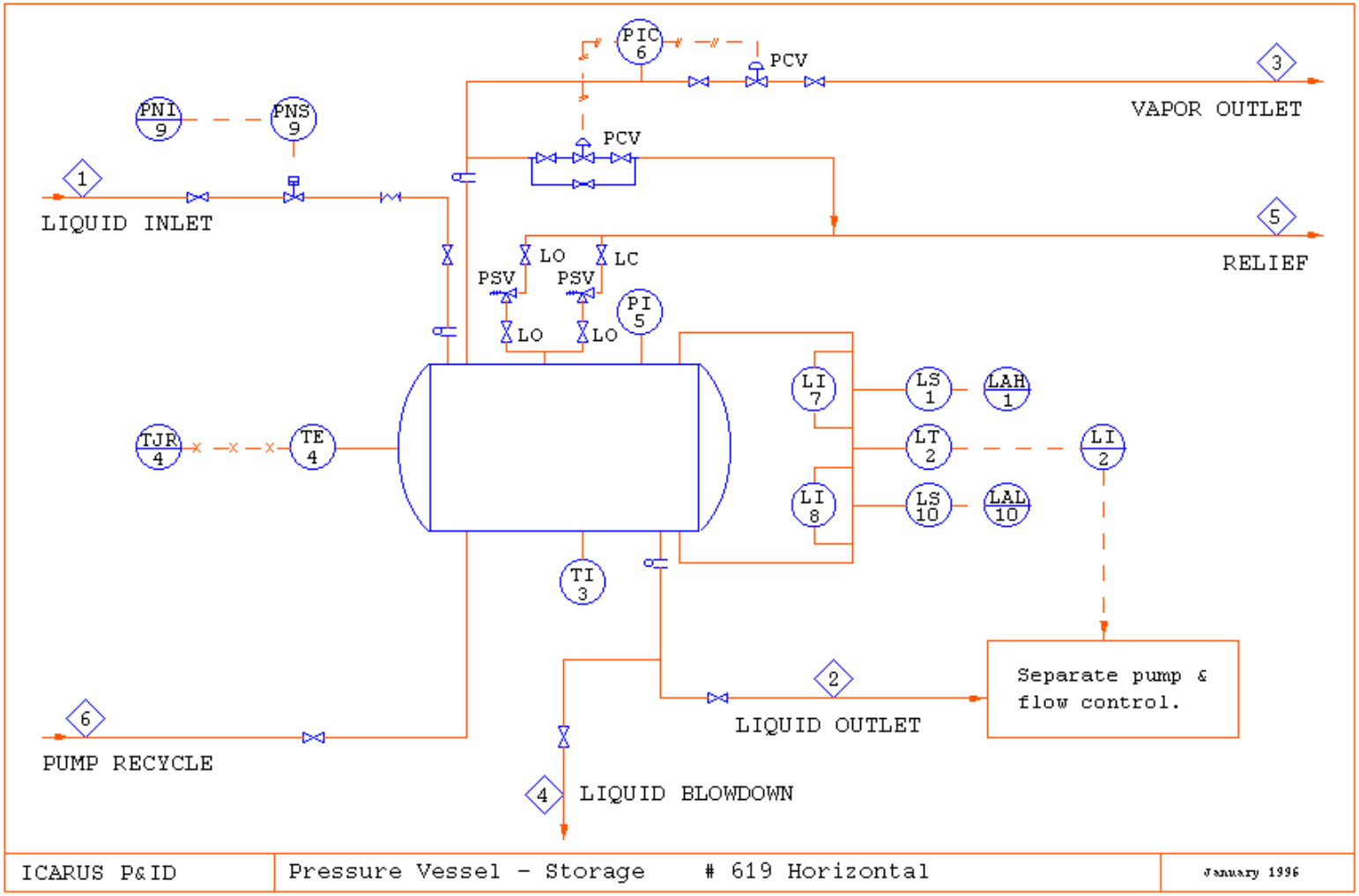
18 Storage Vessel



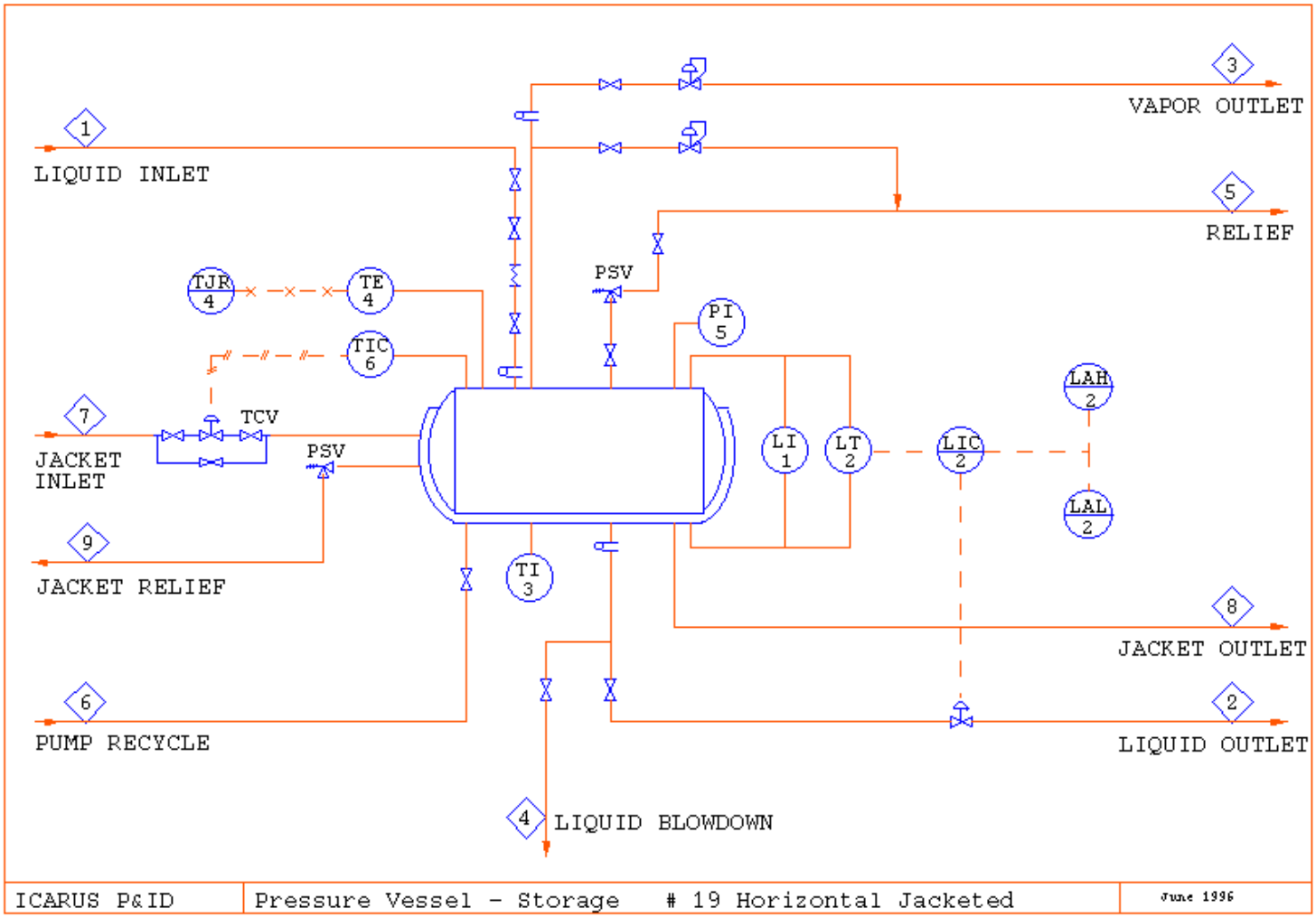
19 Horizontal Pressure Vessel – Storage



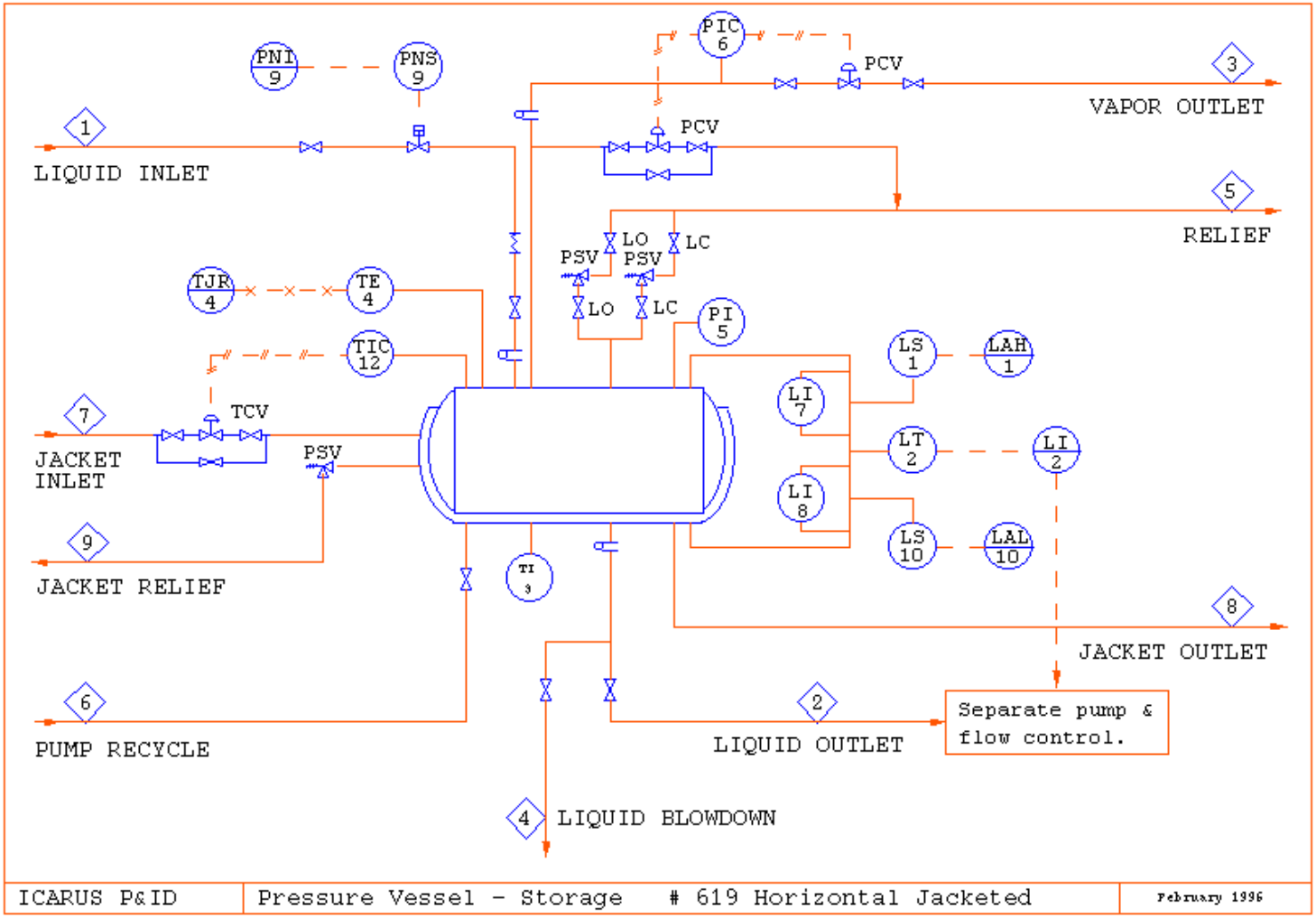
619 Horizontal Pressure Vessel – Storage



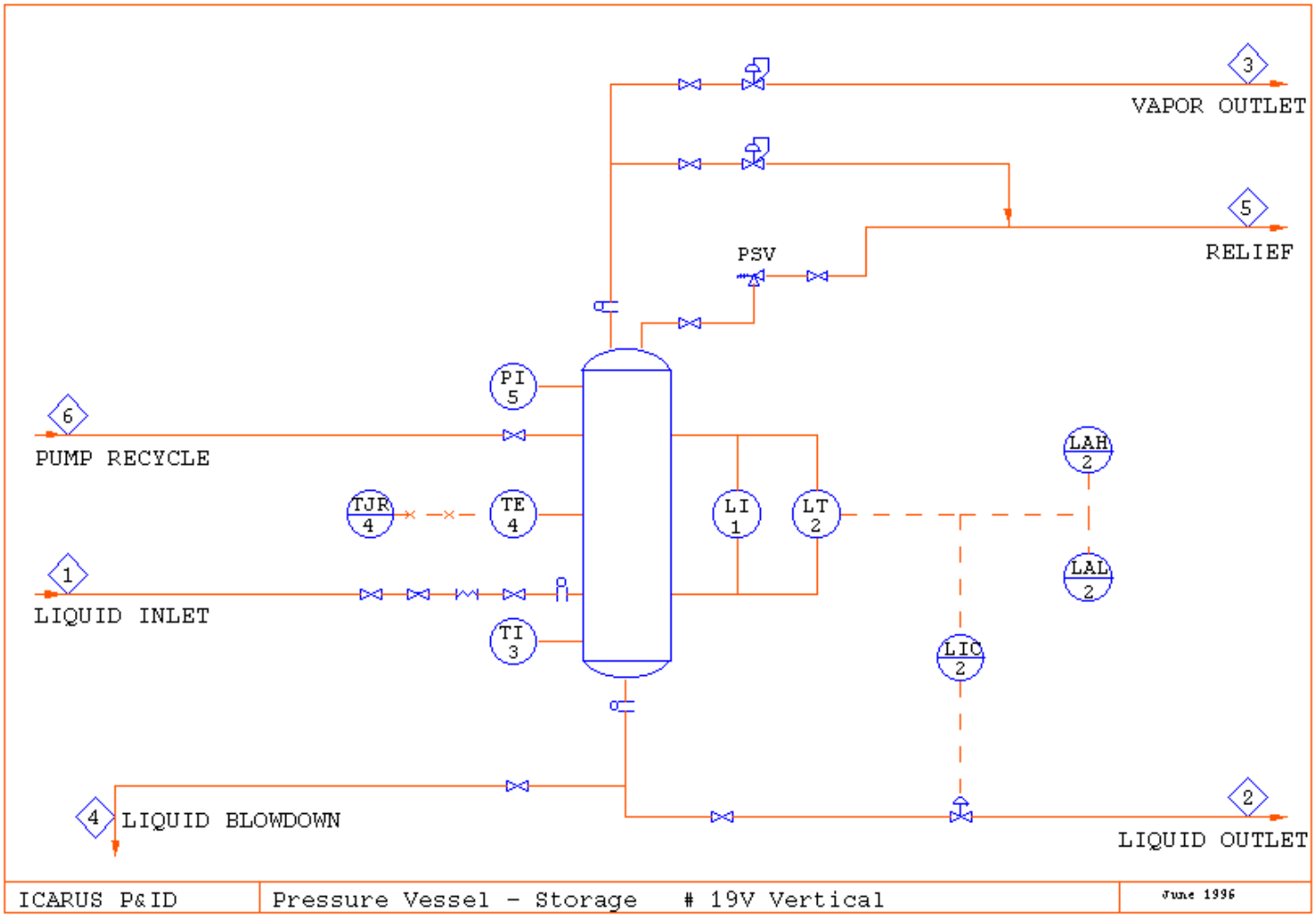
19 Horizontal Jacketed Pressure Vessel – Storage



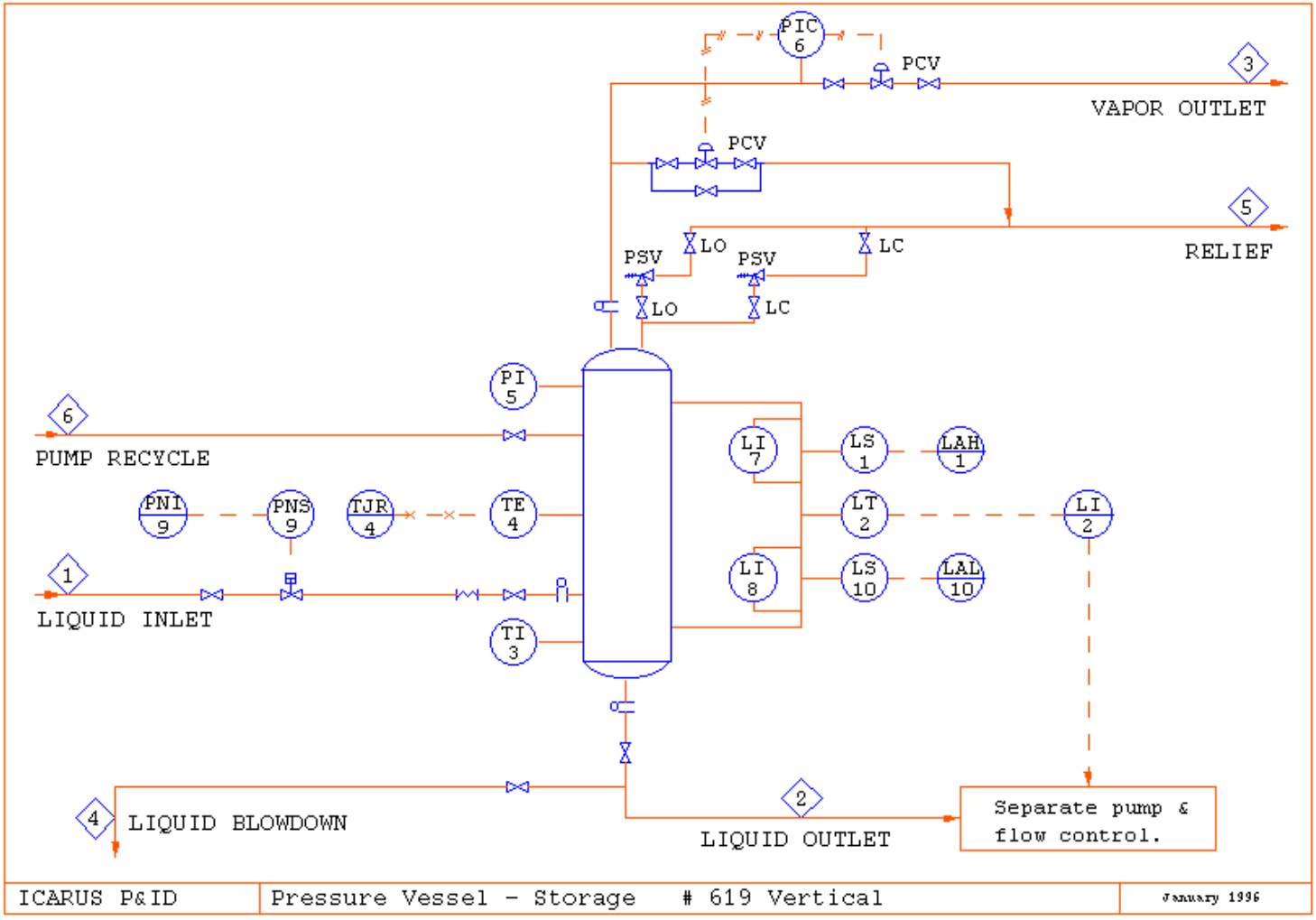
619 Horizontal Jacketed Pressure Vessel – Storage



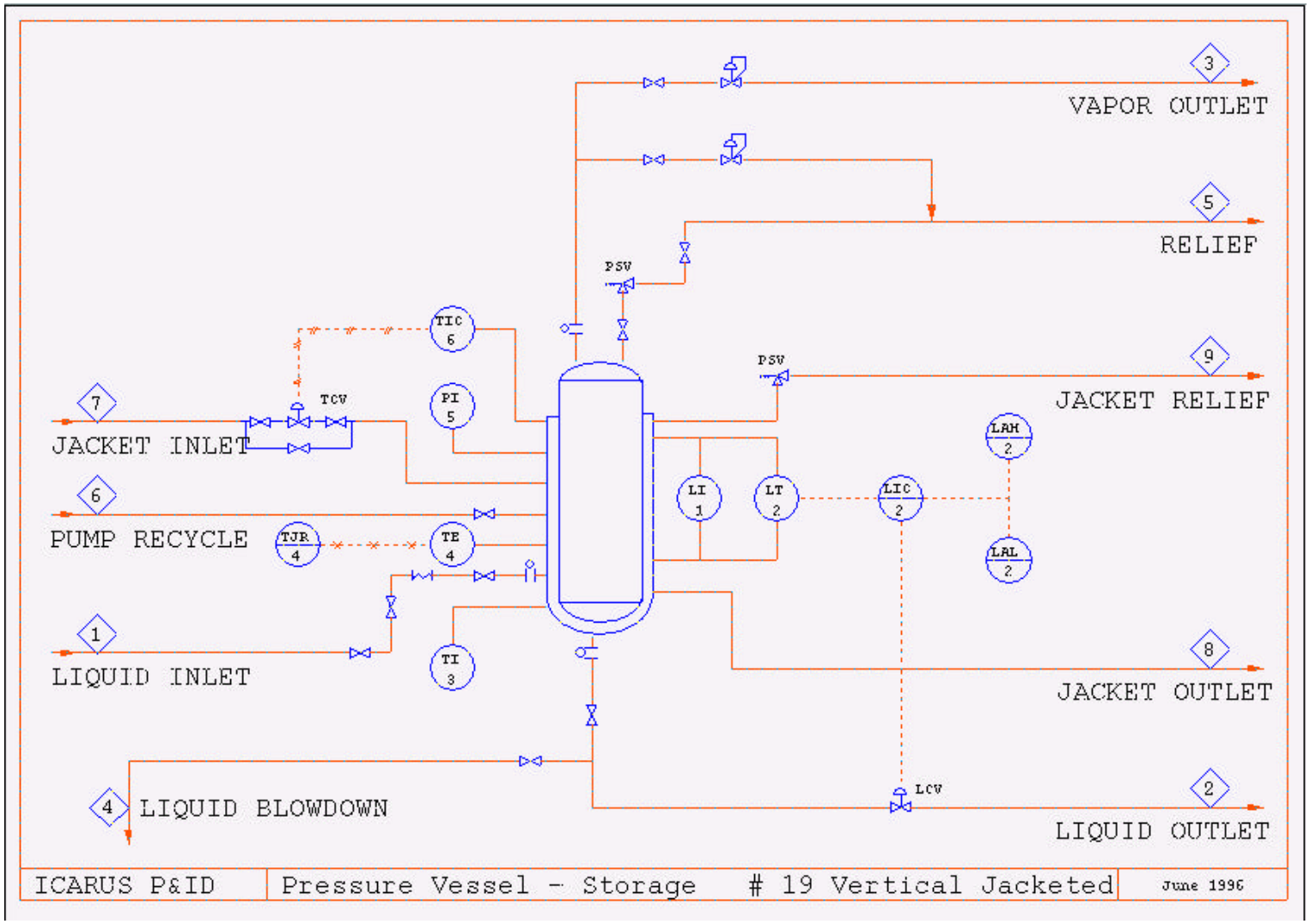
19 Vertical Pressure Vessel – Storage



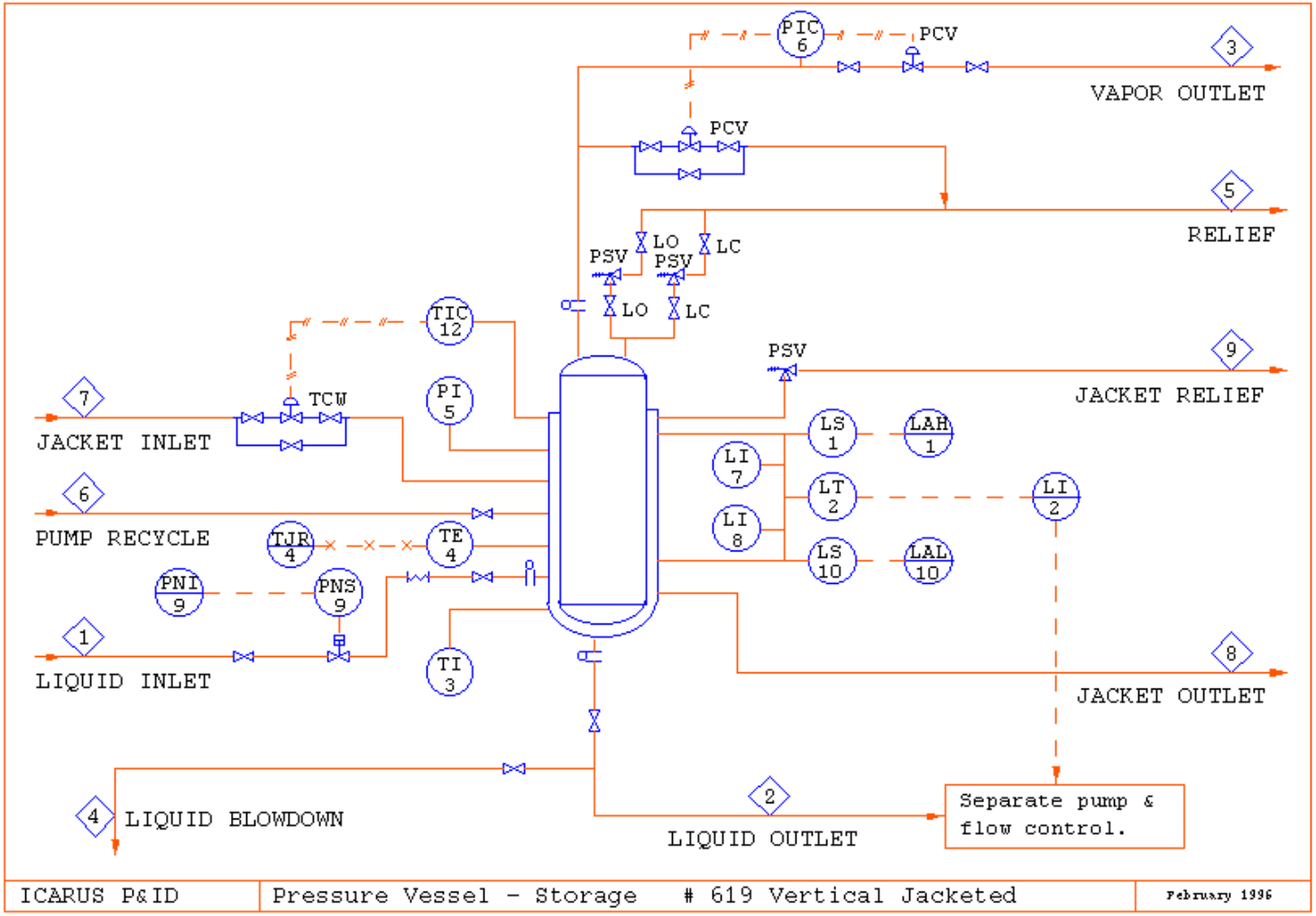
619 Vertical Pressure Vessel – Storage



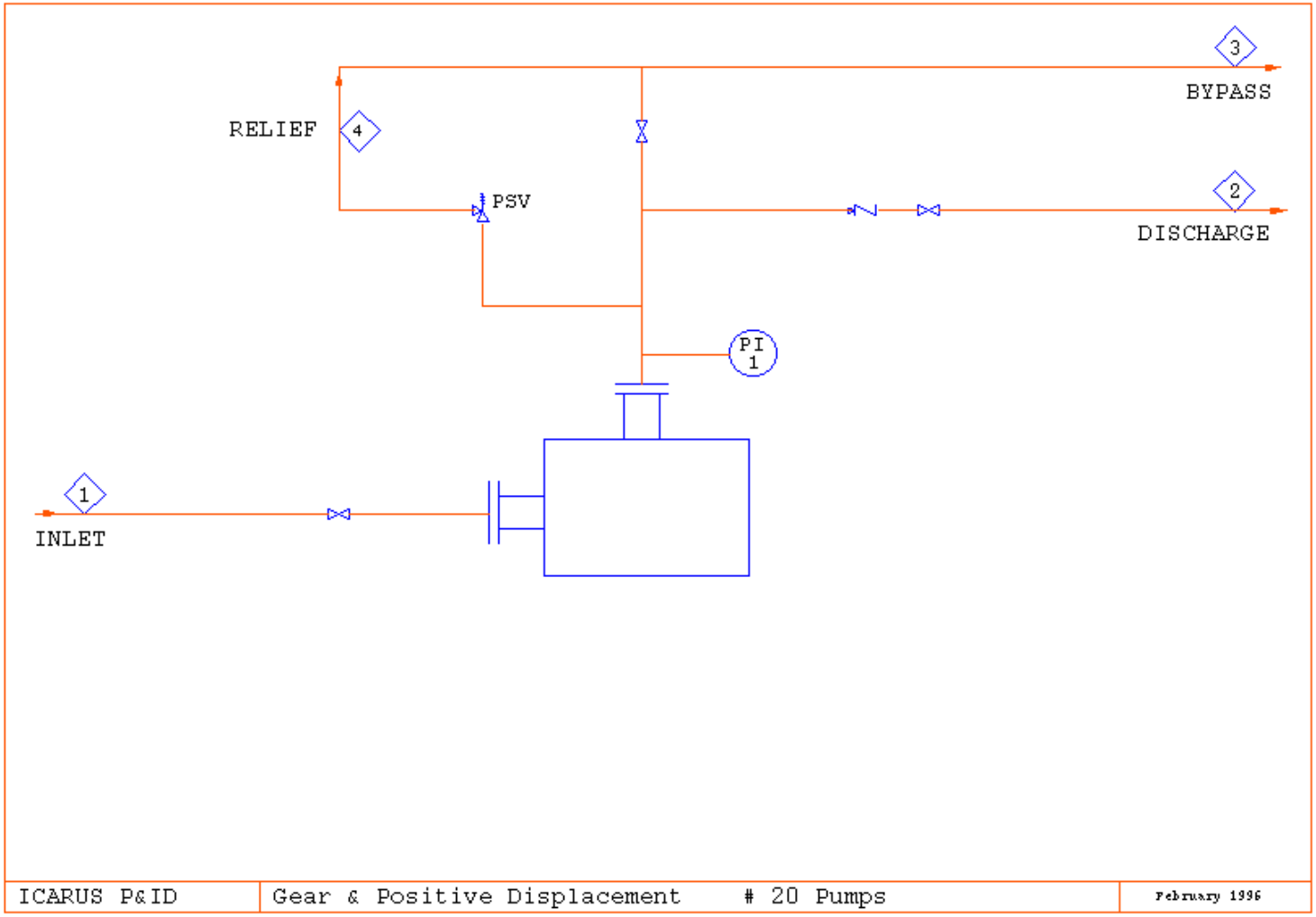
19 Vertical Jacketed Pressure Vessel – Storage



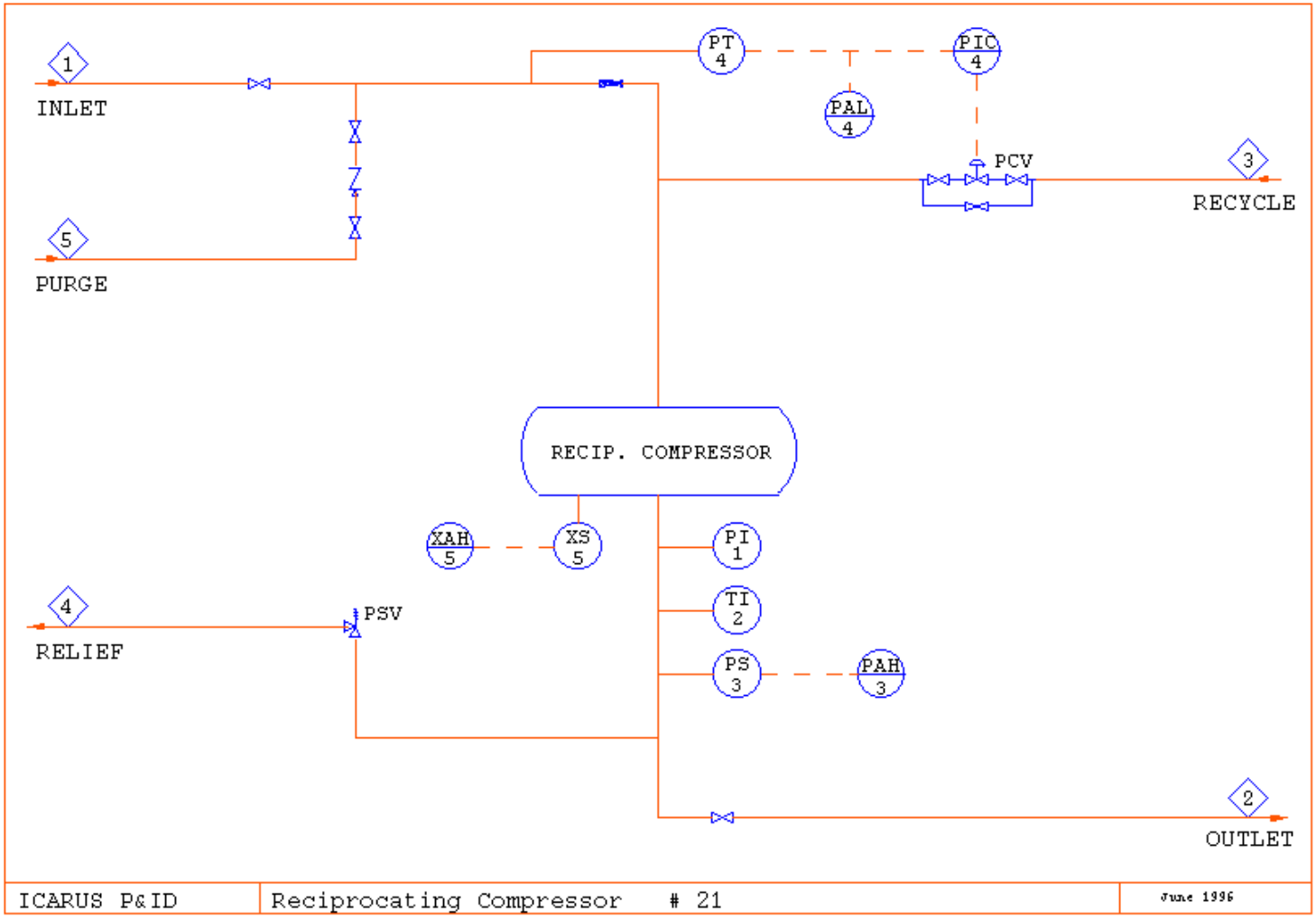
619 Vertical Jacketed Pressure Vessel – Storage



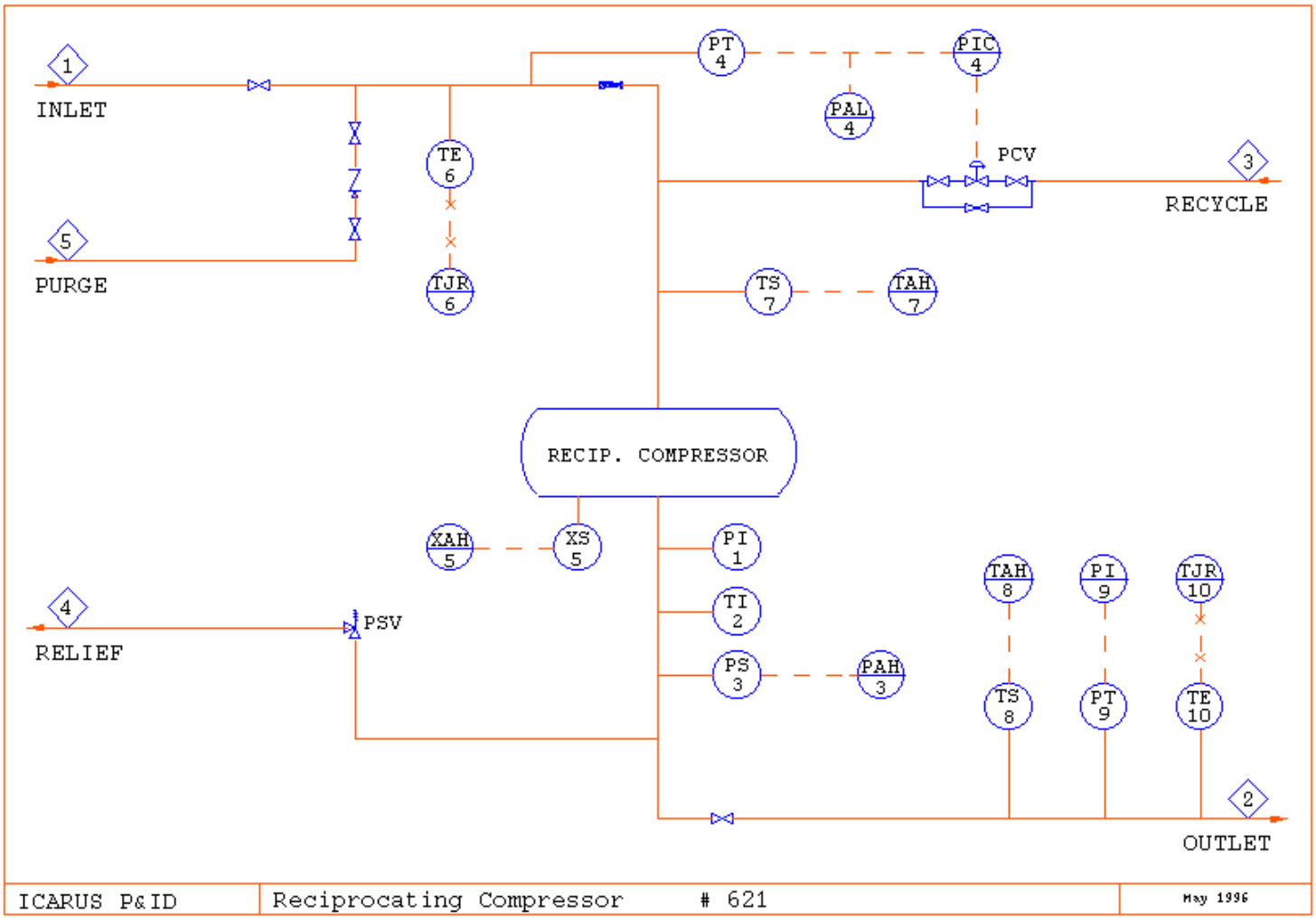
20 Pumps – Gear & Positive Displacement



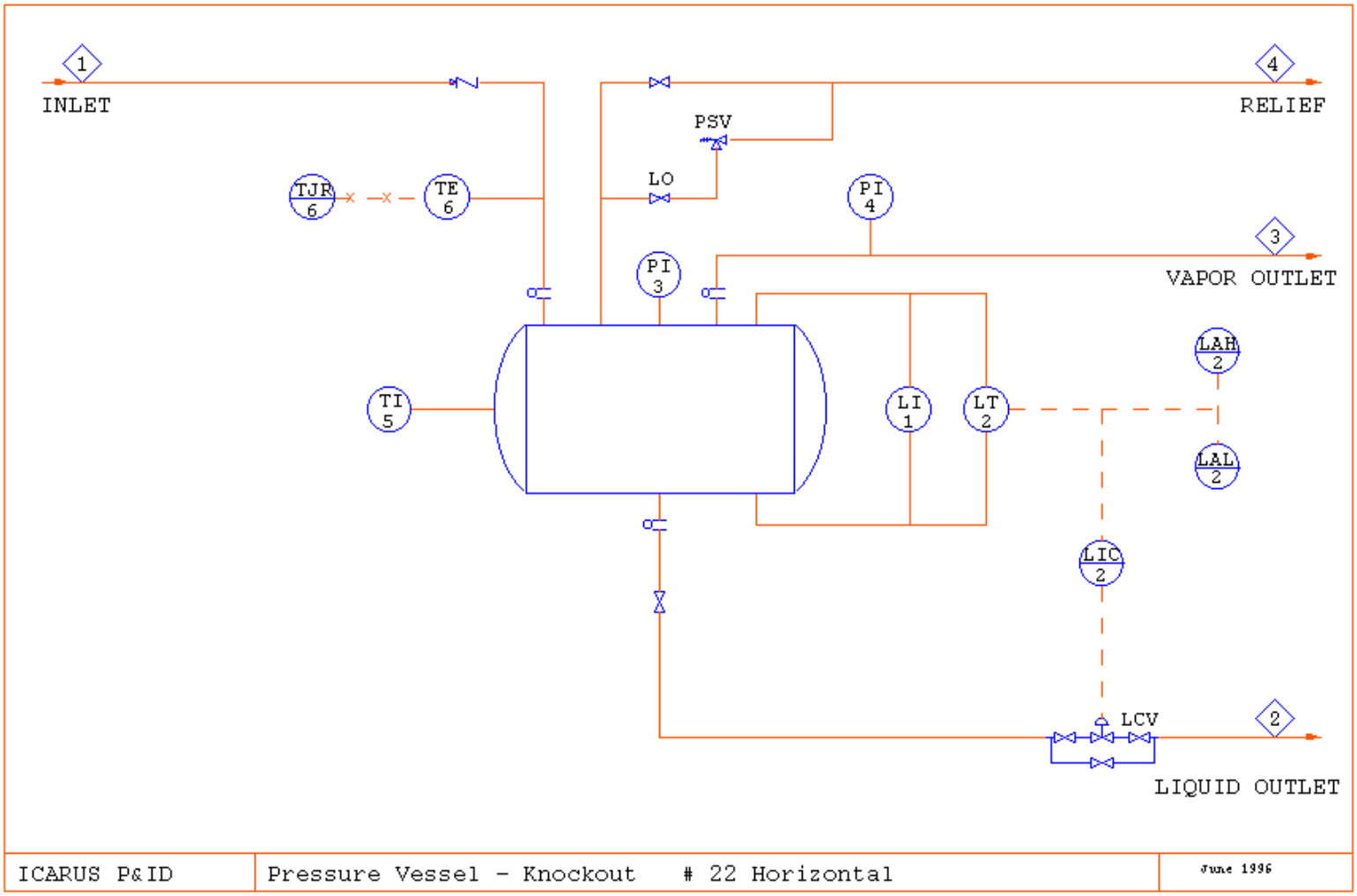
21 Reciprocating Compressor



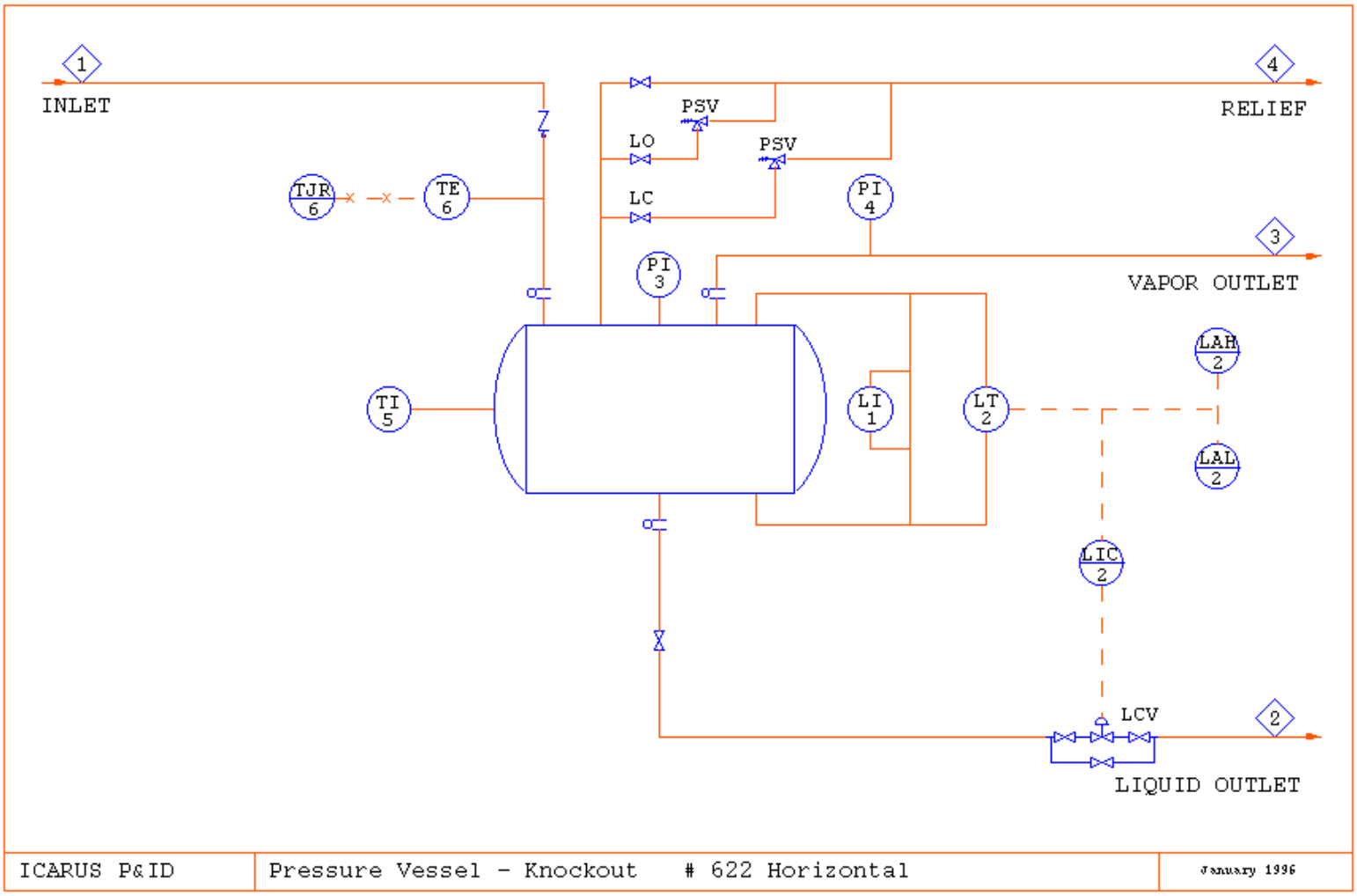
621 Reciprocating Compressor



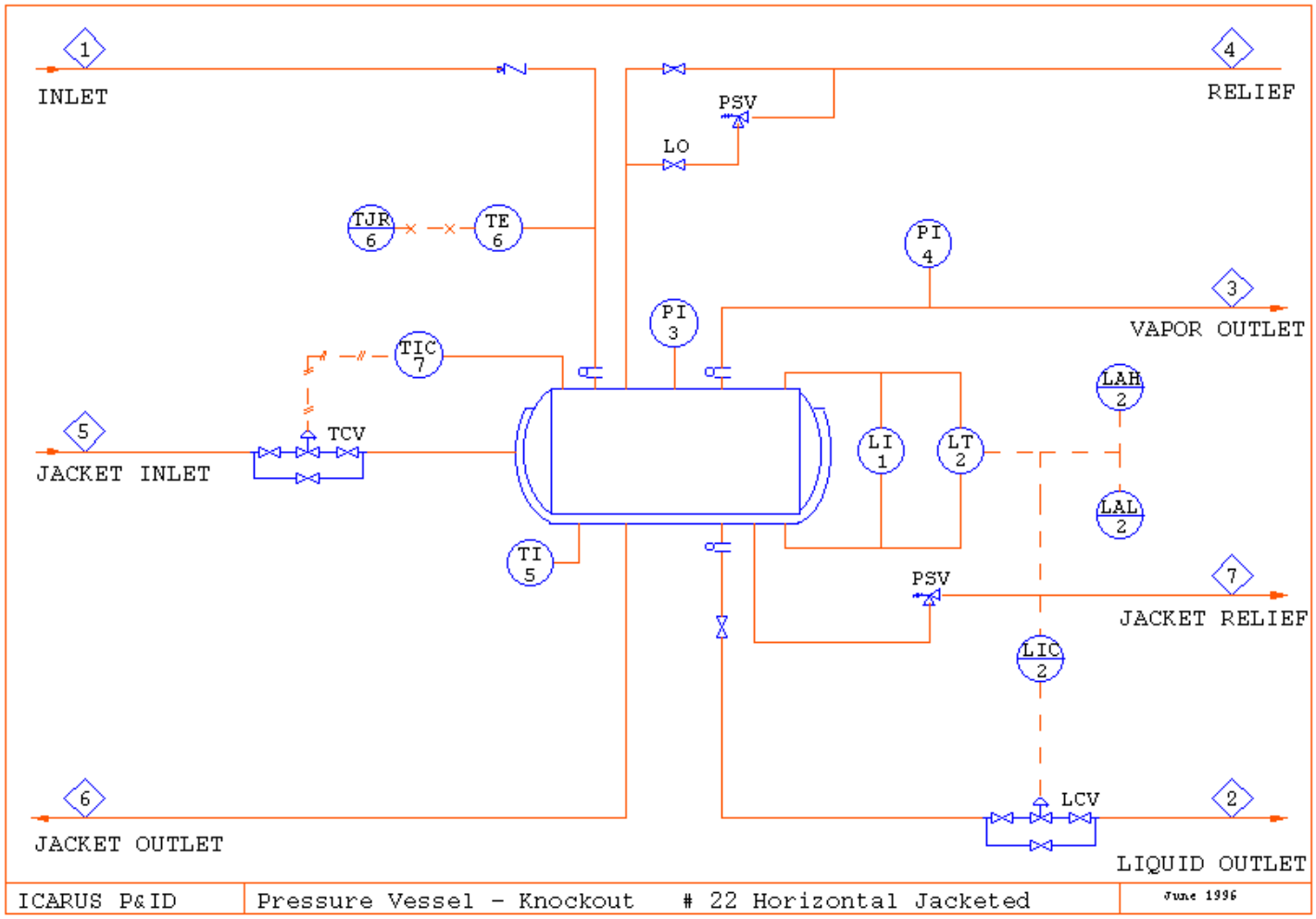
22 Horizontal Pressure Vessel – Knockout



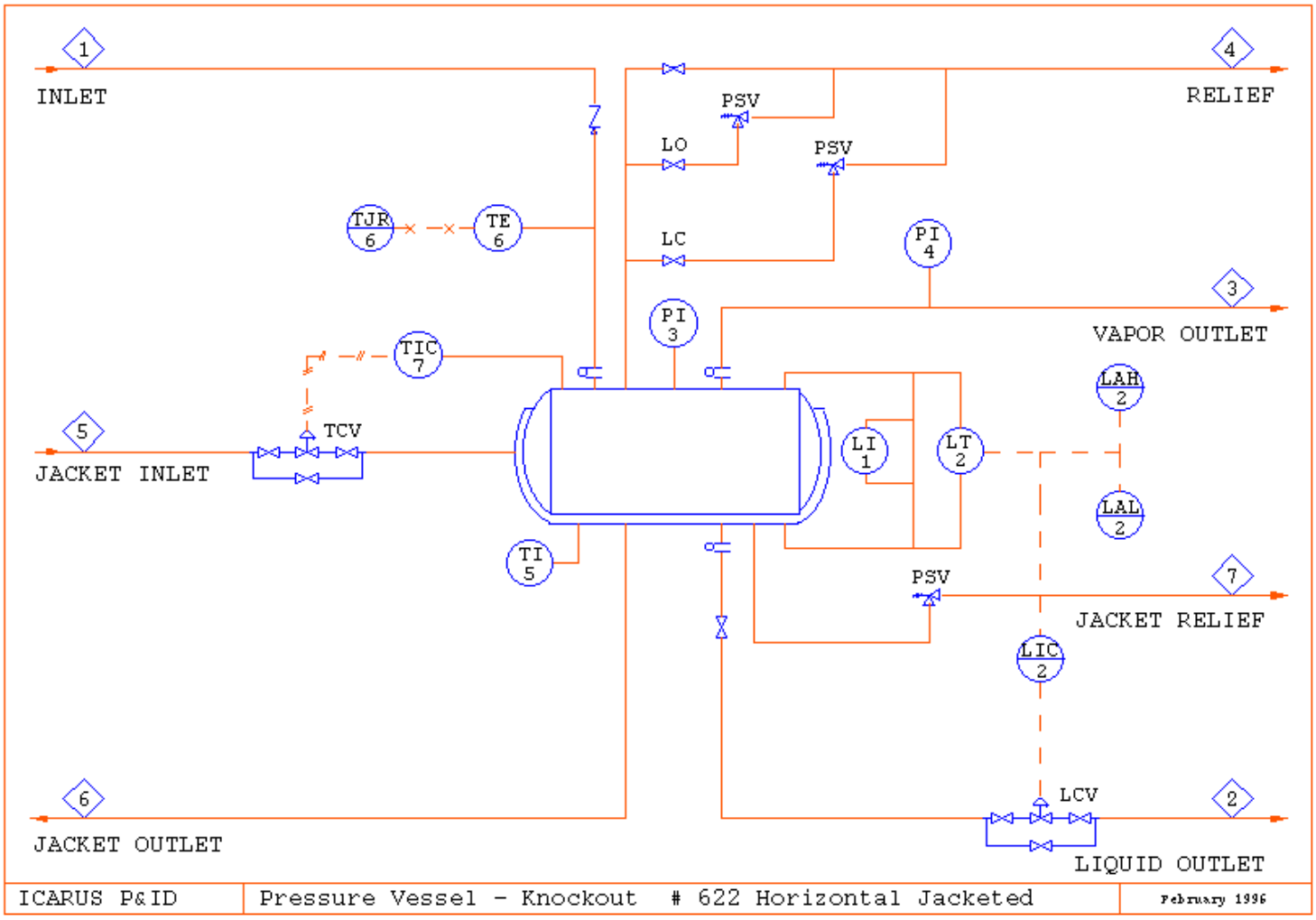
622 Horizontal Pressure Vessel – Knockout



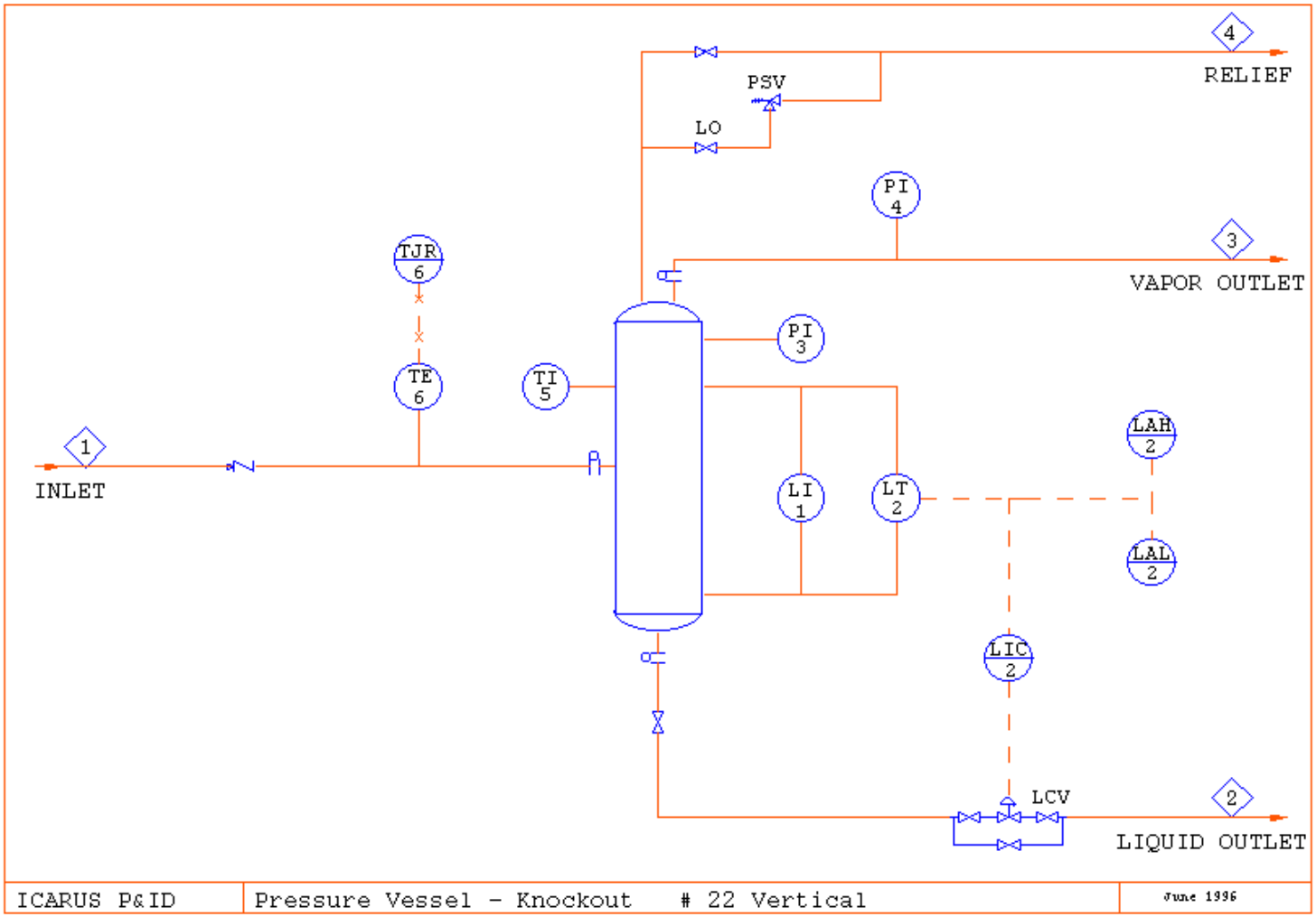
22 Horizontal Jacketed Pressure Vessel – Knockout



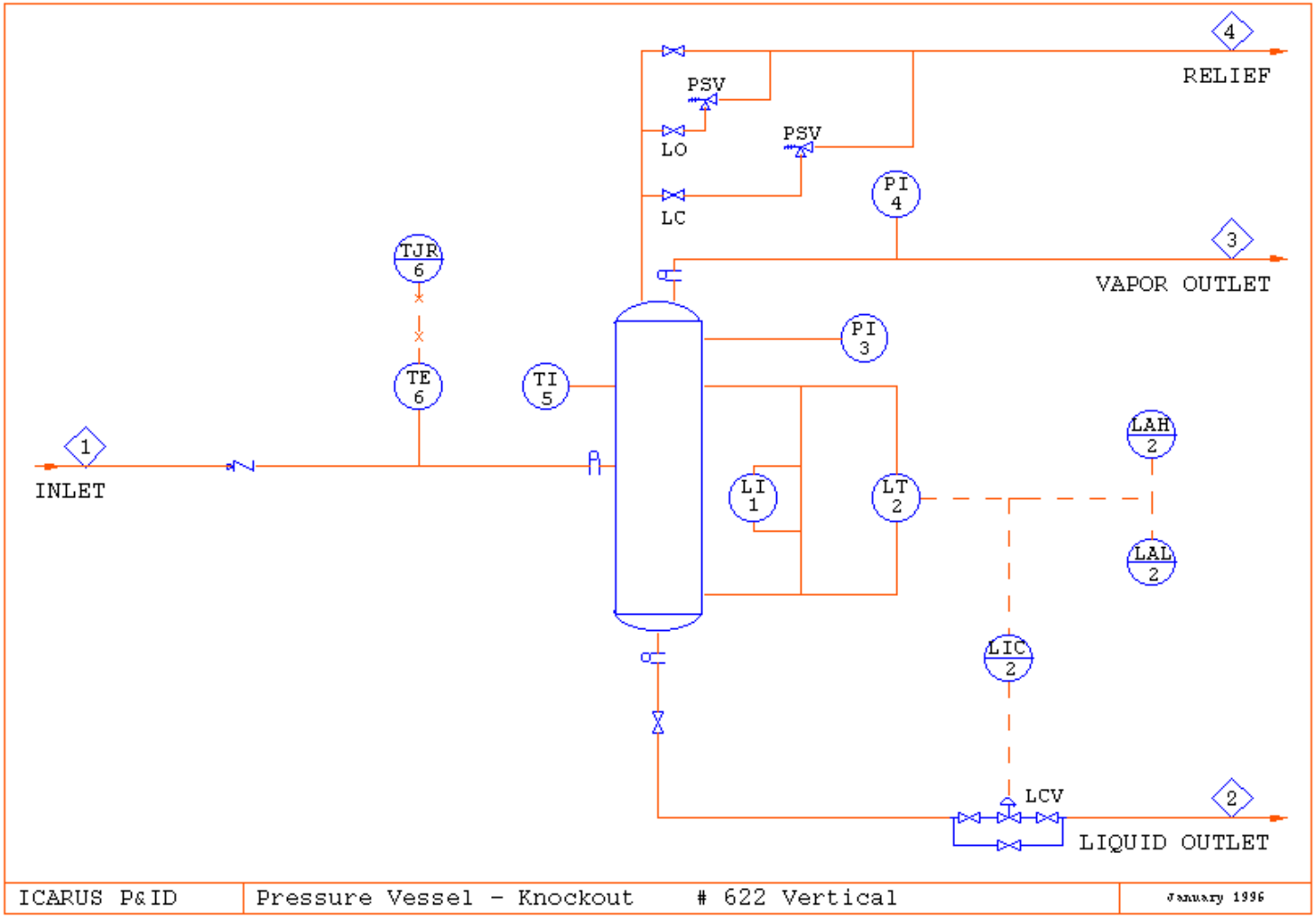
622 Horizontal Jacketed Pressure Vessel – Knockout



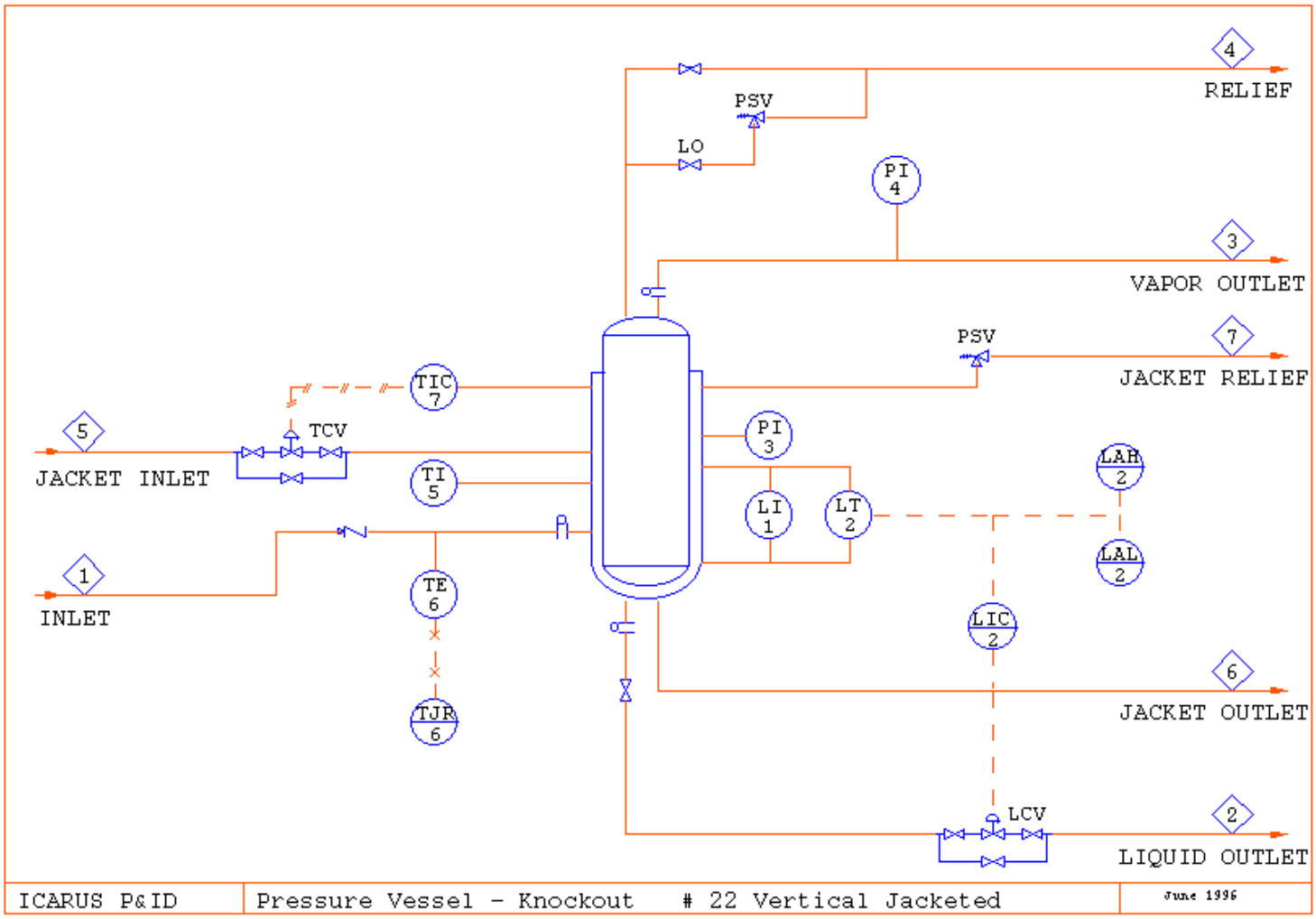
22 Vertical Pressure – Knockout



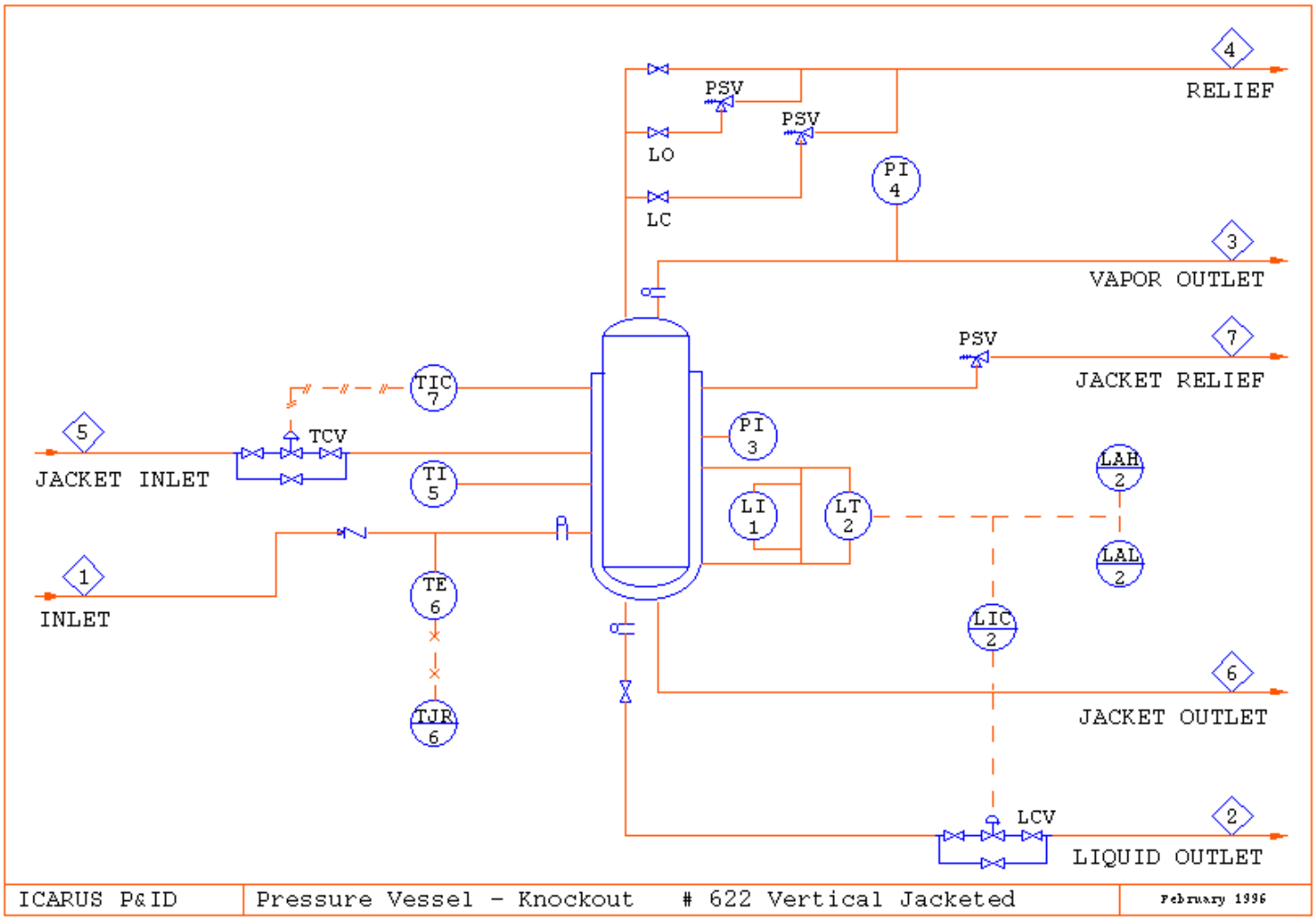
622 Vertical Pressure Vessel – Knockout



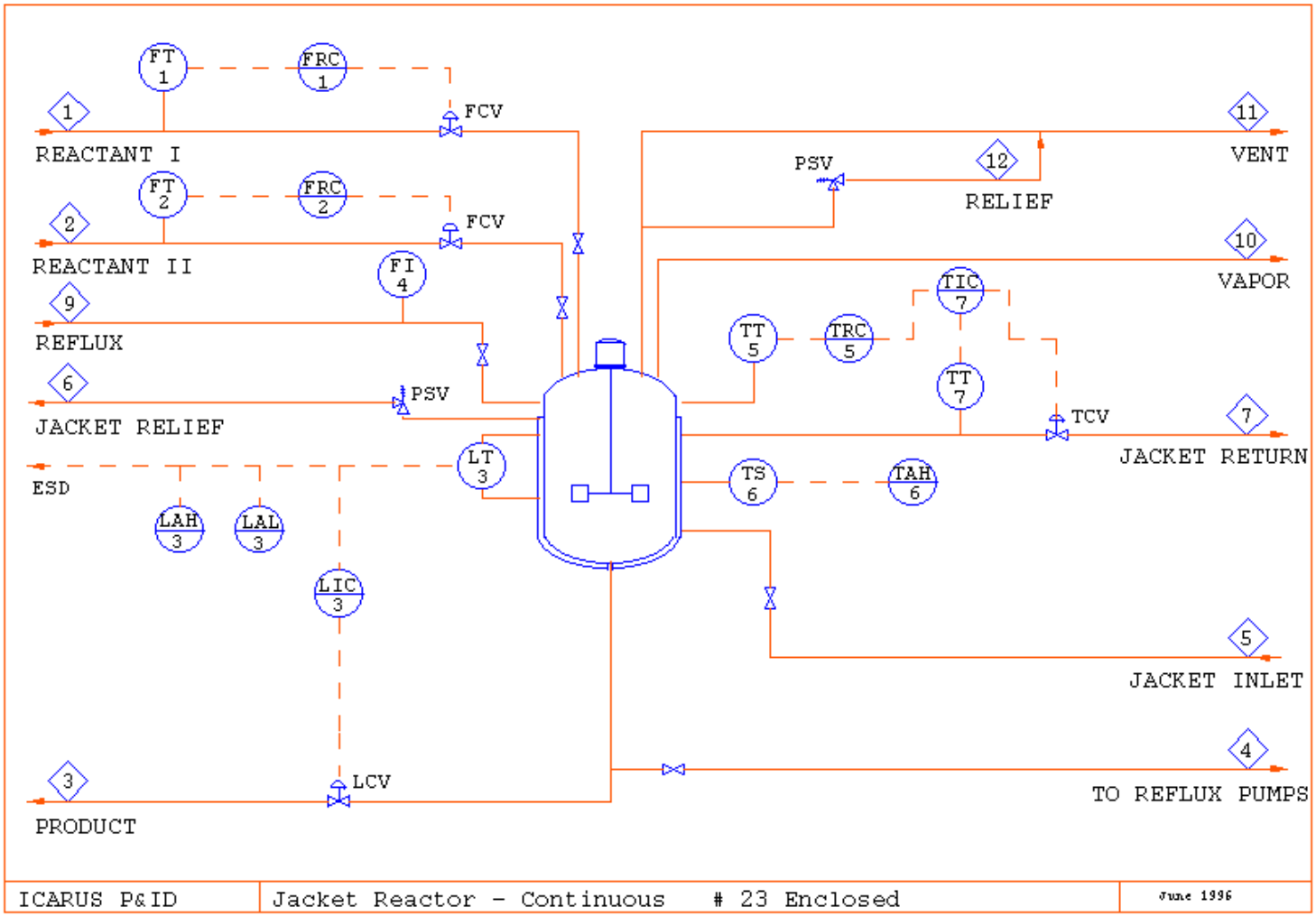
22 Vertical Jacketed Pressure Vessel – Knockout



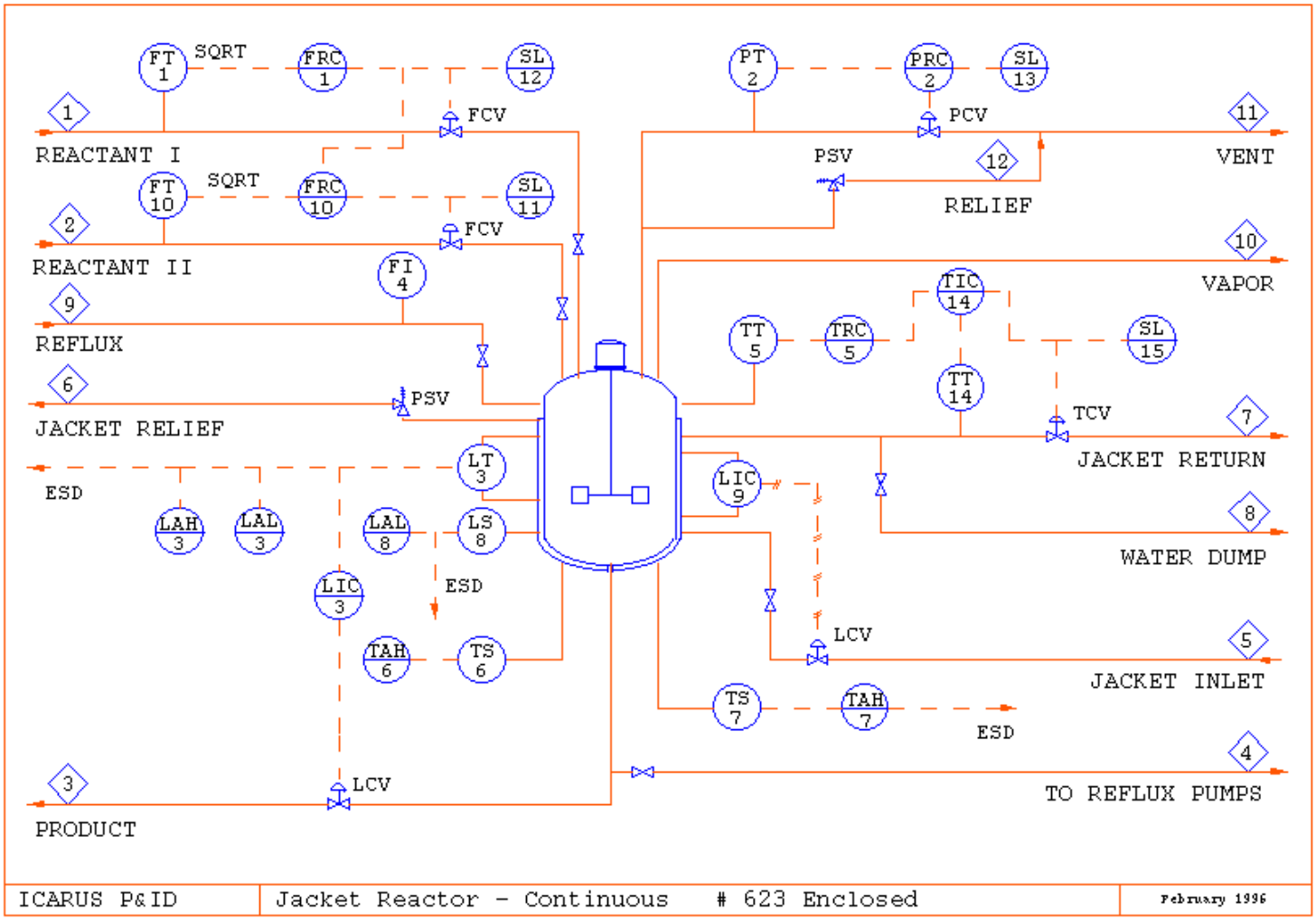
622 Vertical Jacketed Pressure Vessel – Knockout



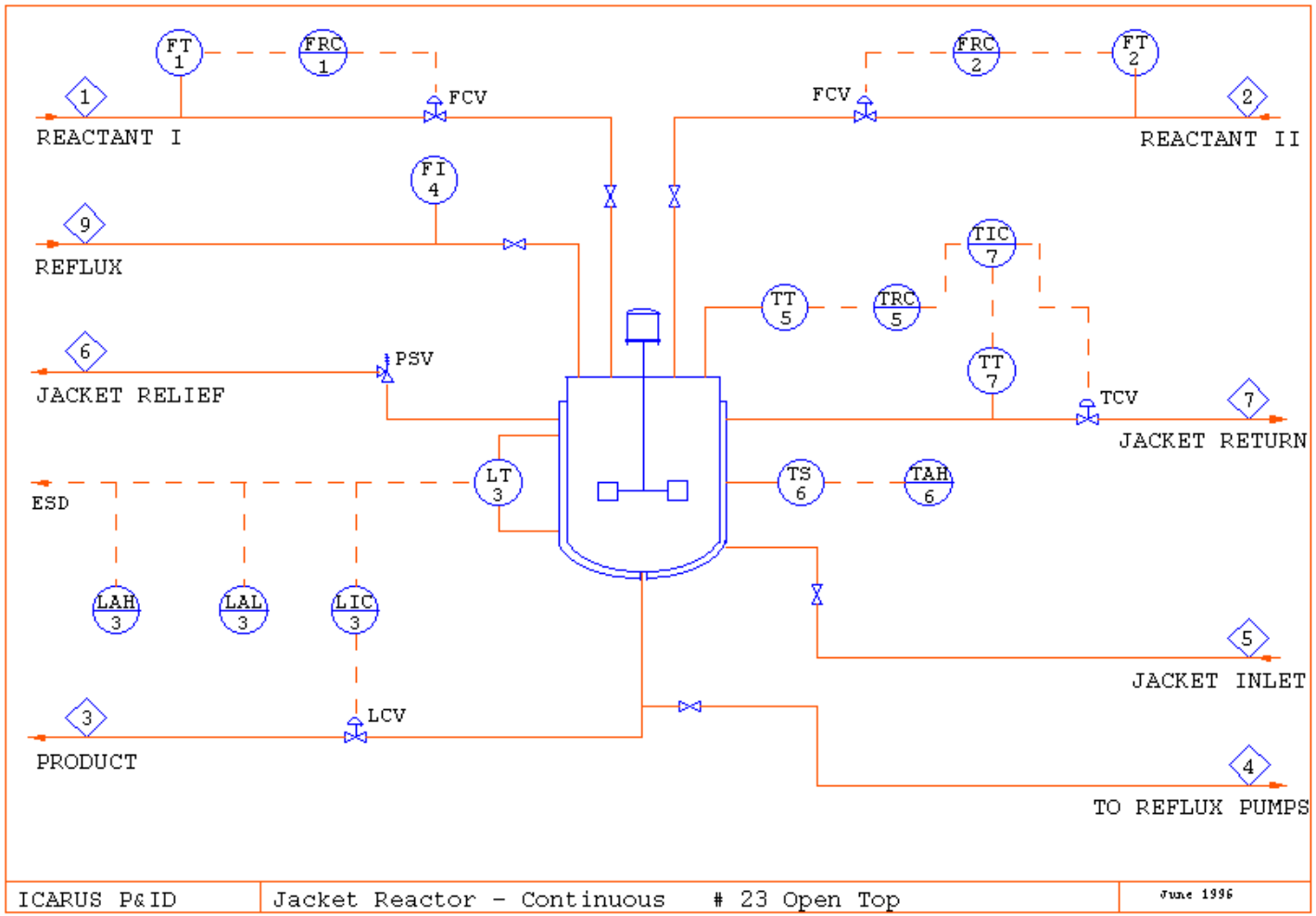
23 Enclosed Jacket Reactor – Continuous



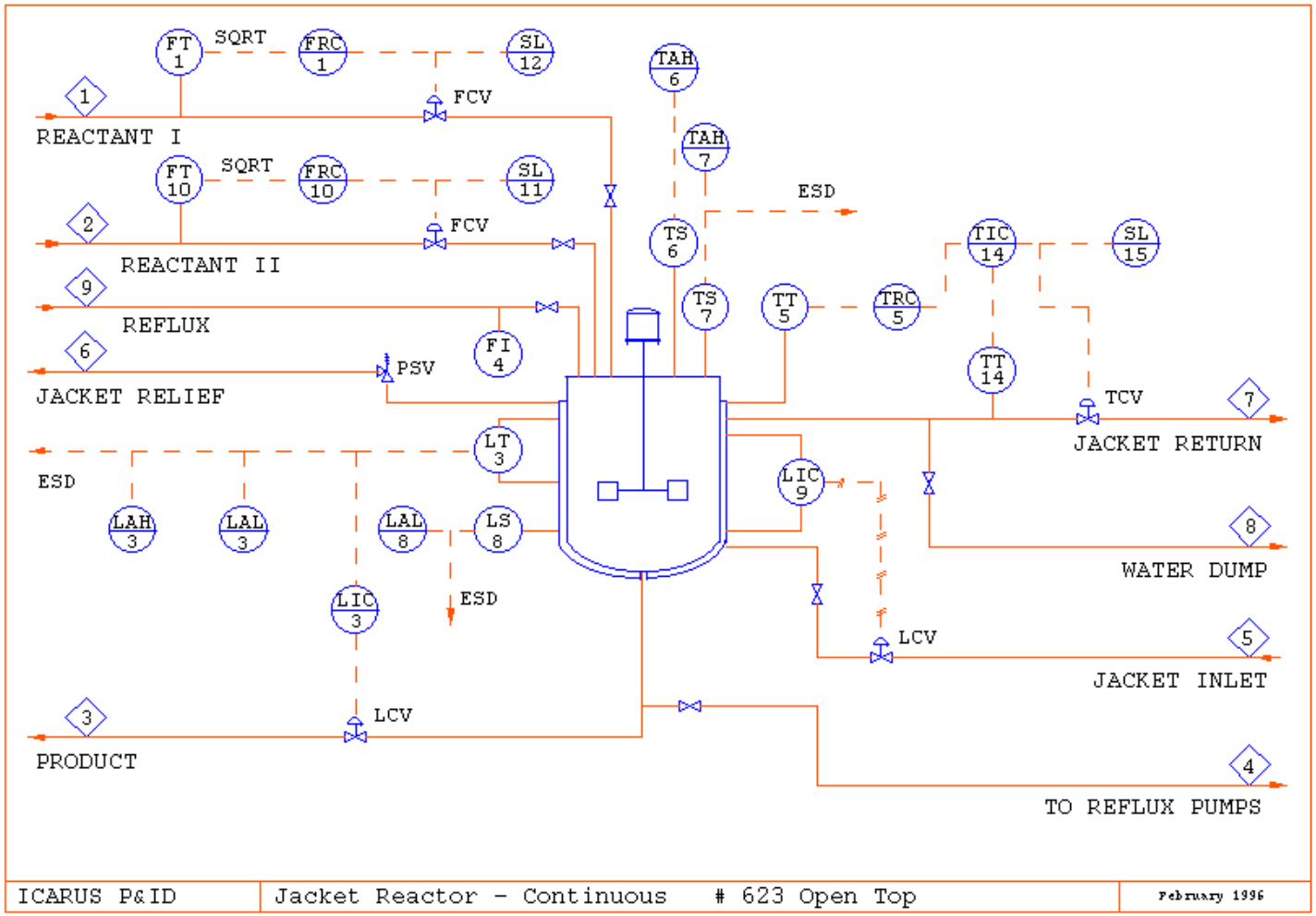
623 Enclosed Jacket Reactor – Continuous



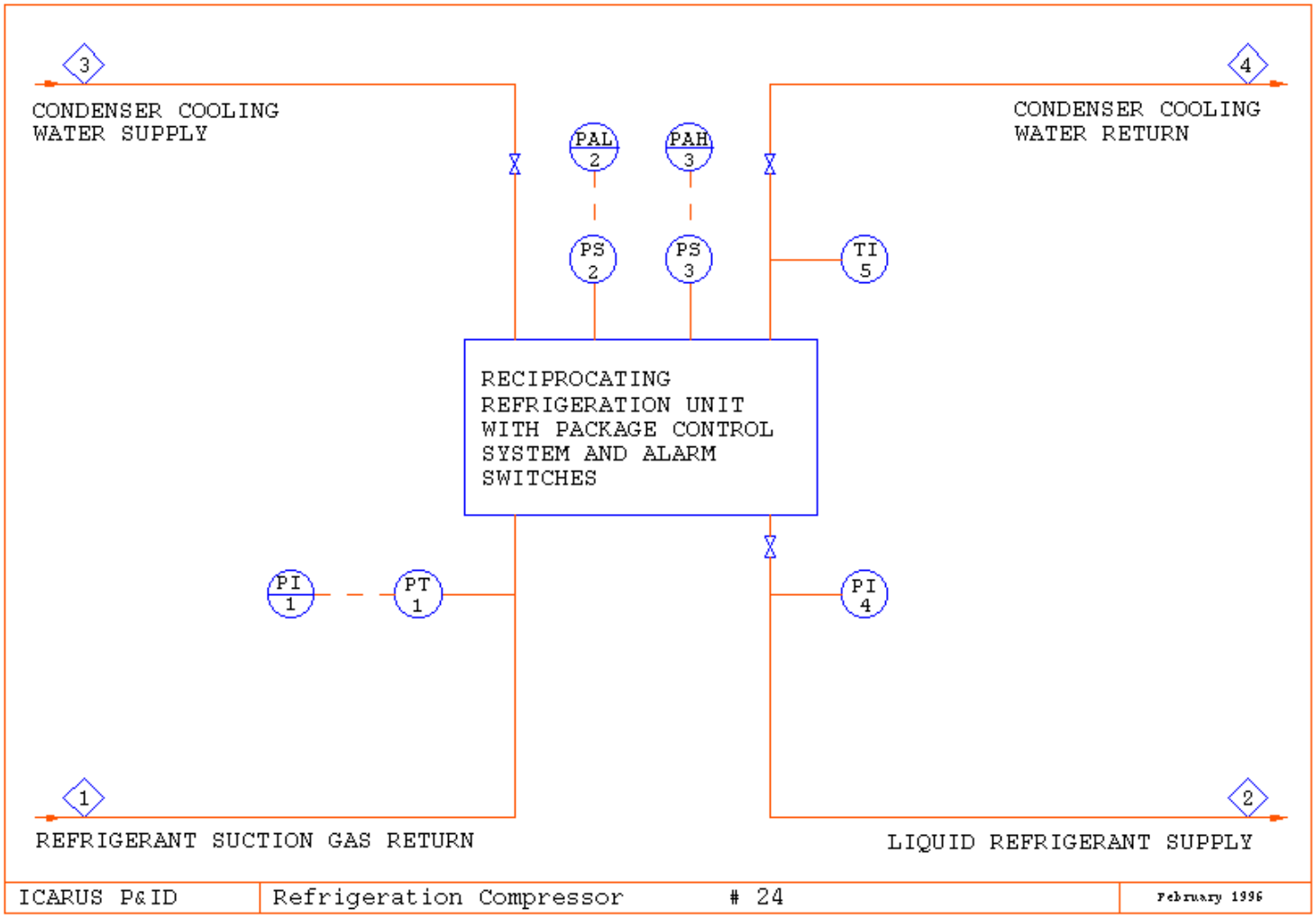
23 Open Top Jacket Reactor – Continuous



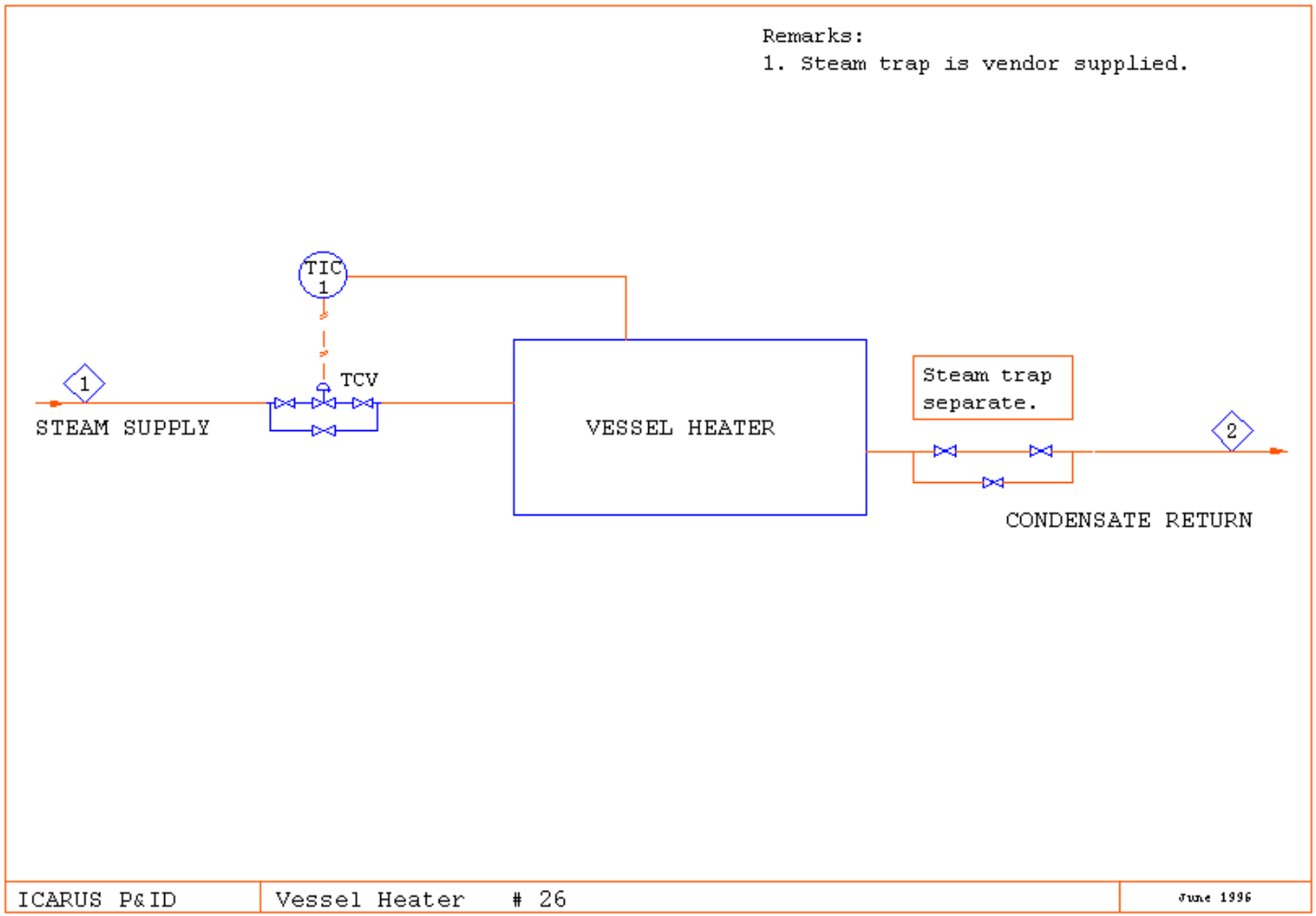
23 Open Top Jacket Reactor – Continuous



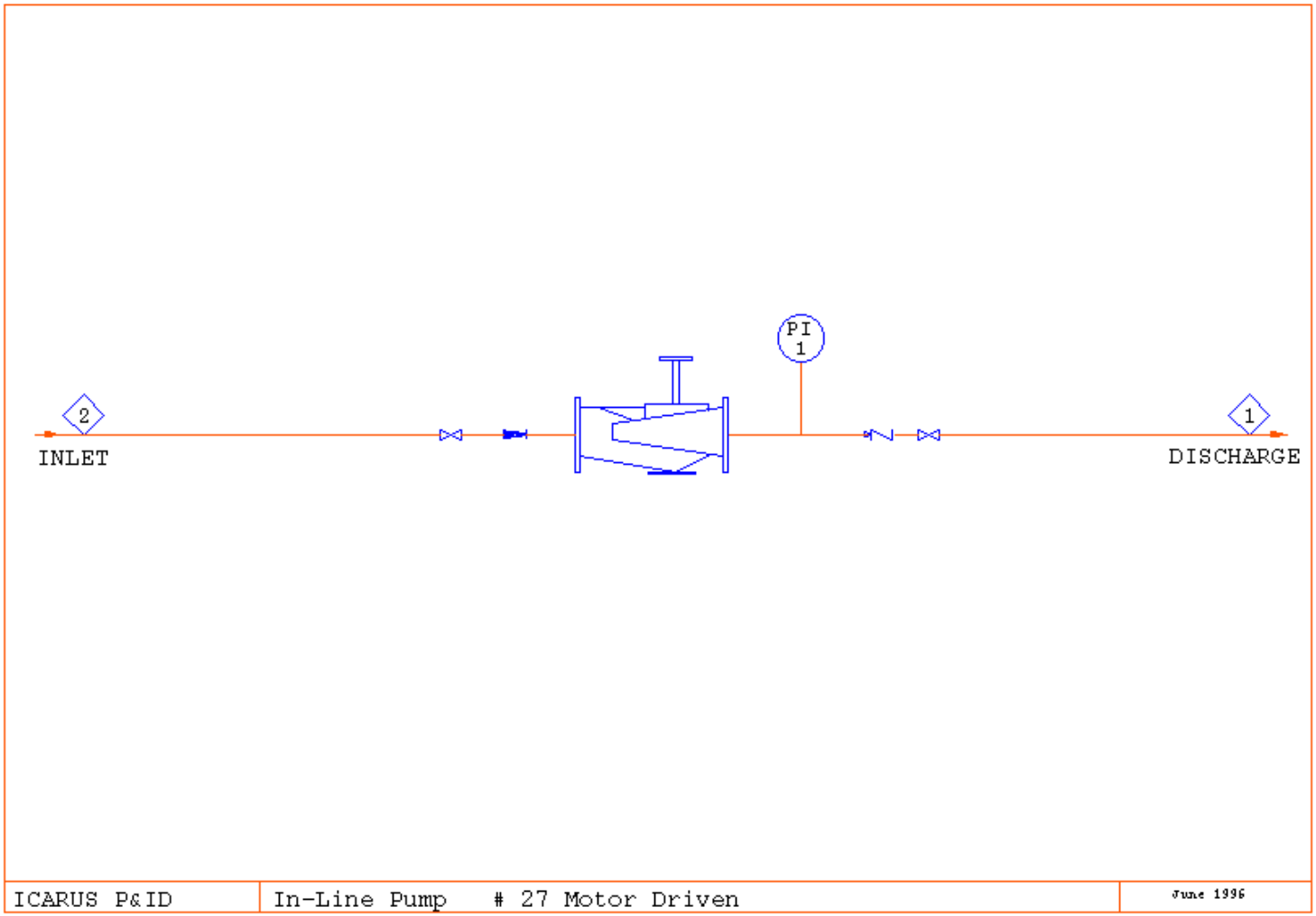
24 Refrigeration Compressor



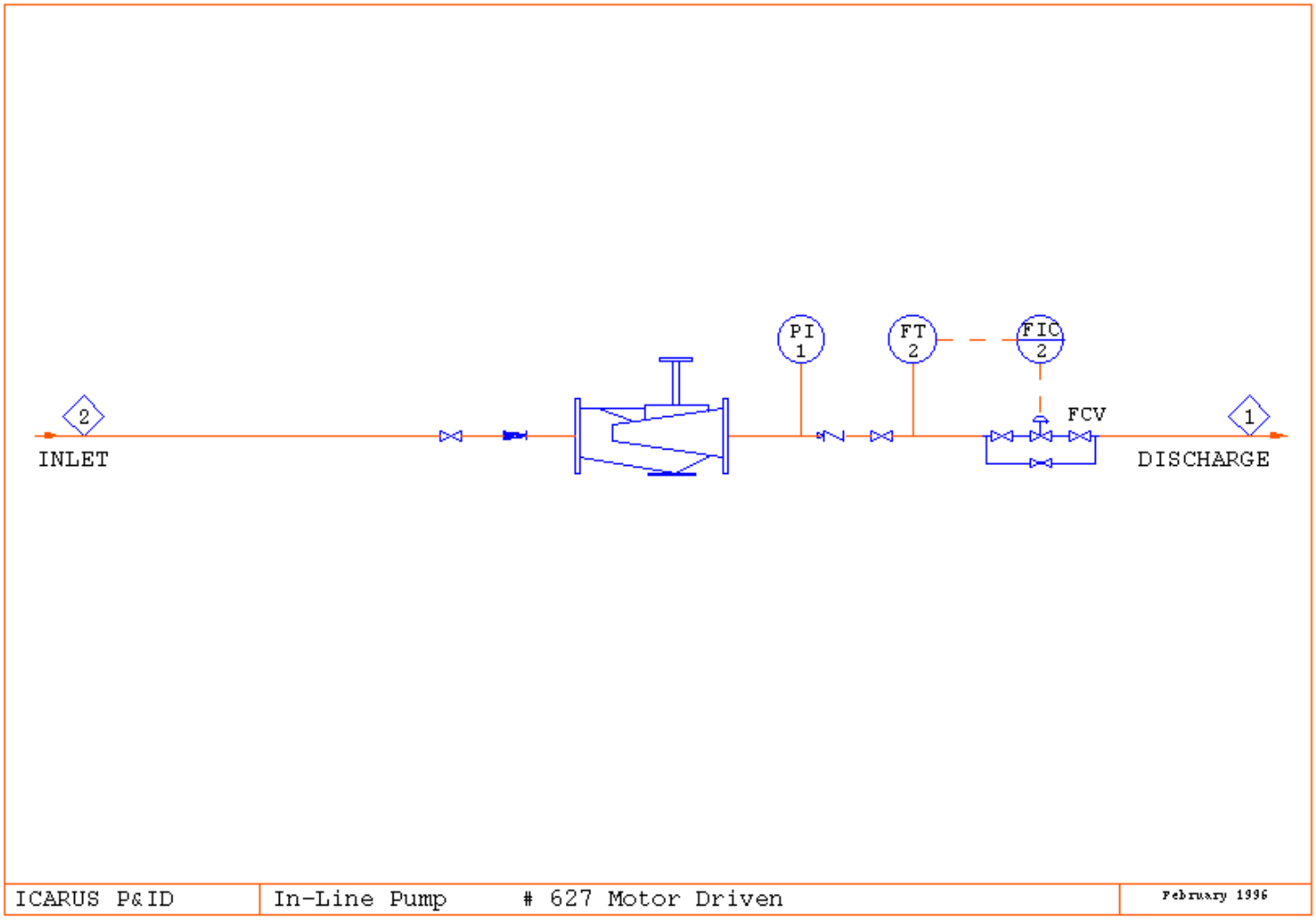
26 Vessel Heater



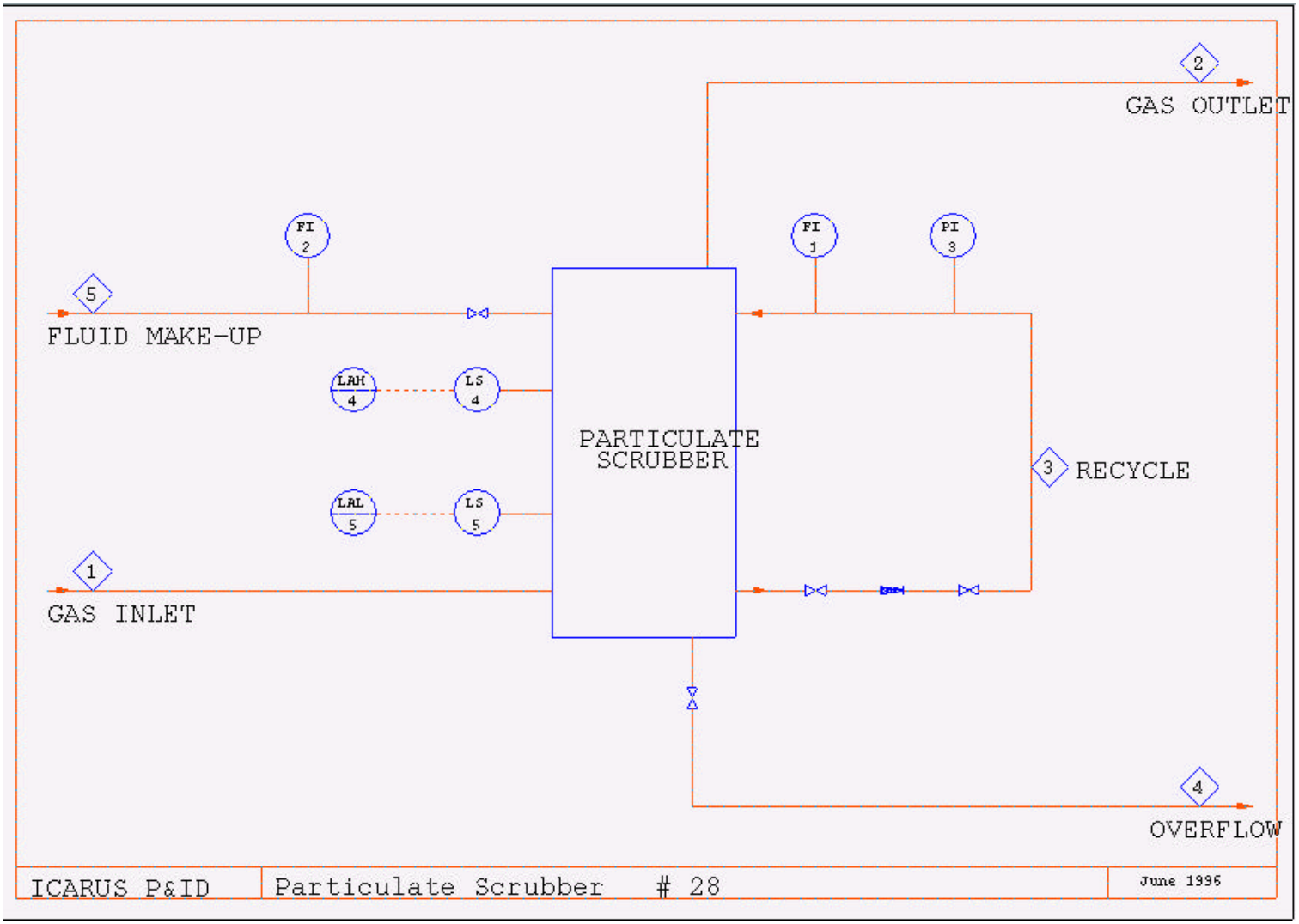
27 Motor Driven In-Line Pump



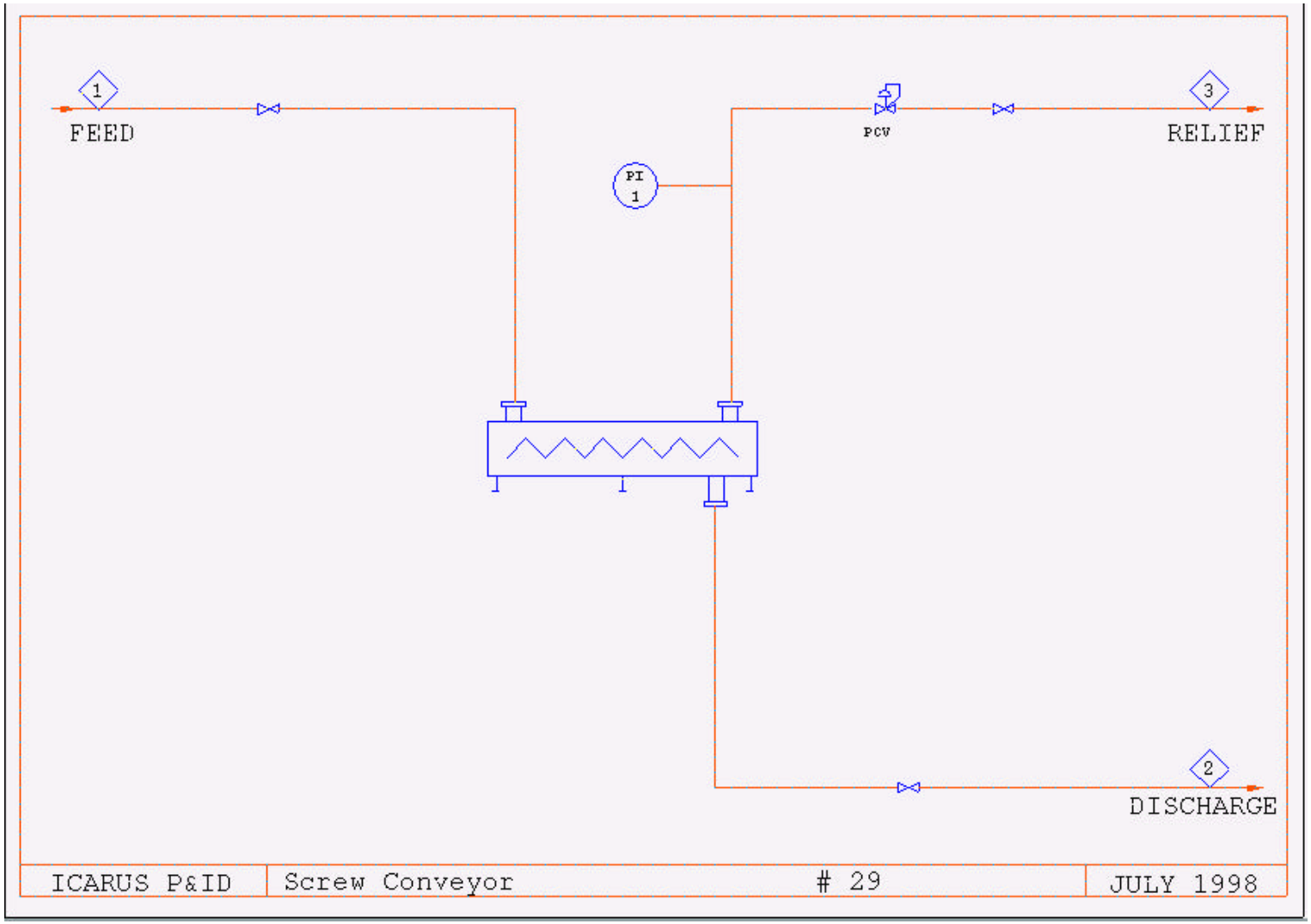
627 Motor Driven In-Line Pump



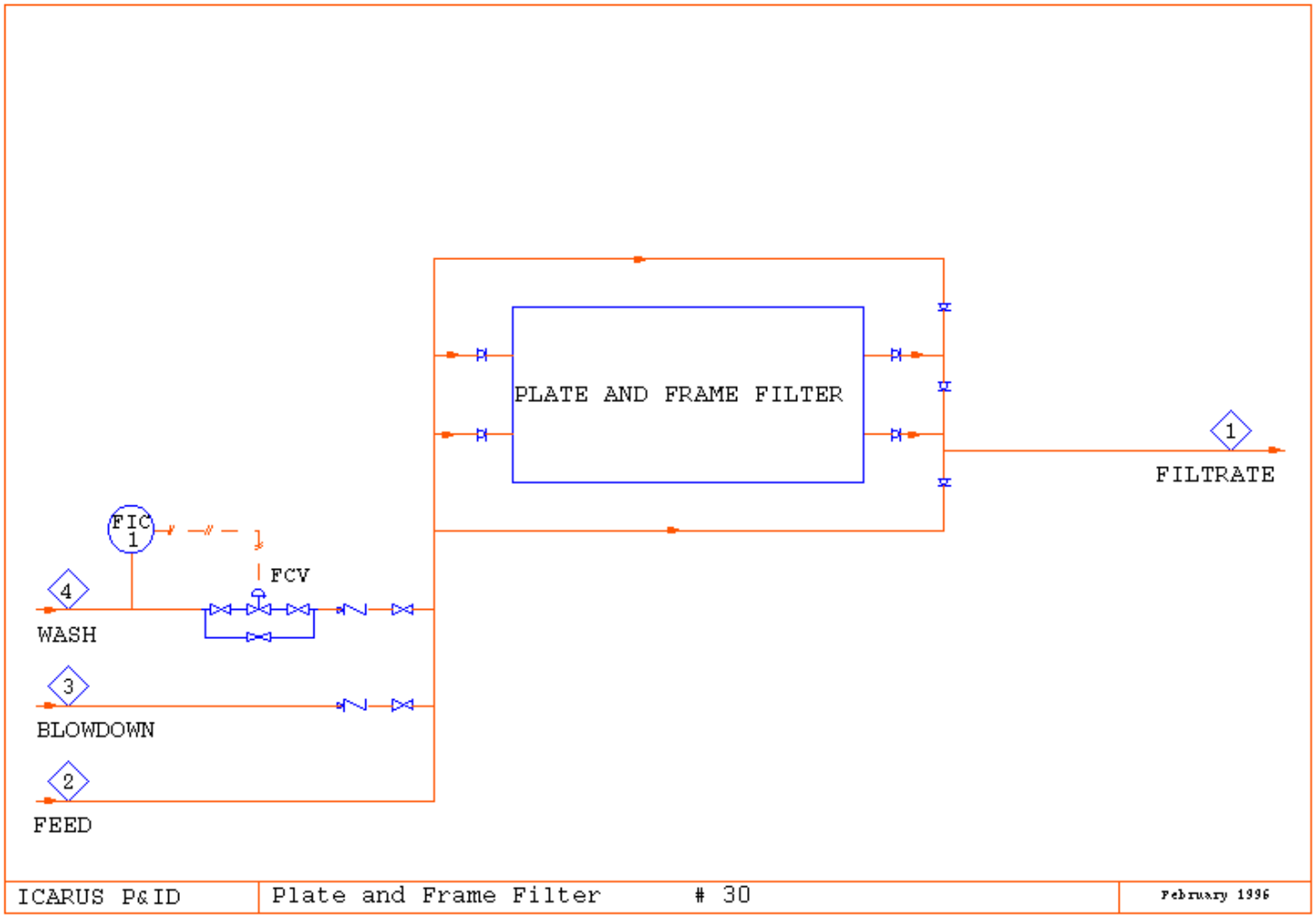
28 Particulate Scrubber



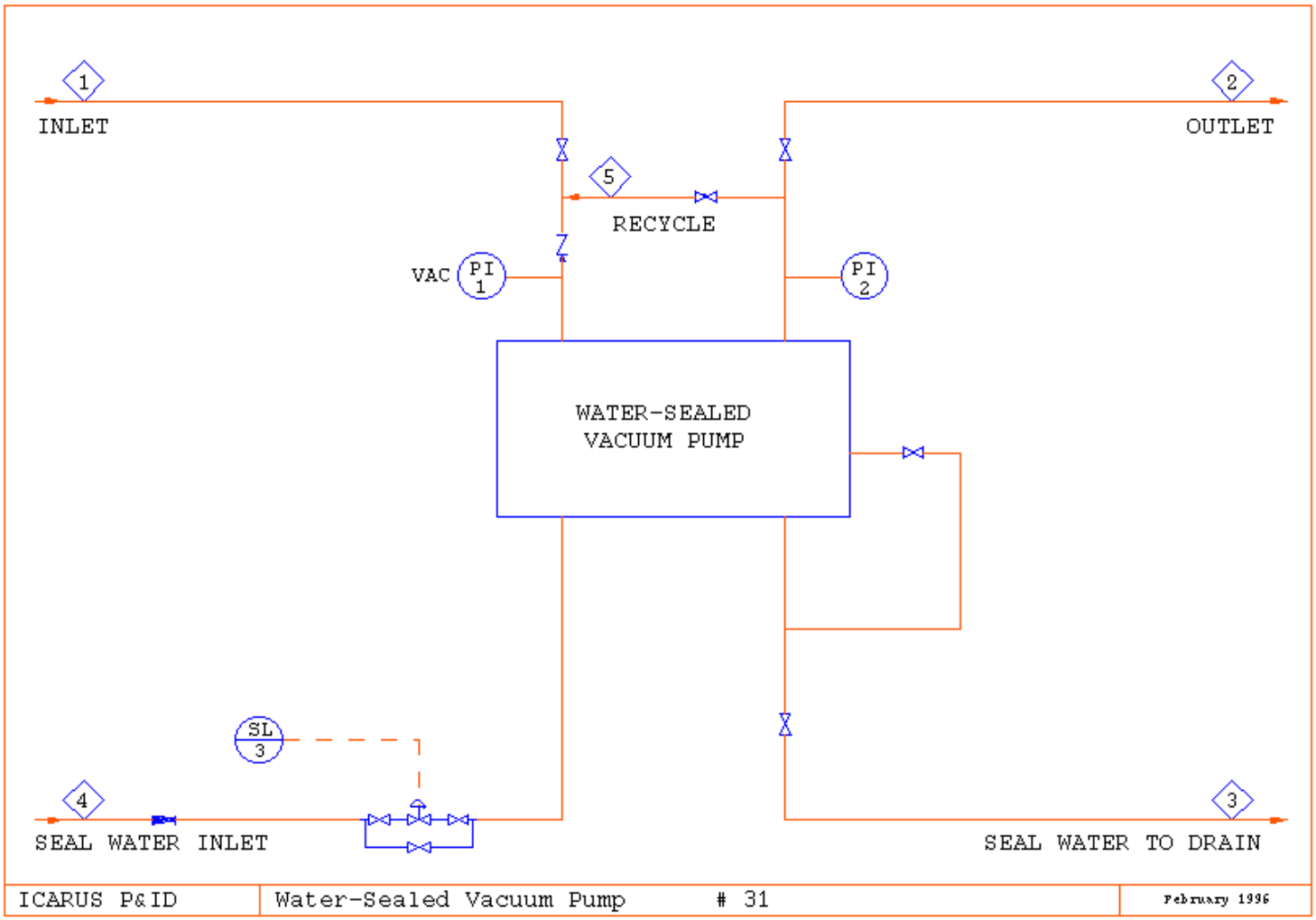
29 Screw Conveyor



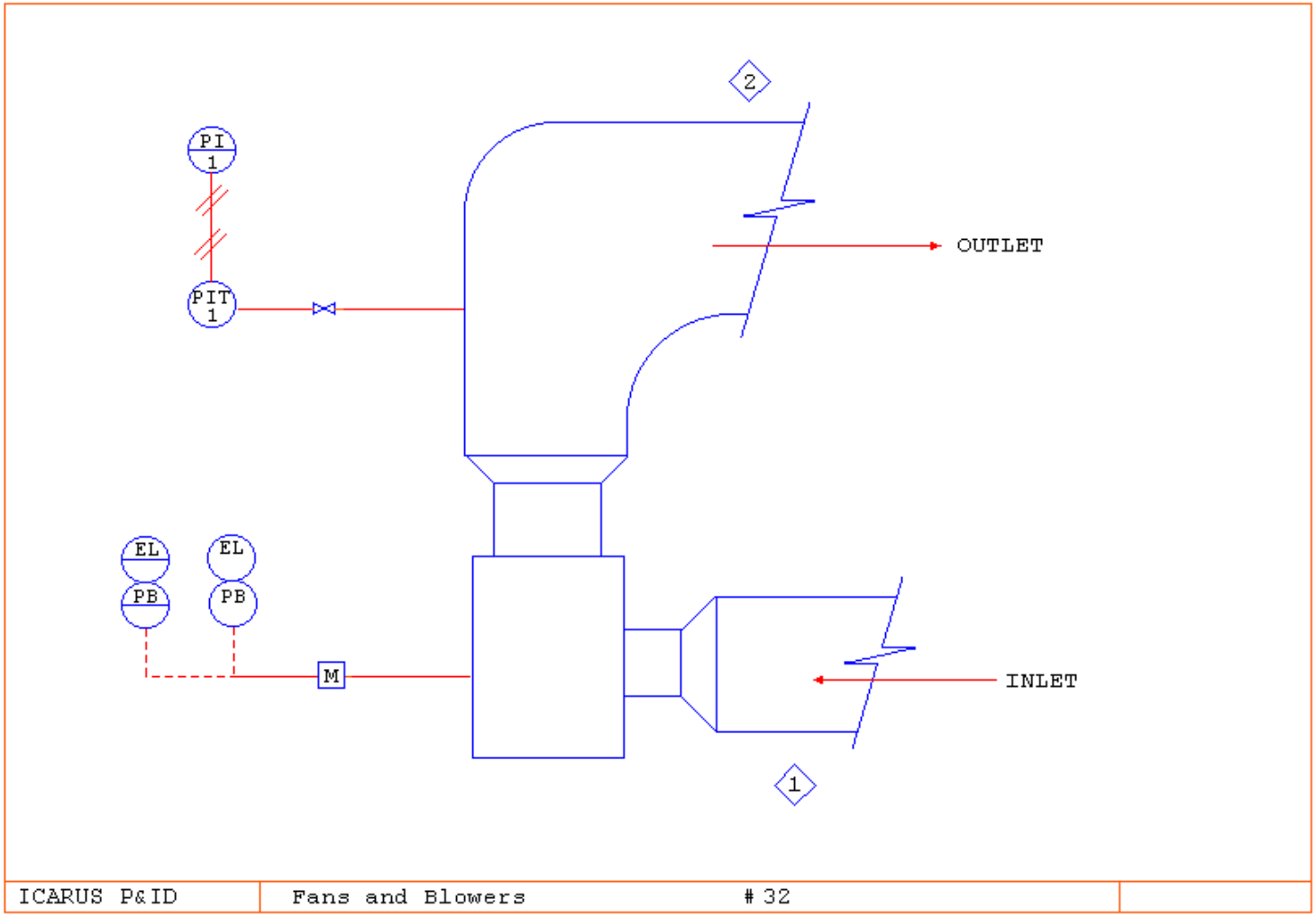
30 Plate and Frame Filter



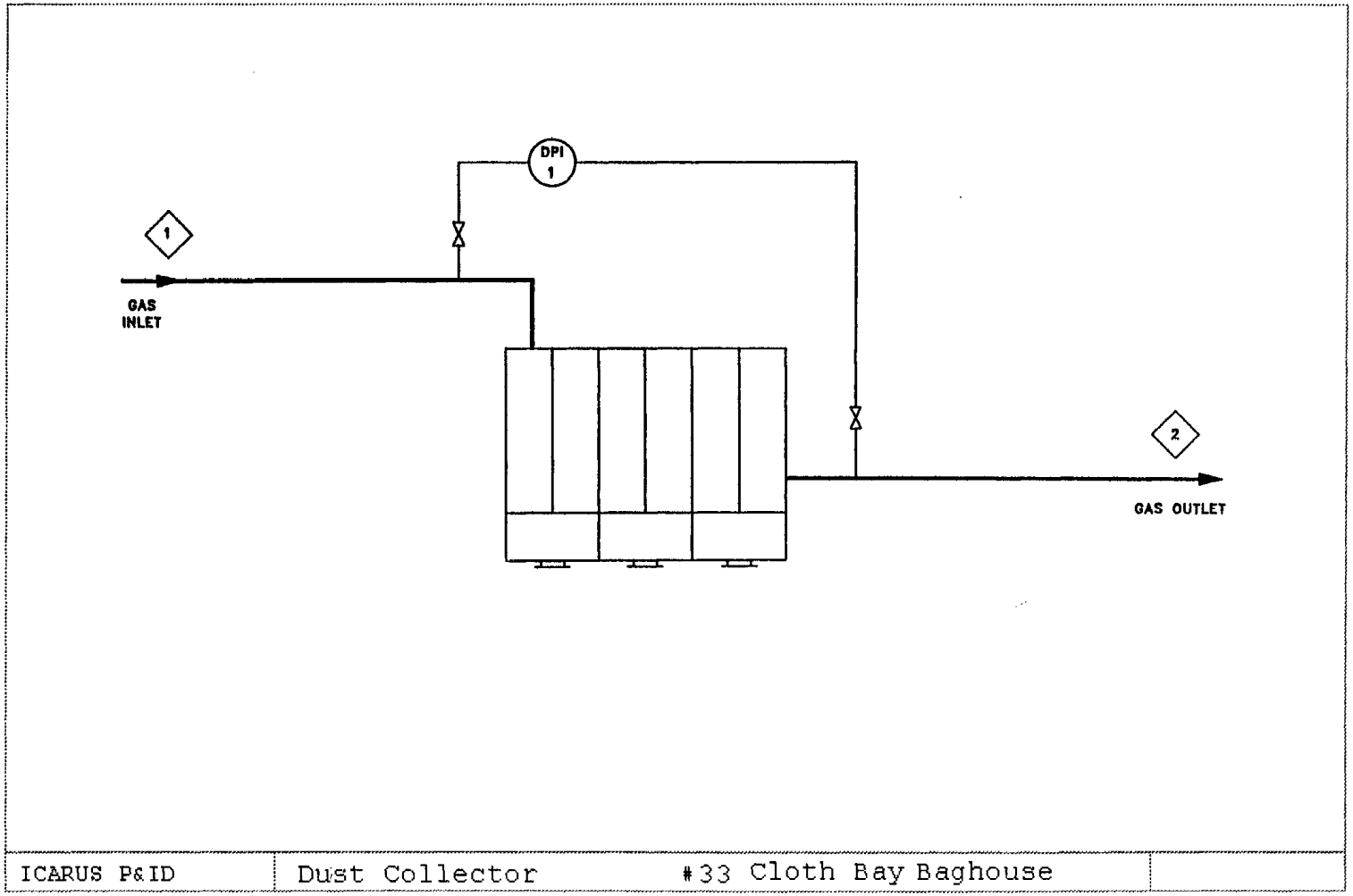
31 Water-Sealed Vacuum Pump



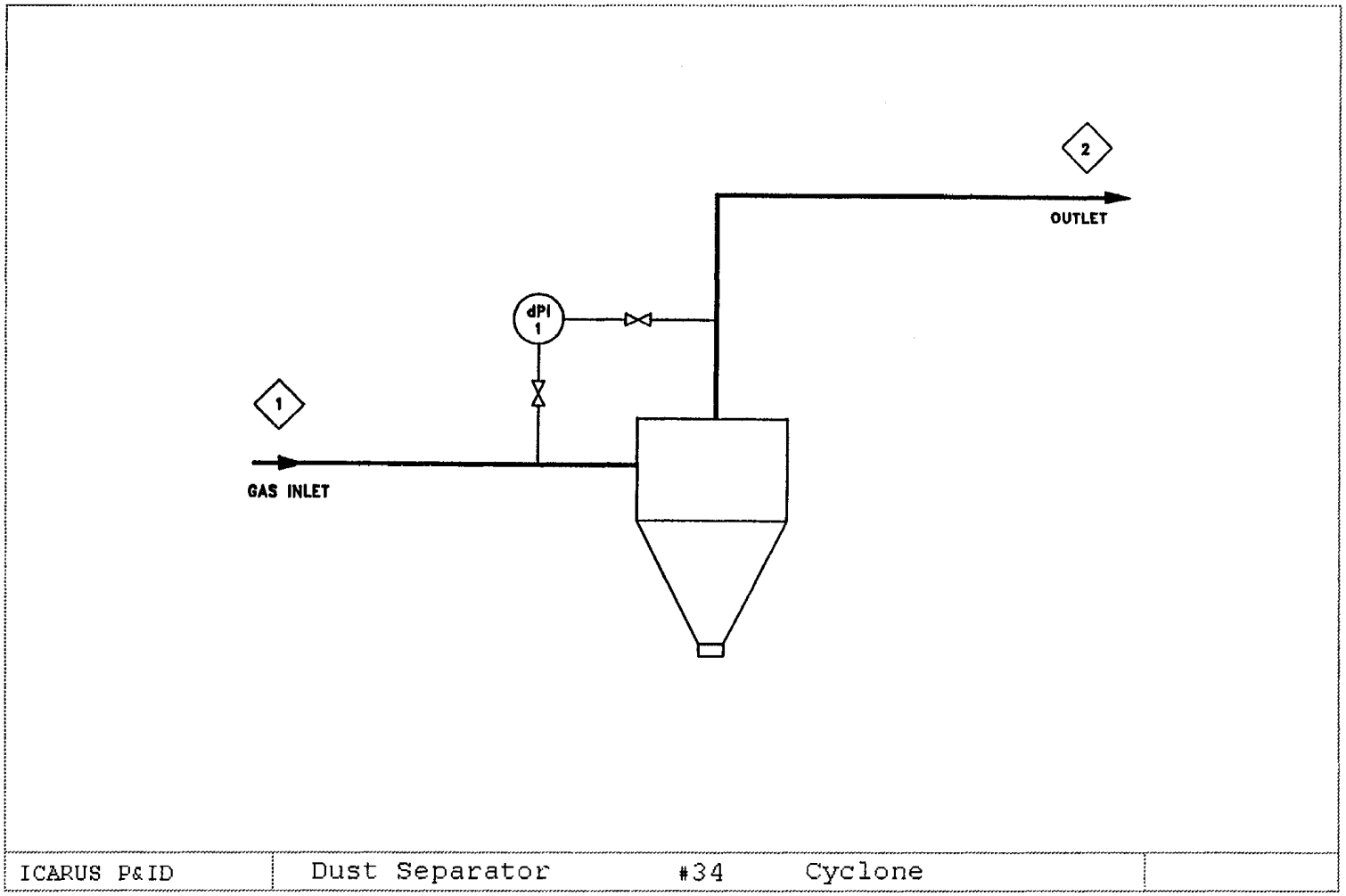
32 Fans and Blowers



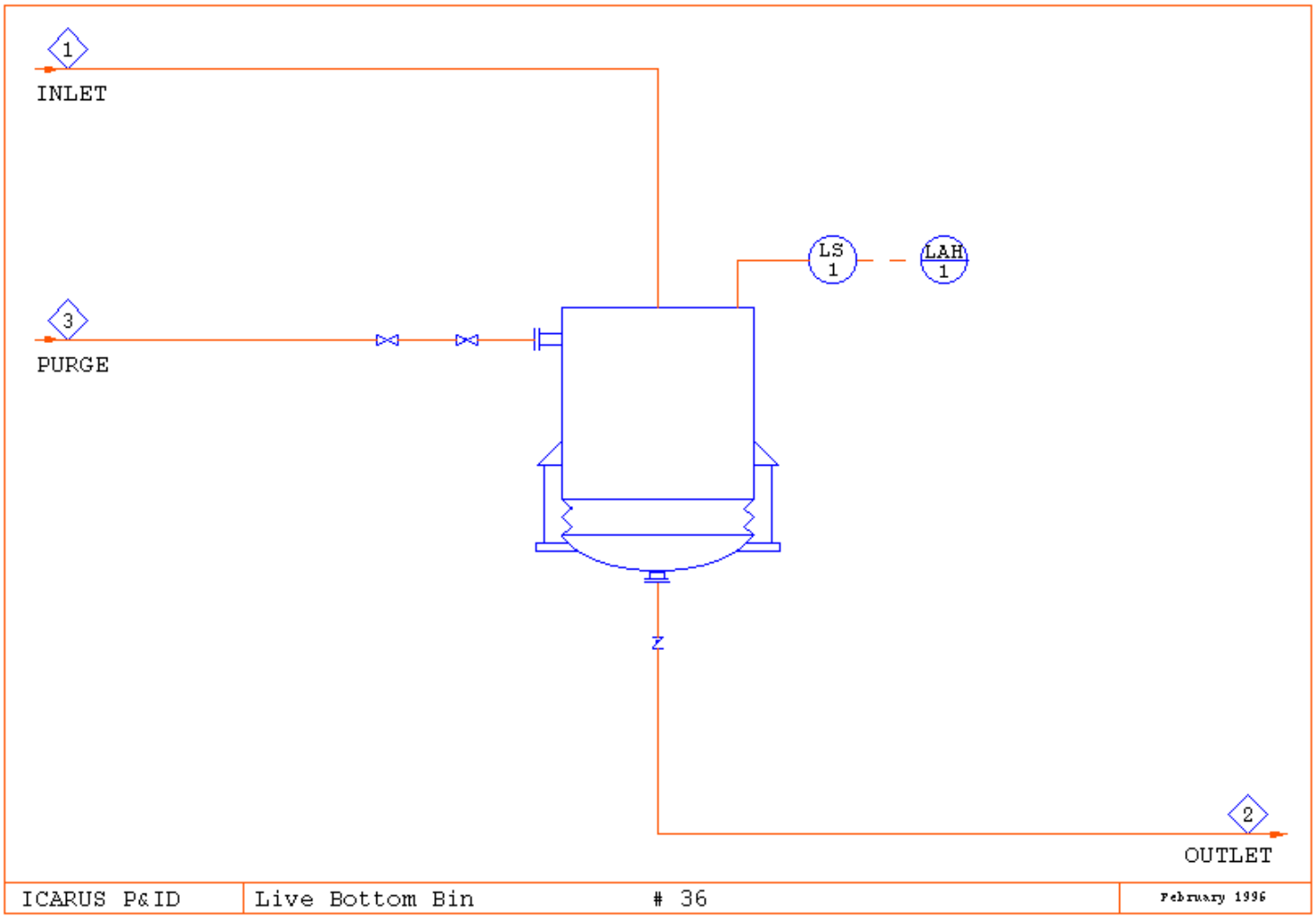
33 Cloth Bay Baghouse Dust Collector



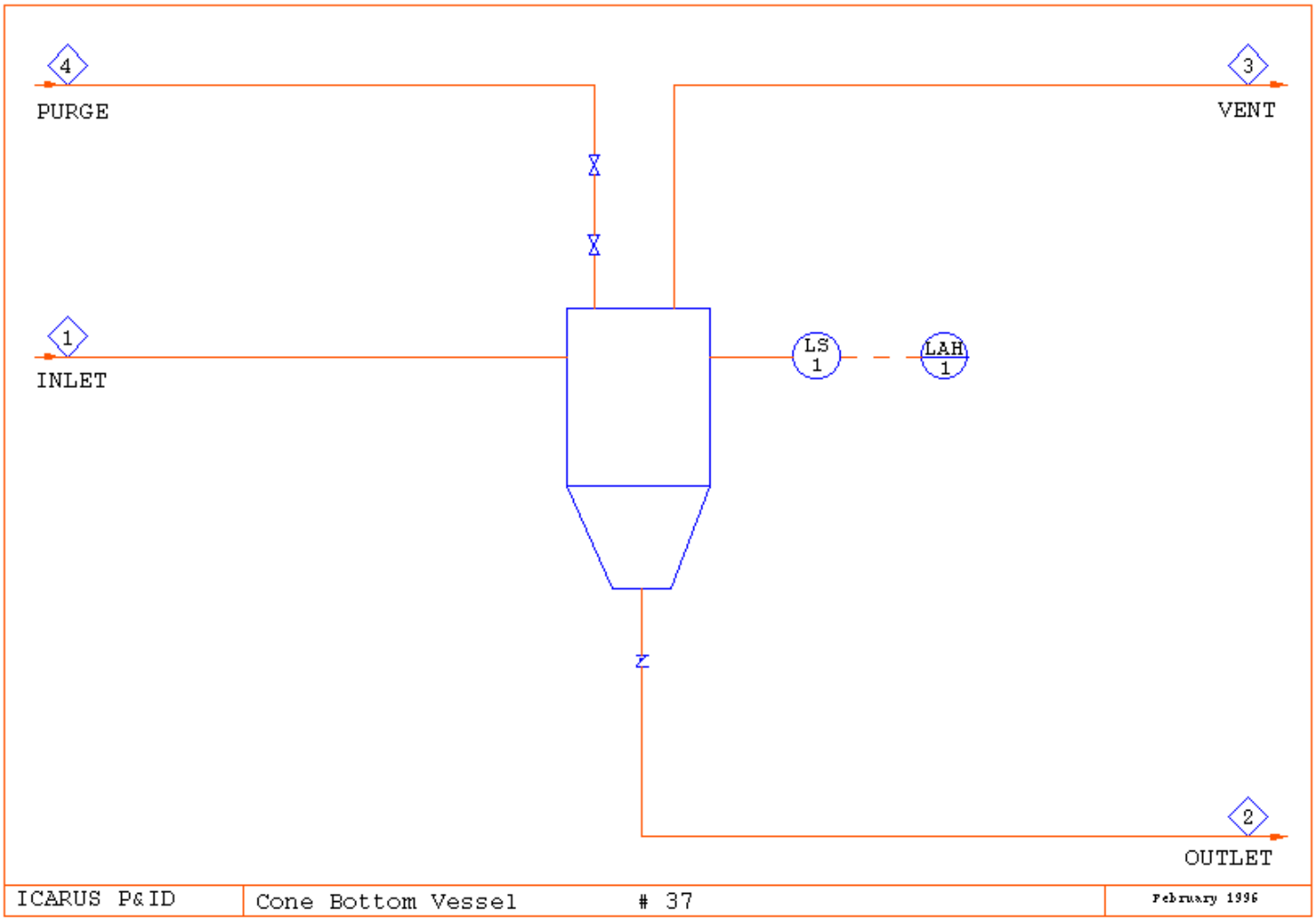
34 Cyclone Dust Collector



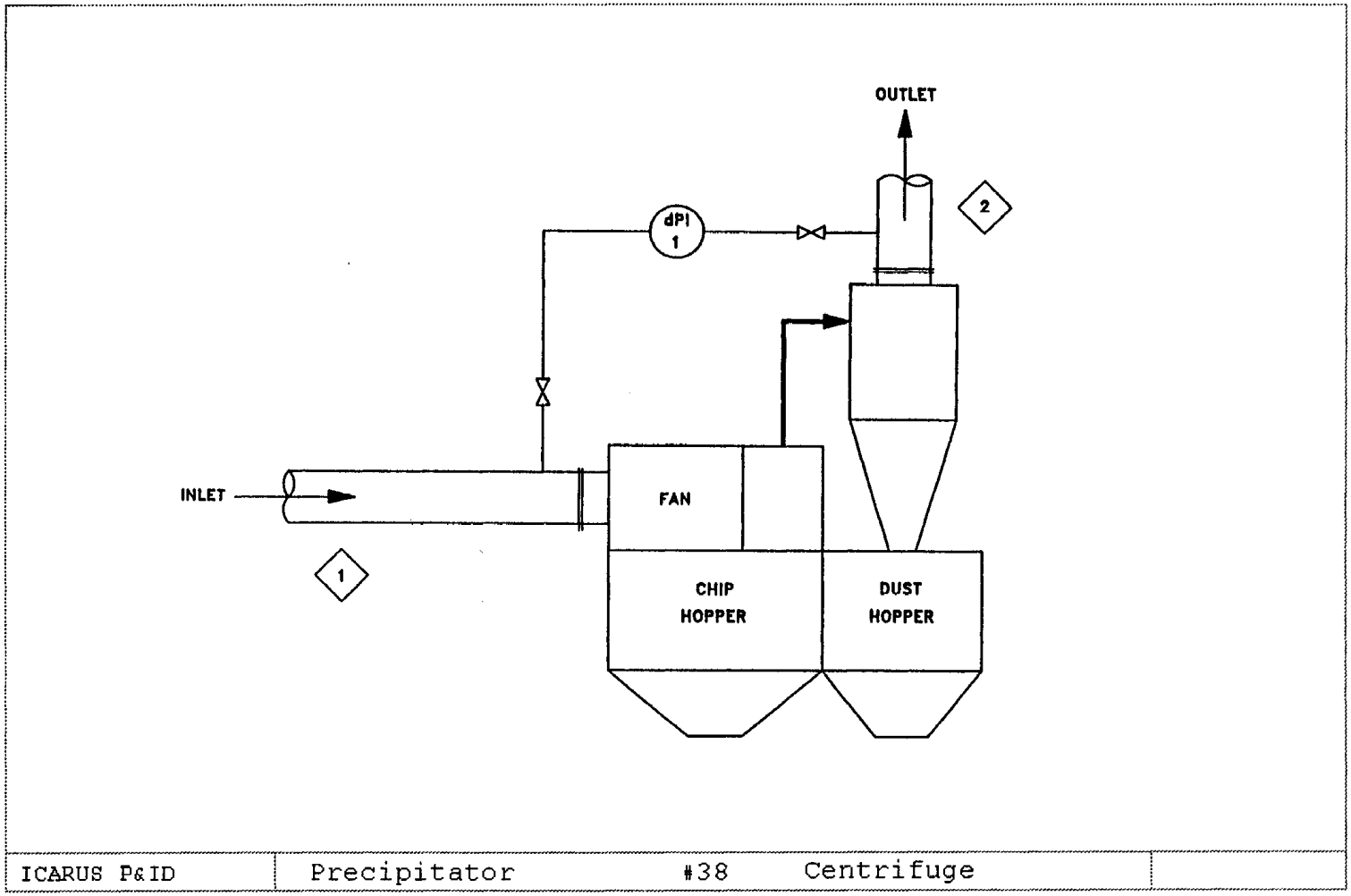
36 Live Bottom Bin



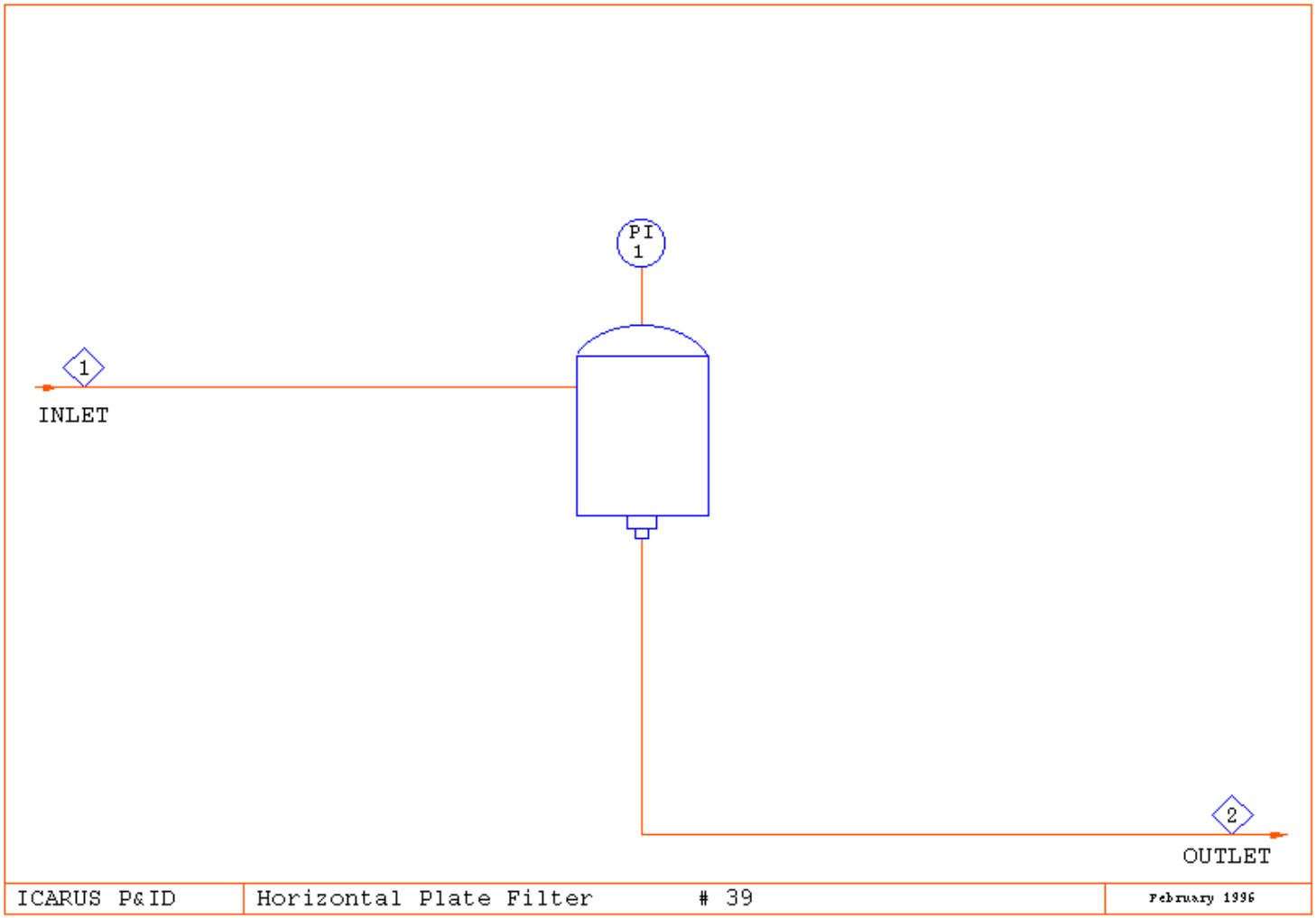
37 Cone Bottom Vessel



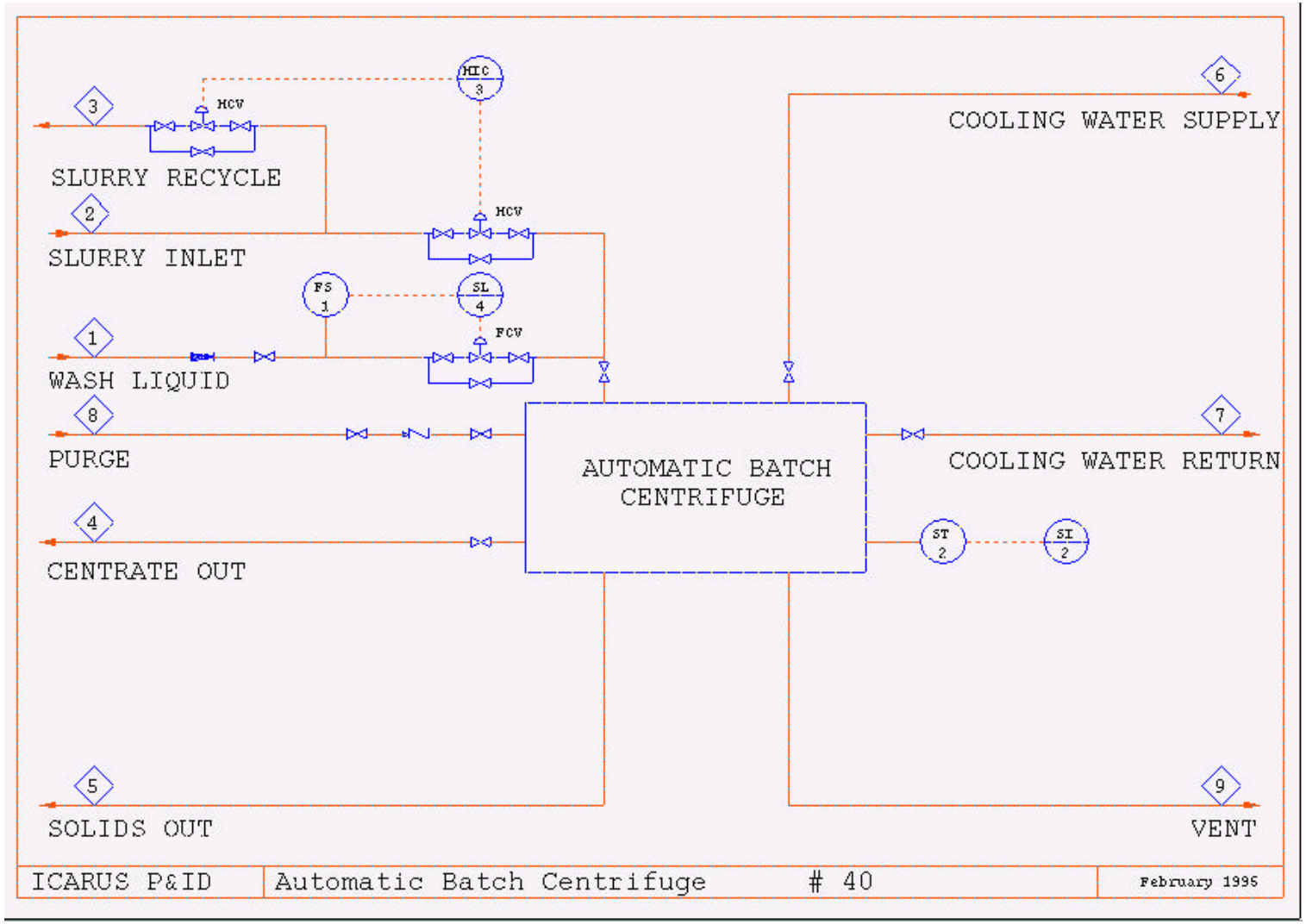
38 Centrifuge Precipitator



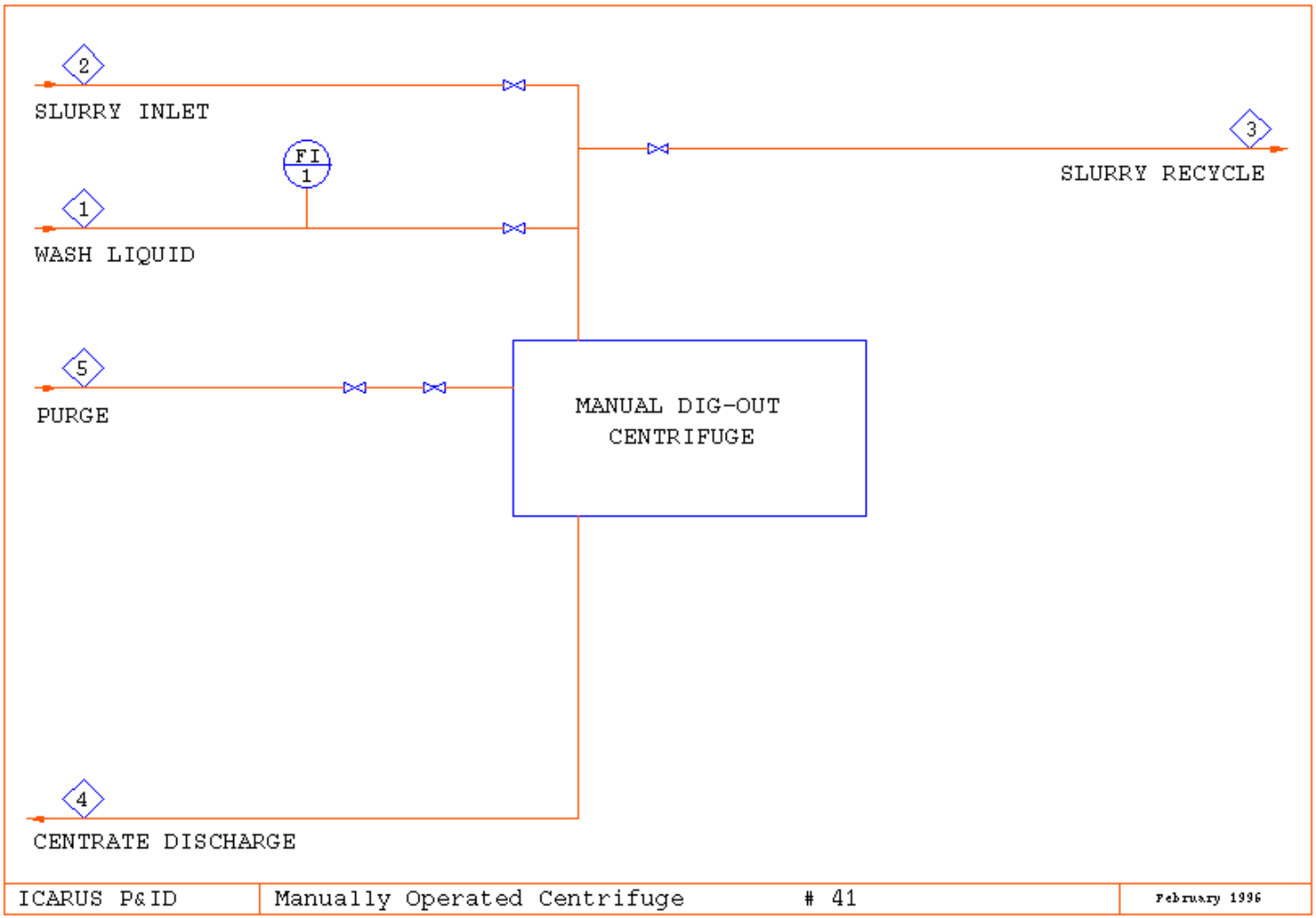
39 Horizontal Plate Filter



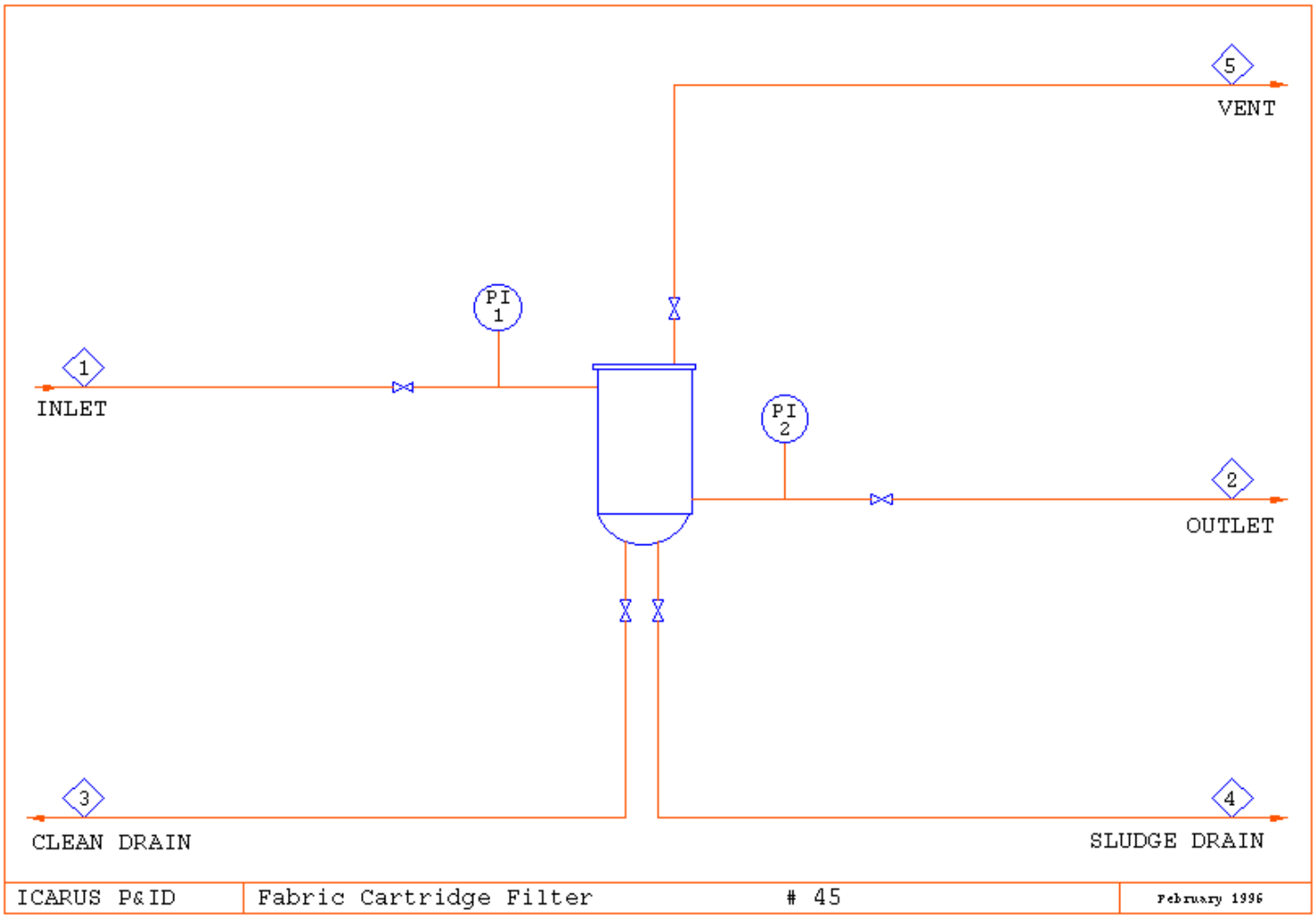
40 Automatic Batch Centrifuge



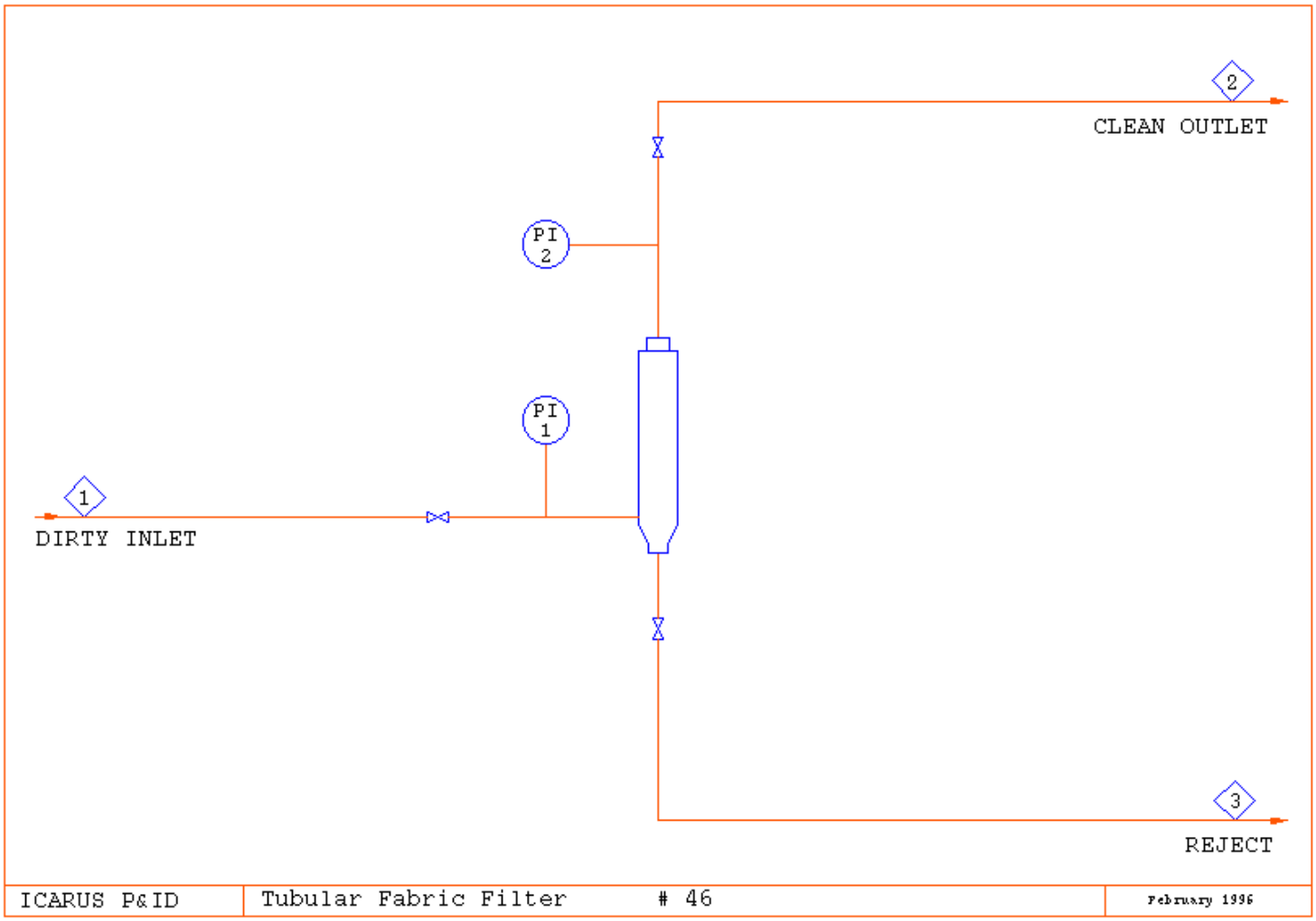
41 Manually Operated Centrifuge



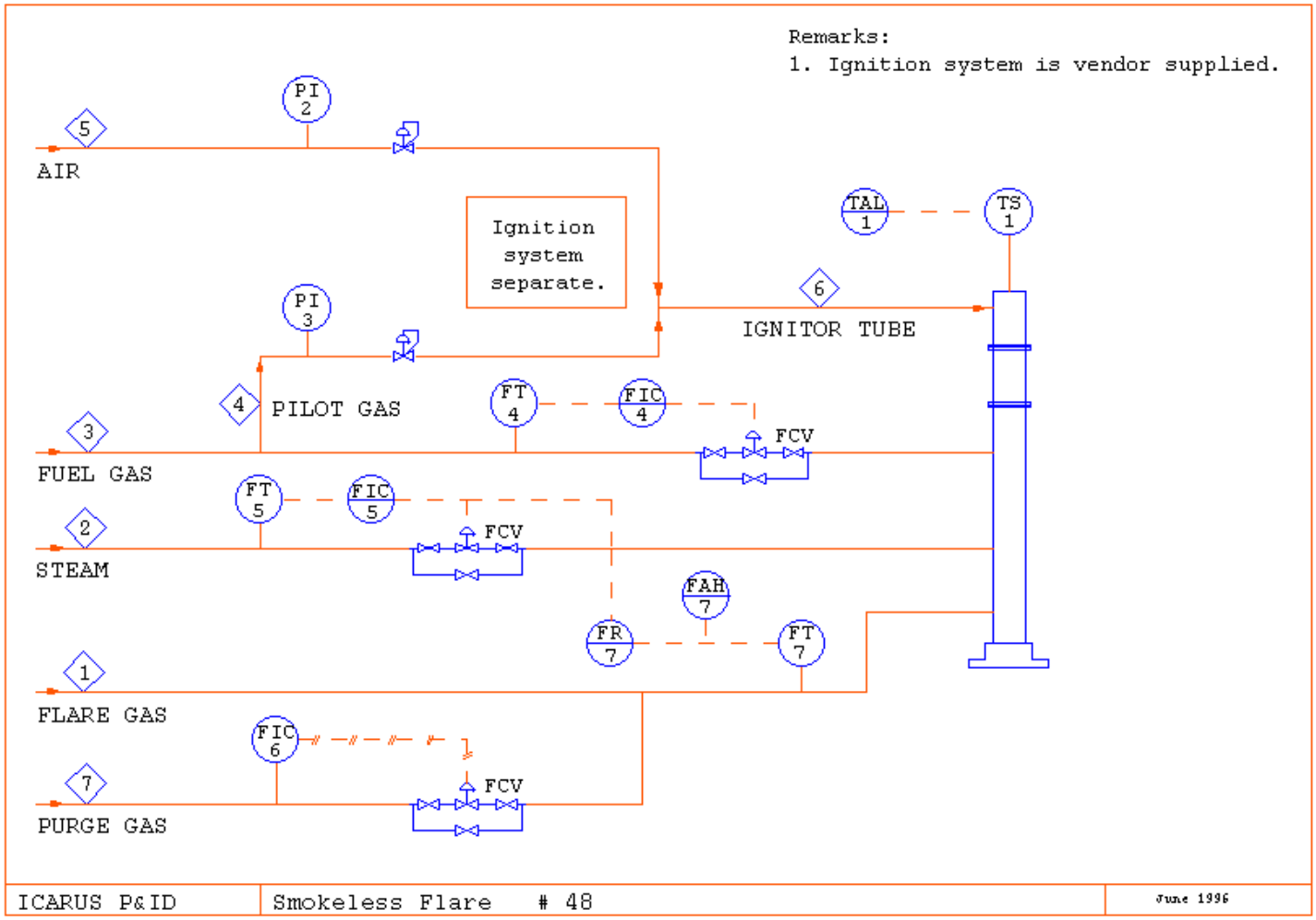
45 Fabric Cartridge Filter



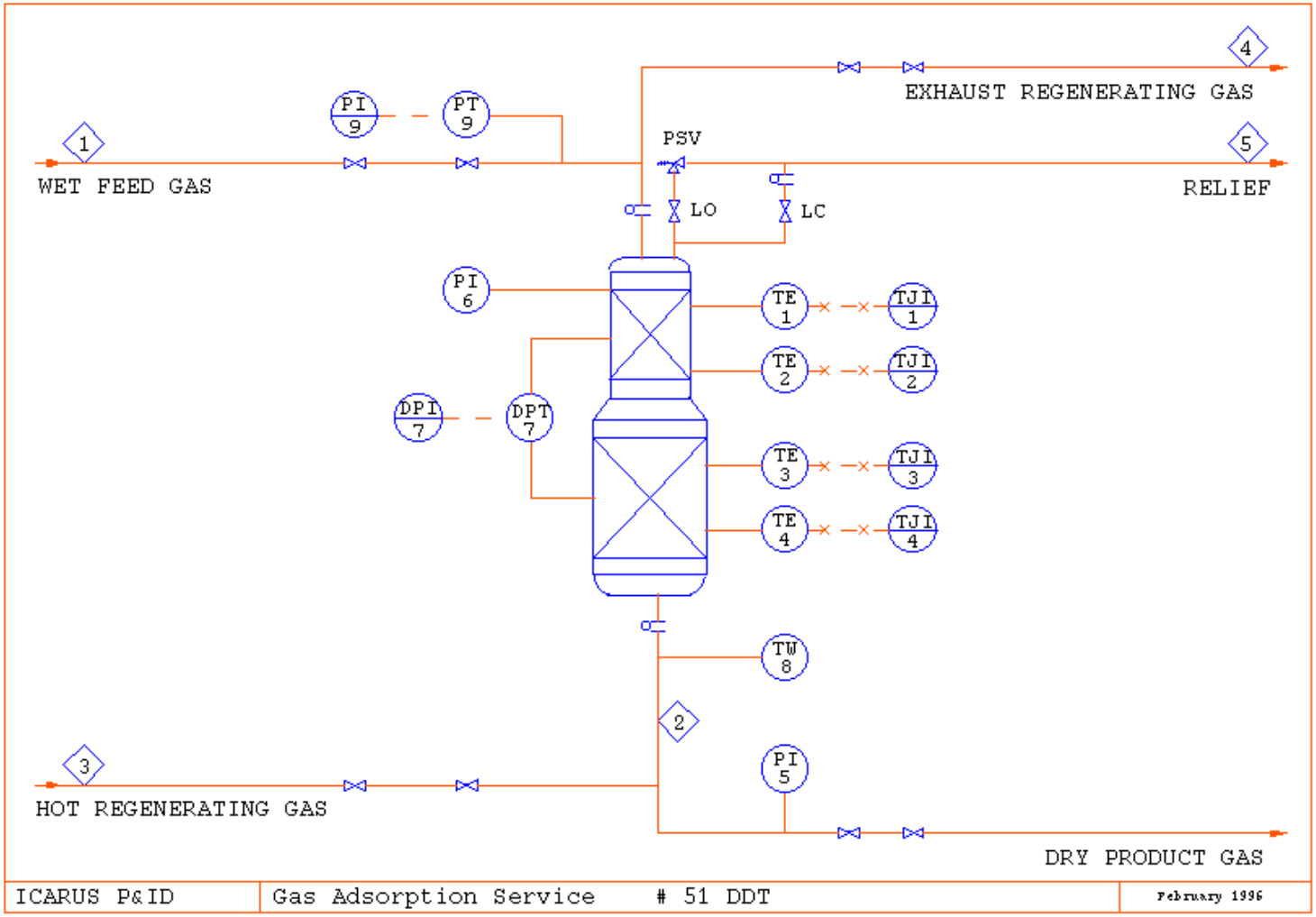
46 Tubular Fabric Filter



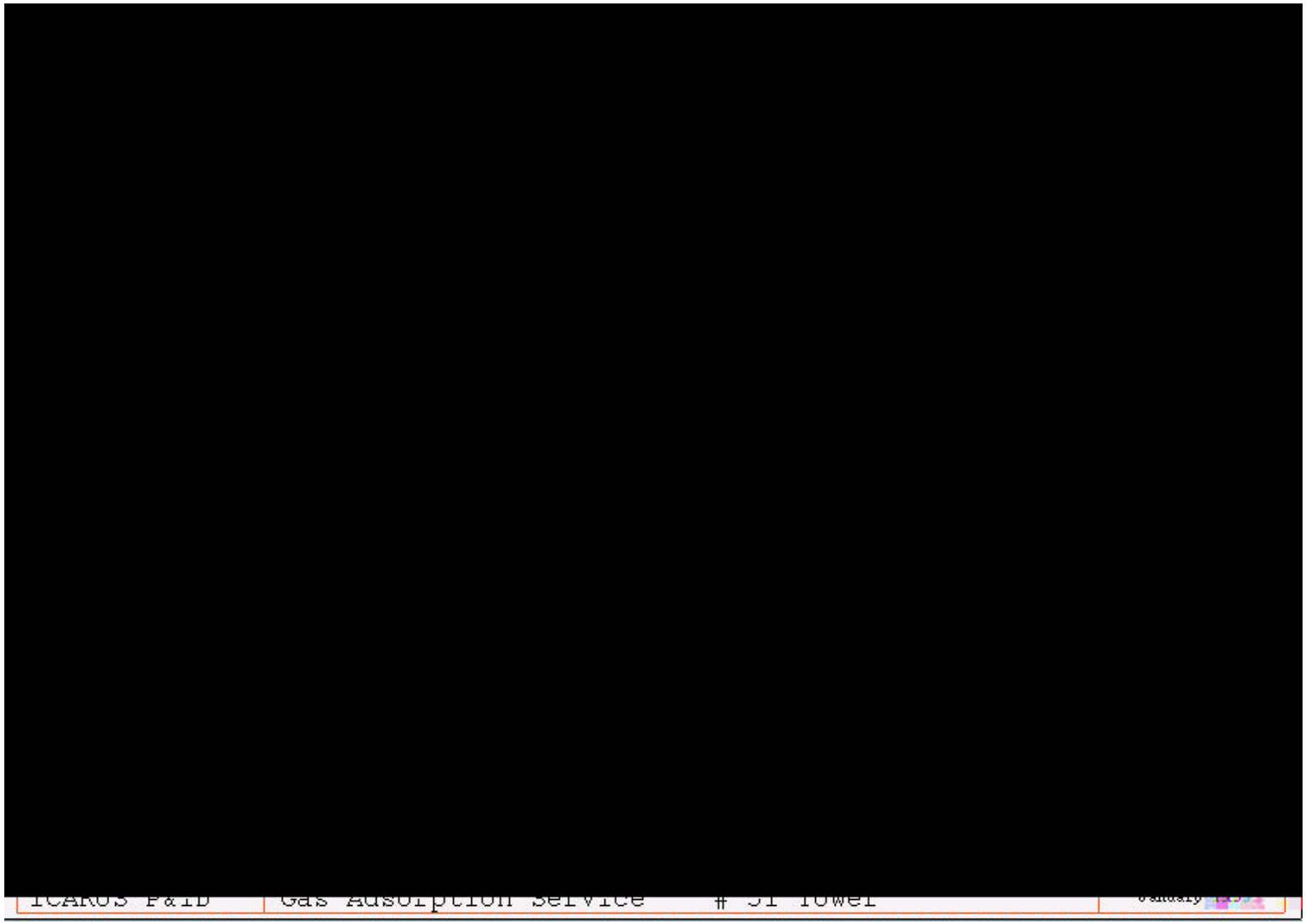
48 Smokeless Flare



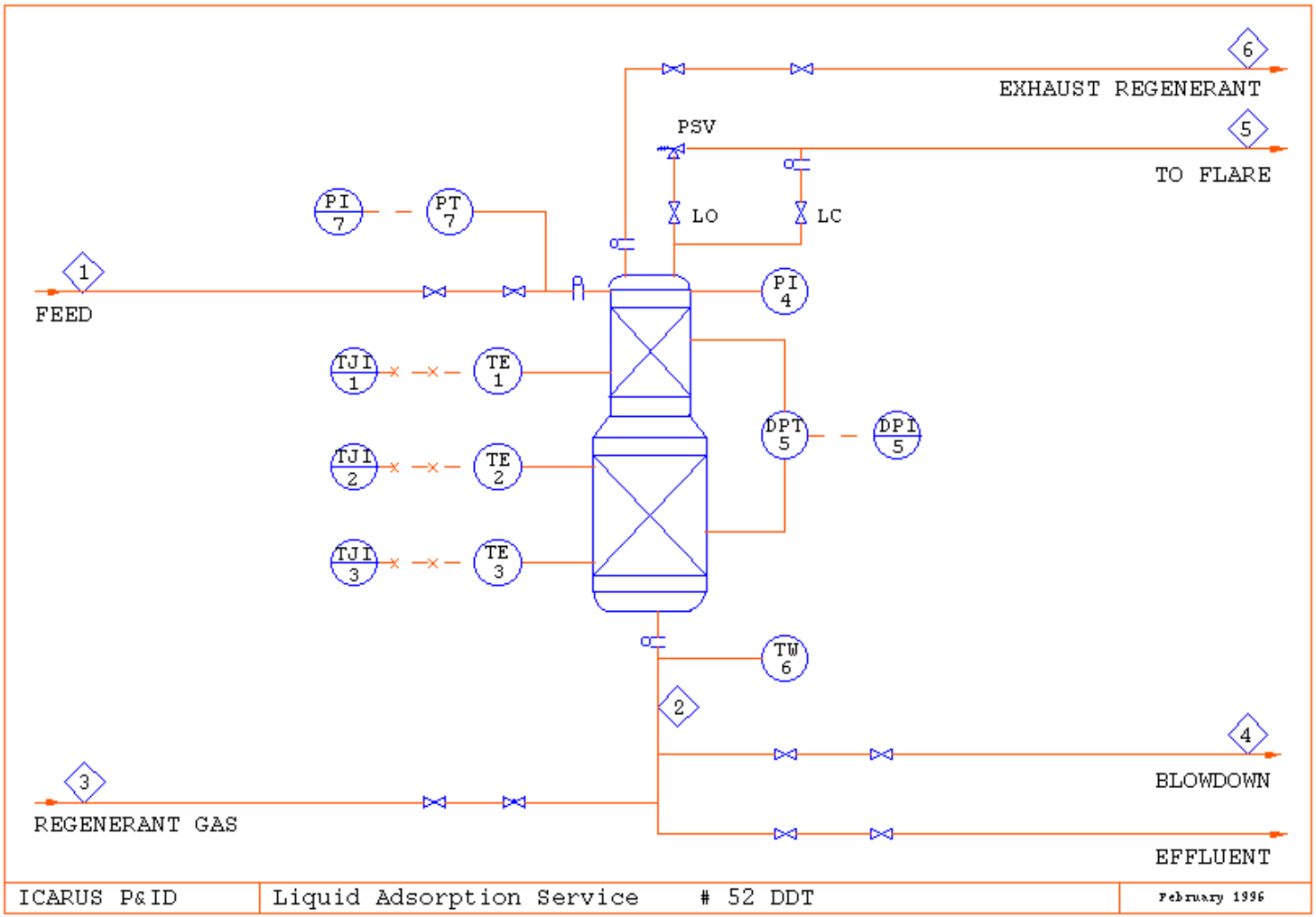
51 DDT – Gas Adsorption Service



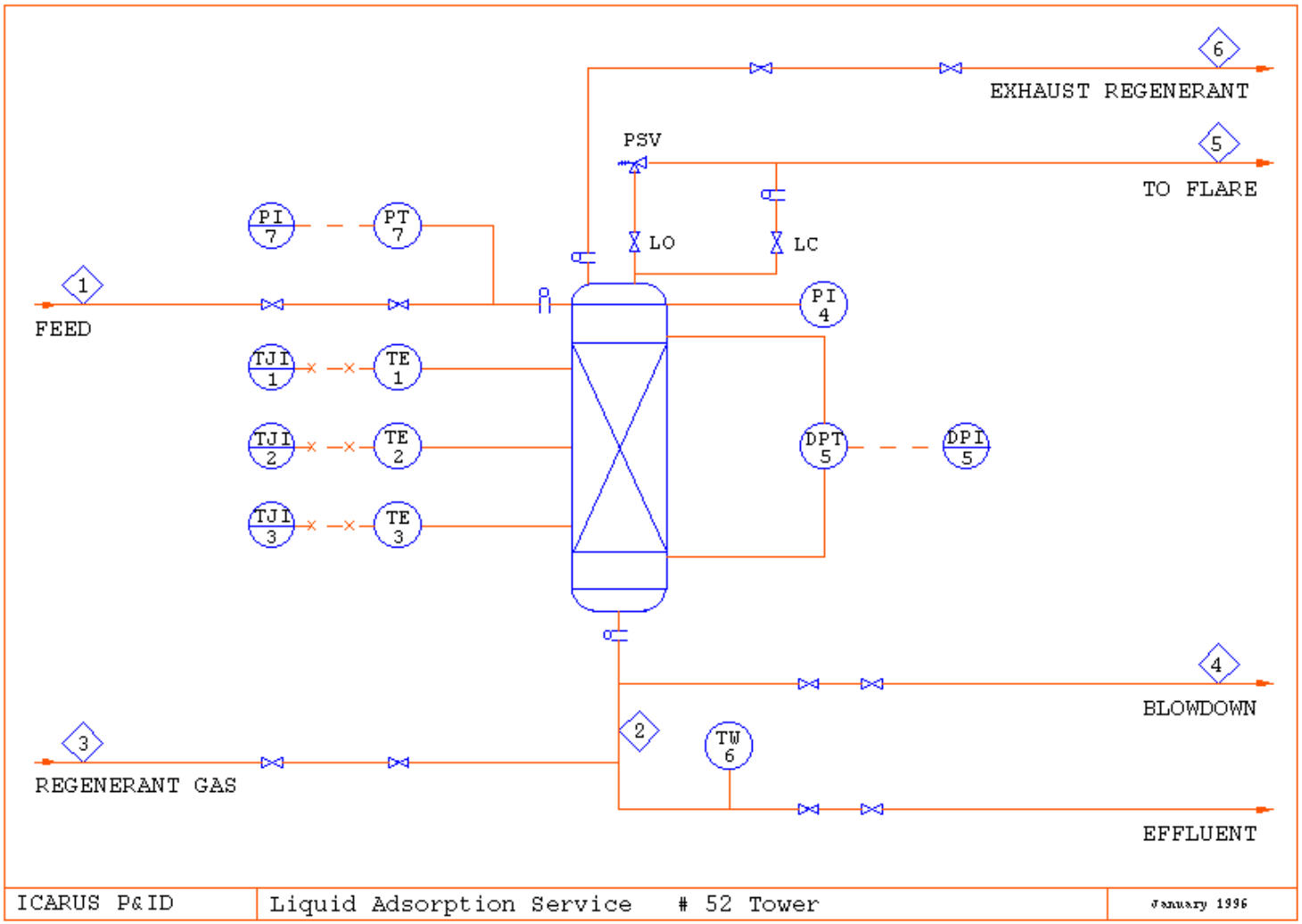
51 Tower – Gas Adsorption Service



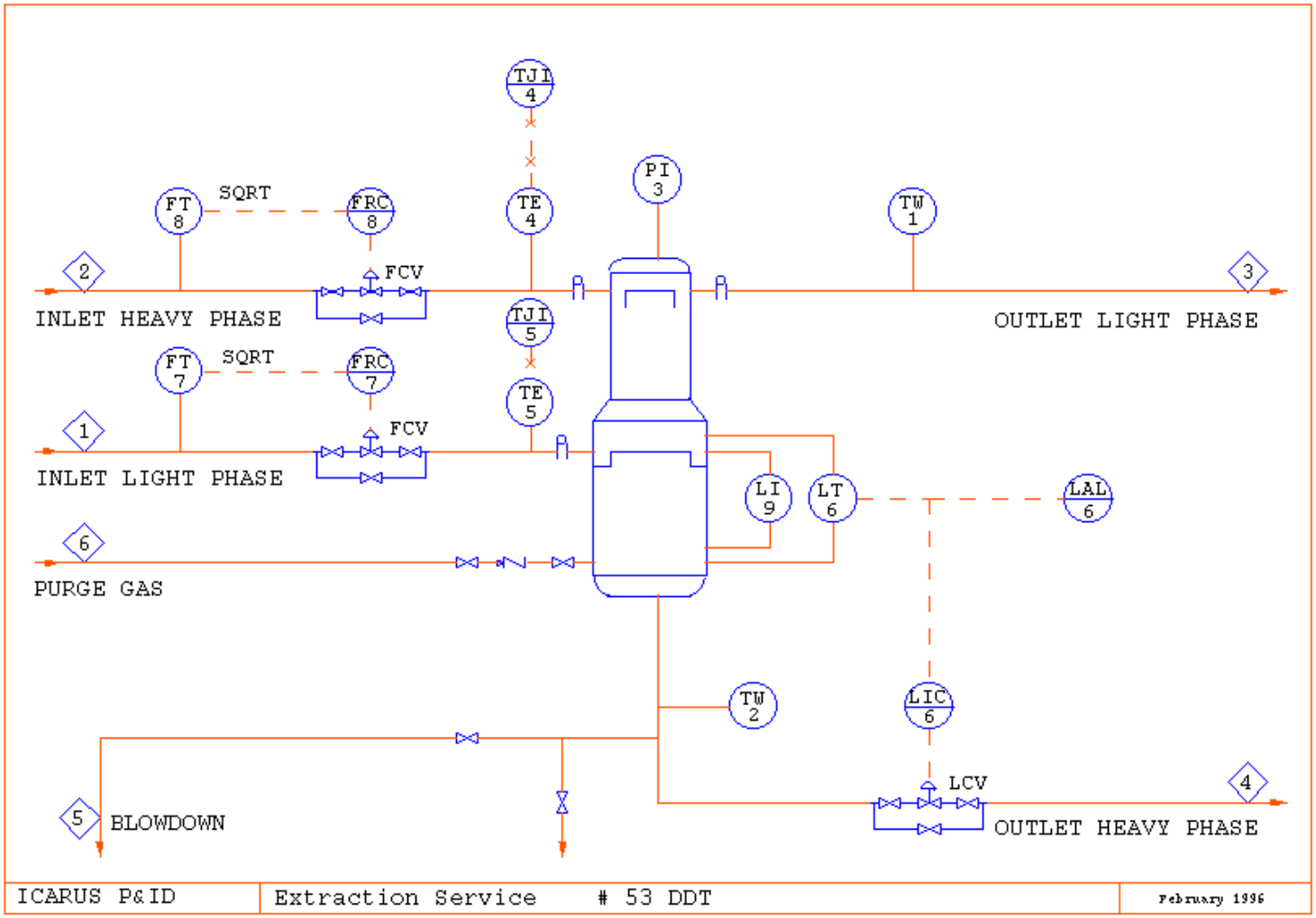
52 DDT – Liquid Adsorption Service



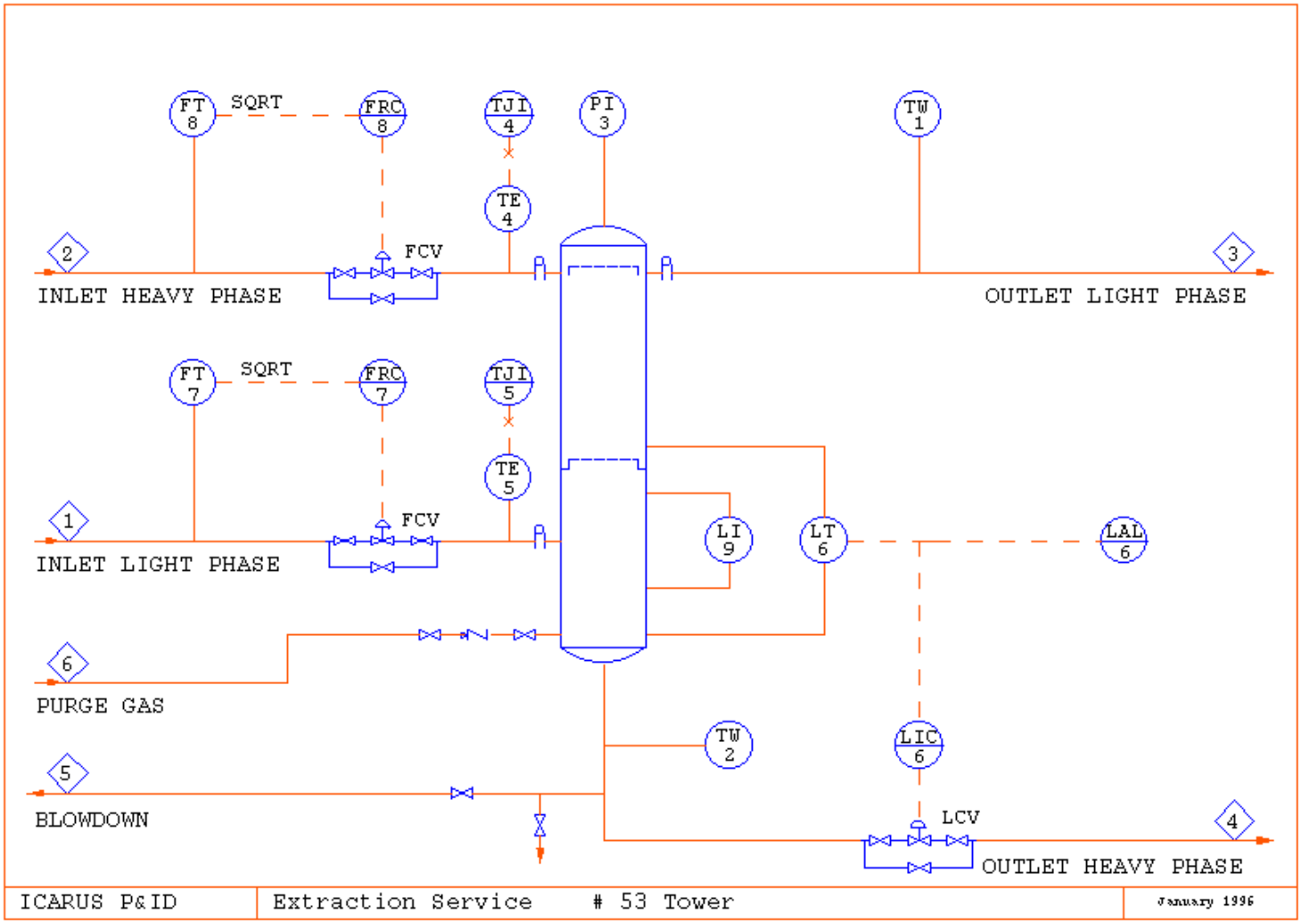
52 Tower – Liquid Adsorption Service



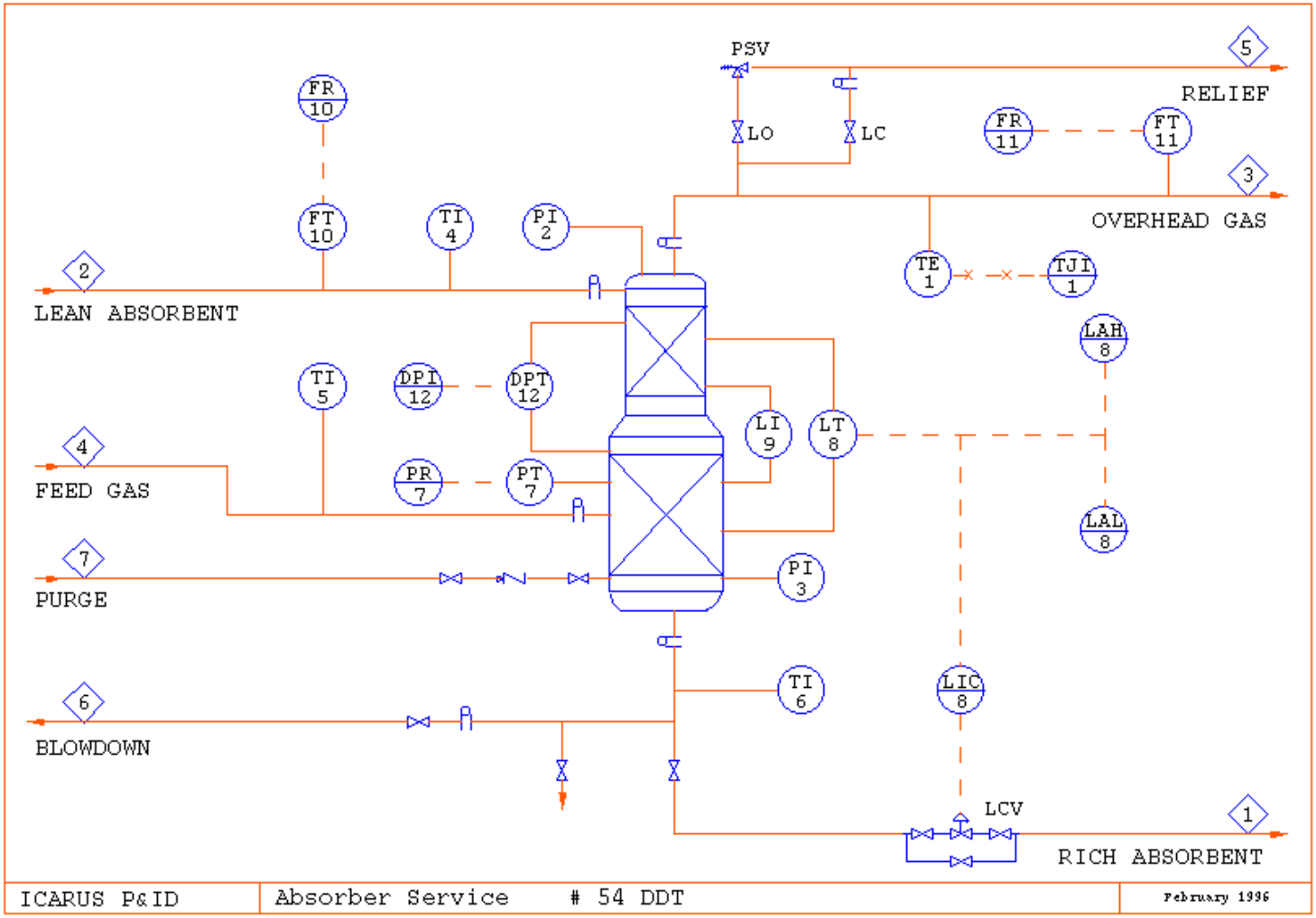
53 DDT – Extraction Service



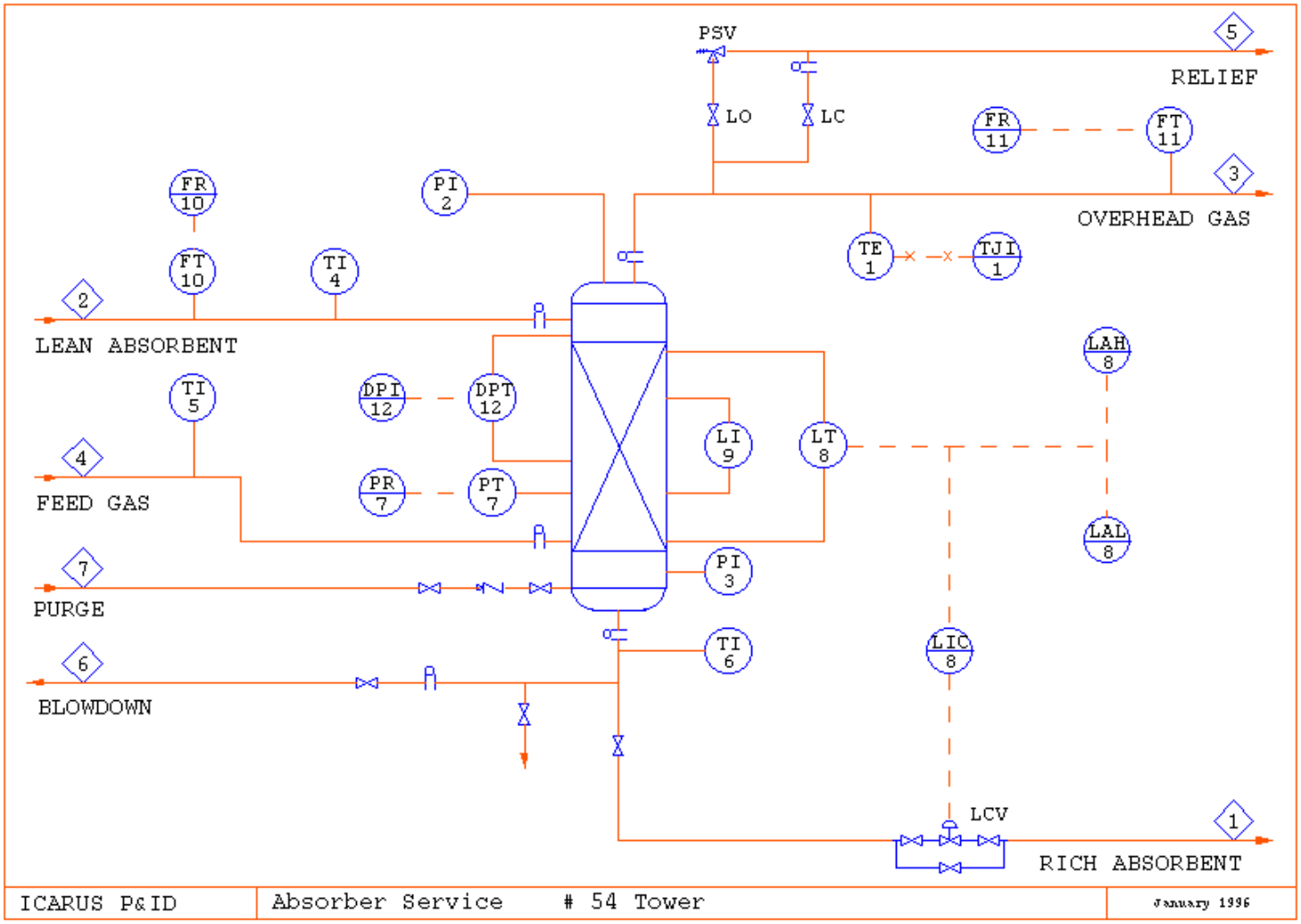
53 Tower – Extraction Service



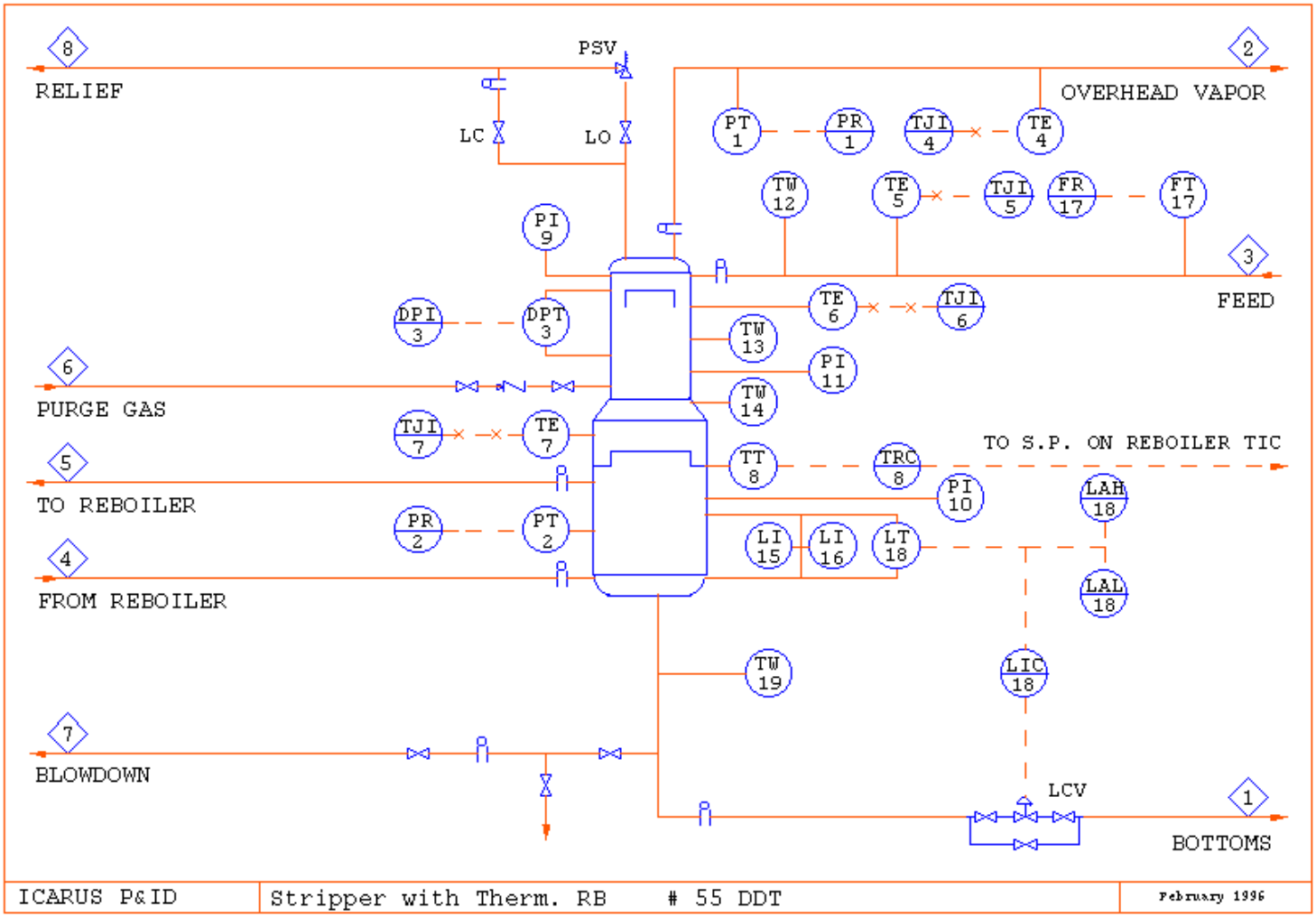
54 DDT – Absorber Service



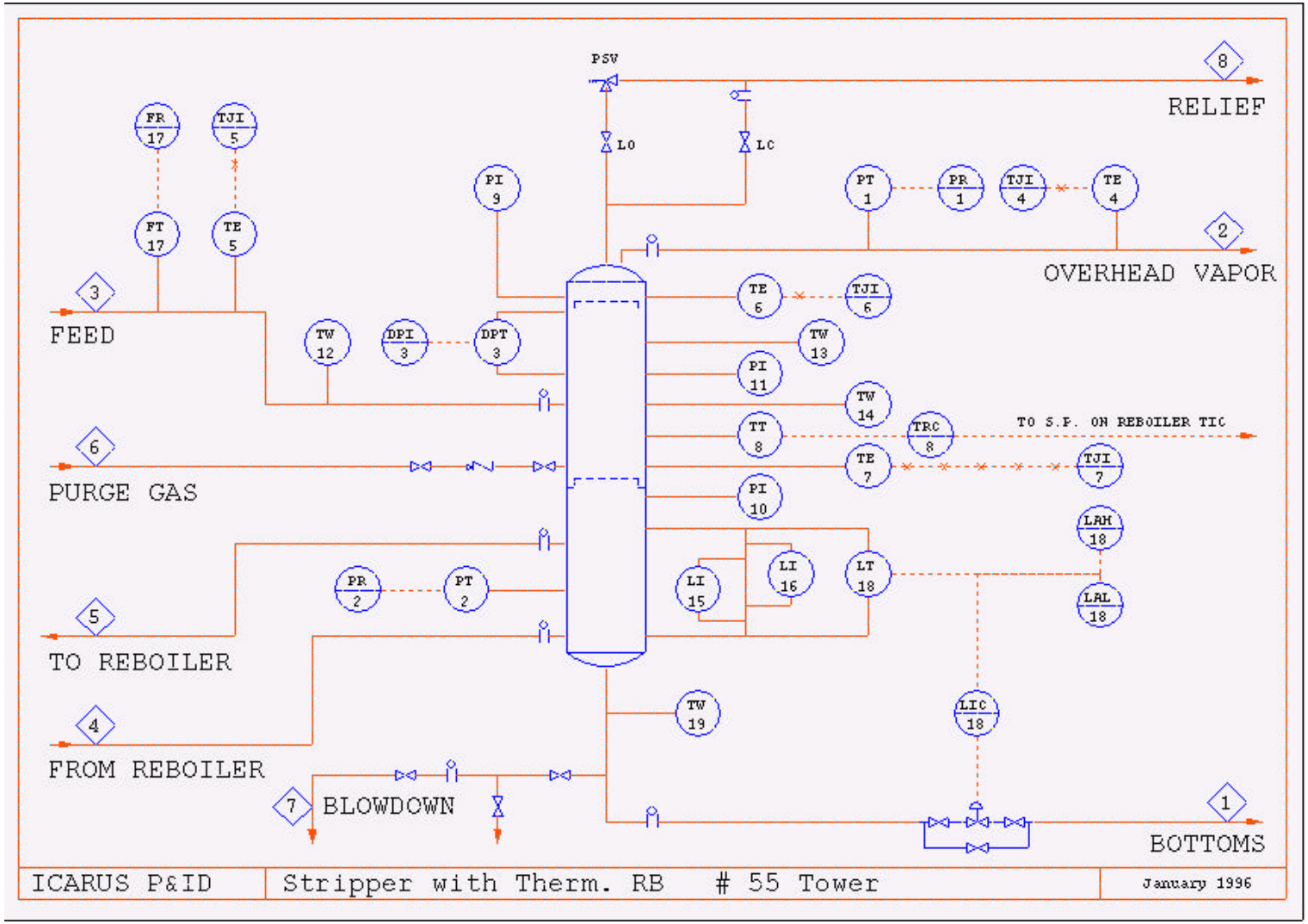
54 Tower – Absorber Service



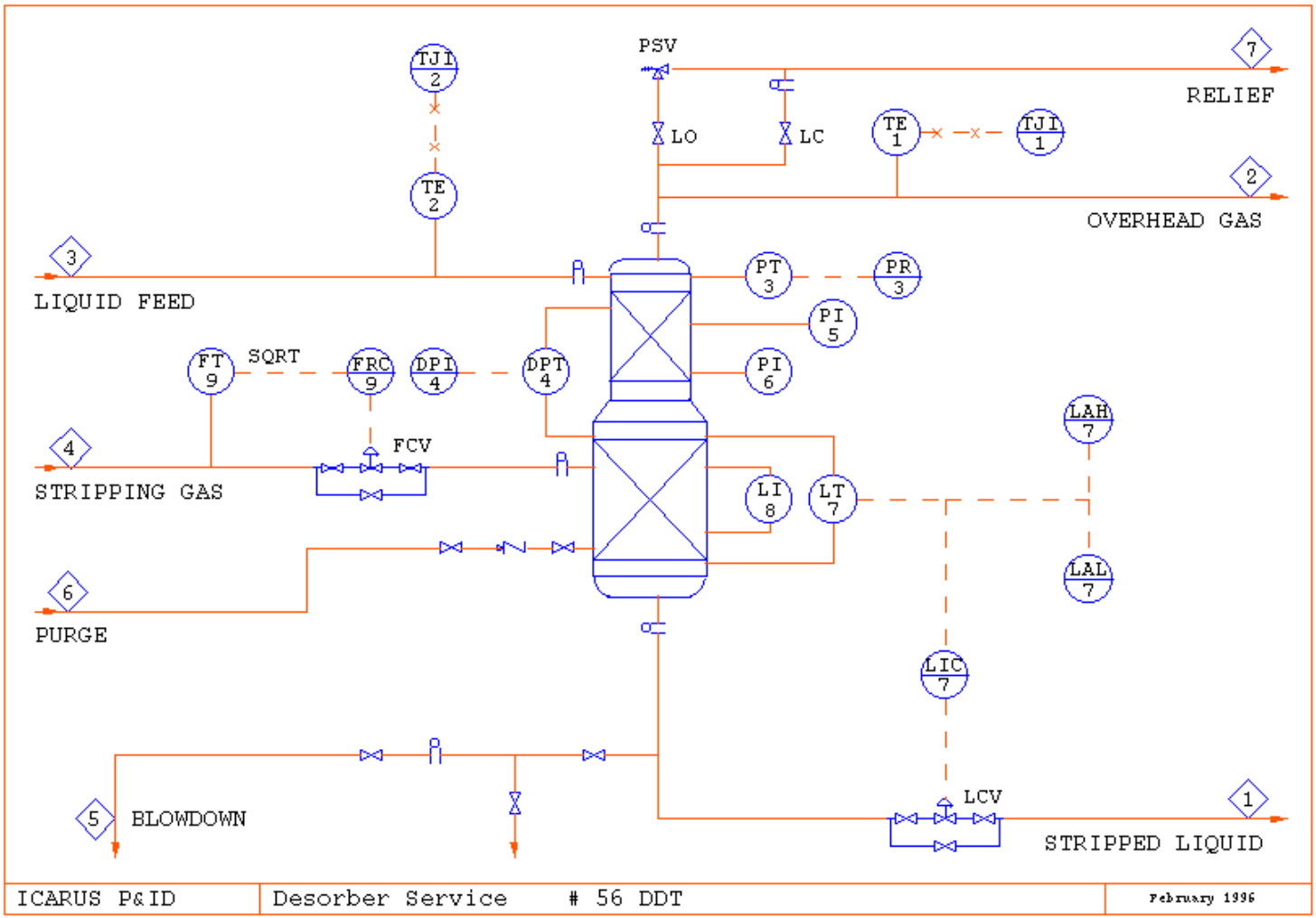
55 DDT – Stripper with Therm. RB



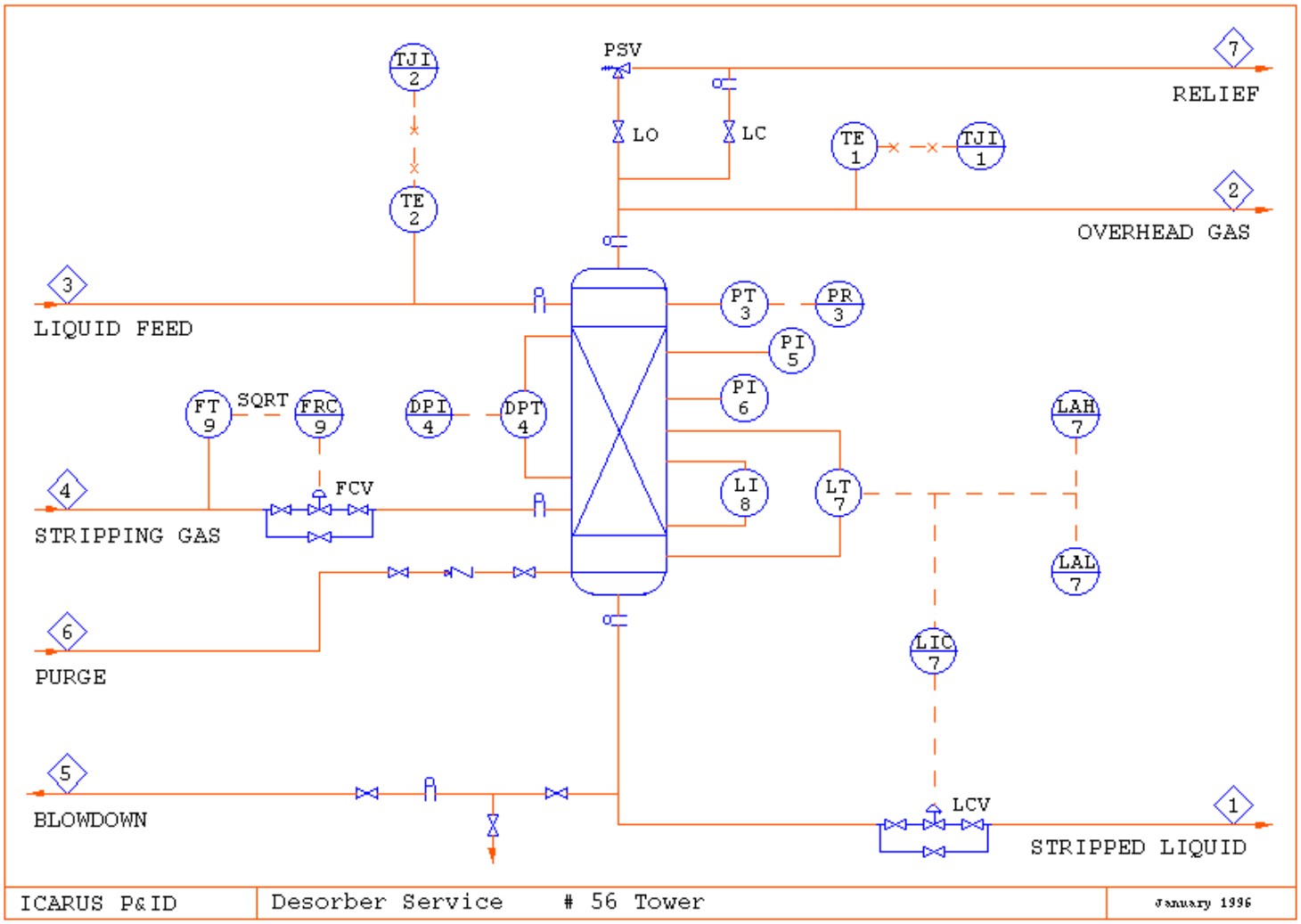
55 Tower – Stripper with Therm. RB



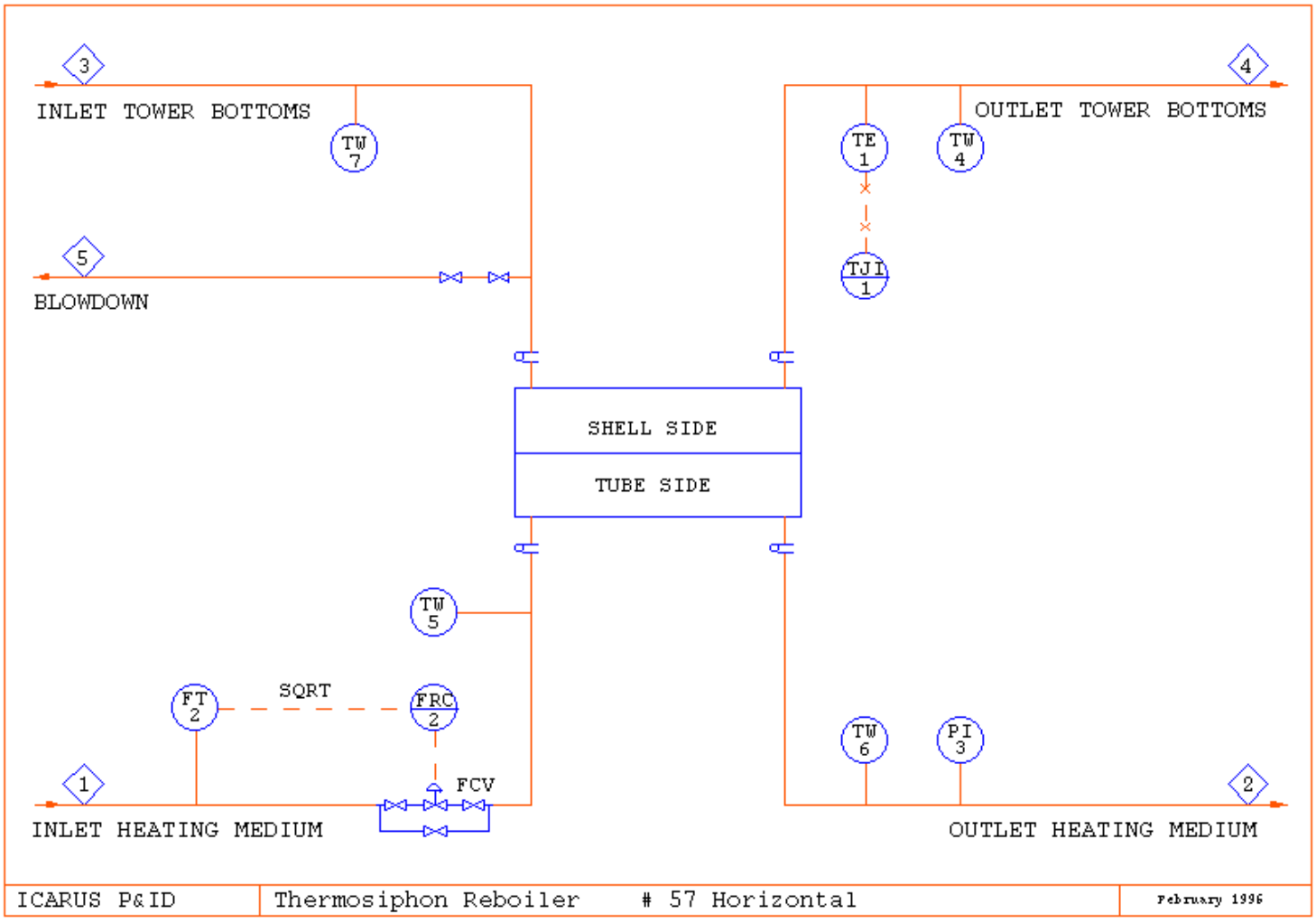
56 DDT – Desorber Service



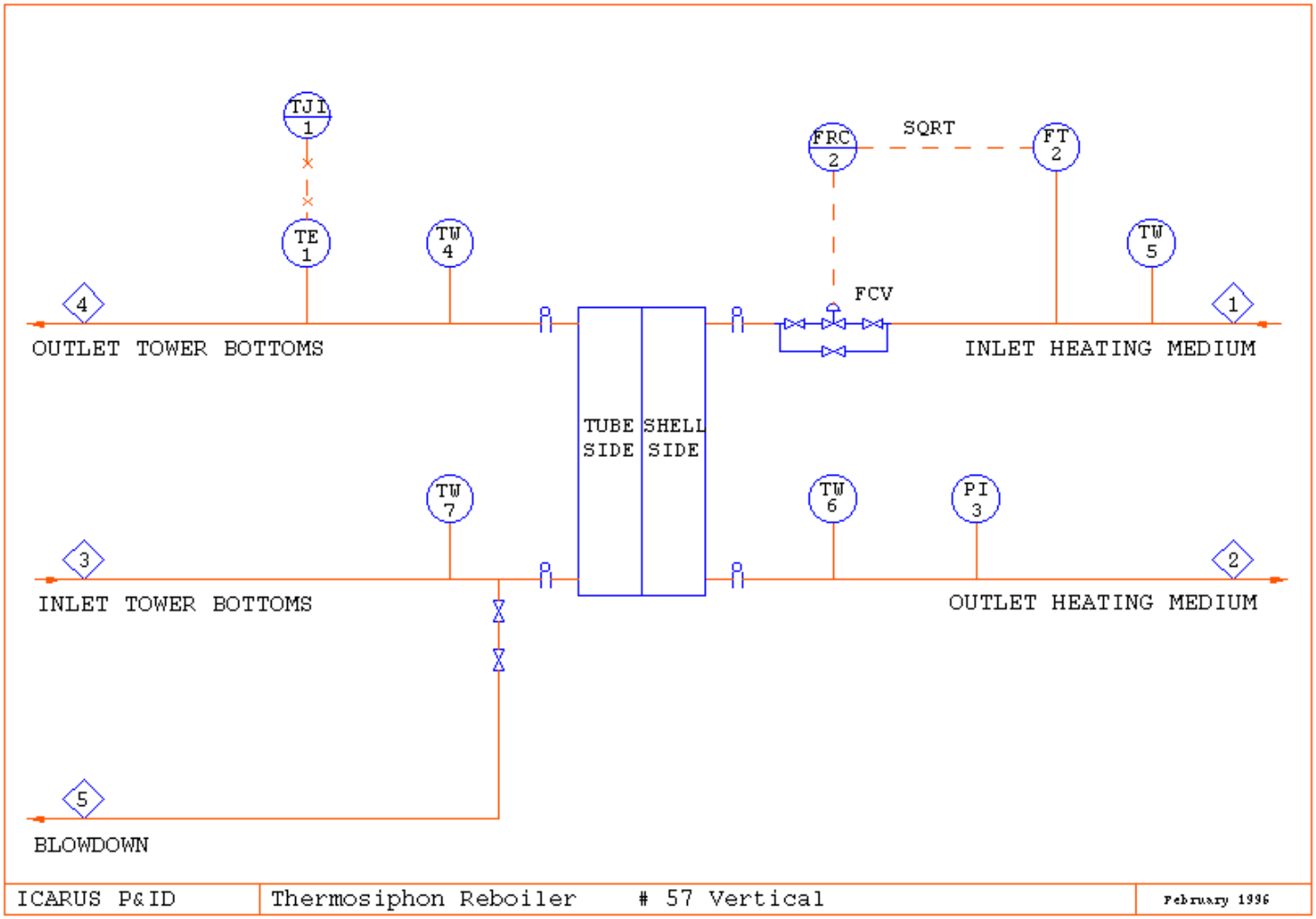
56 Tower – Desorber Service



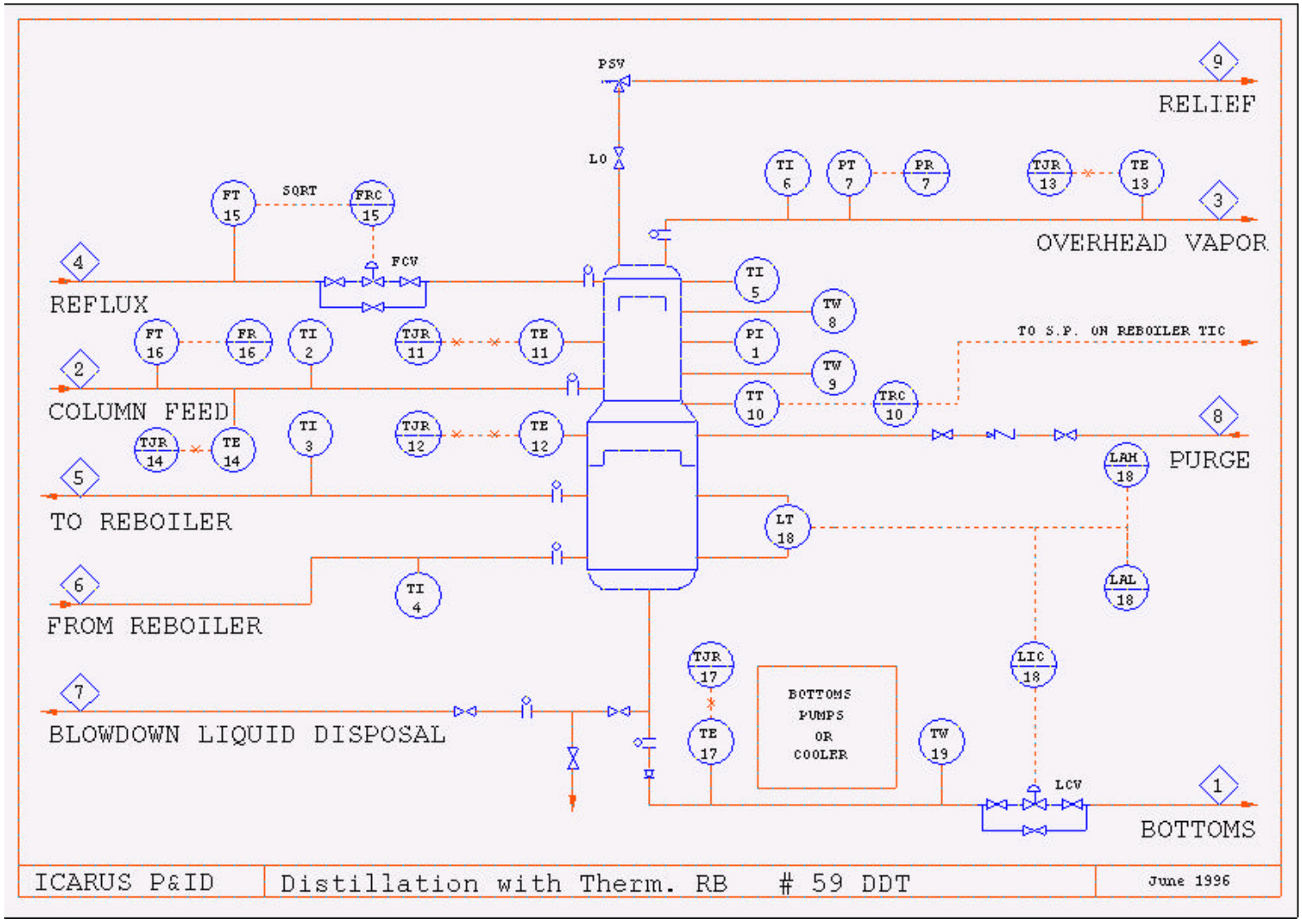
57 Horizontal Thermosiphon Reboiler



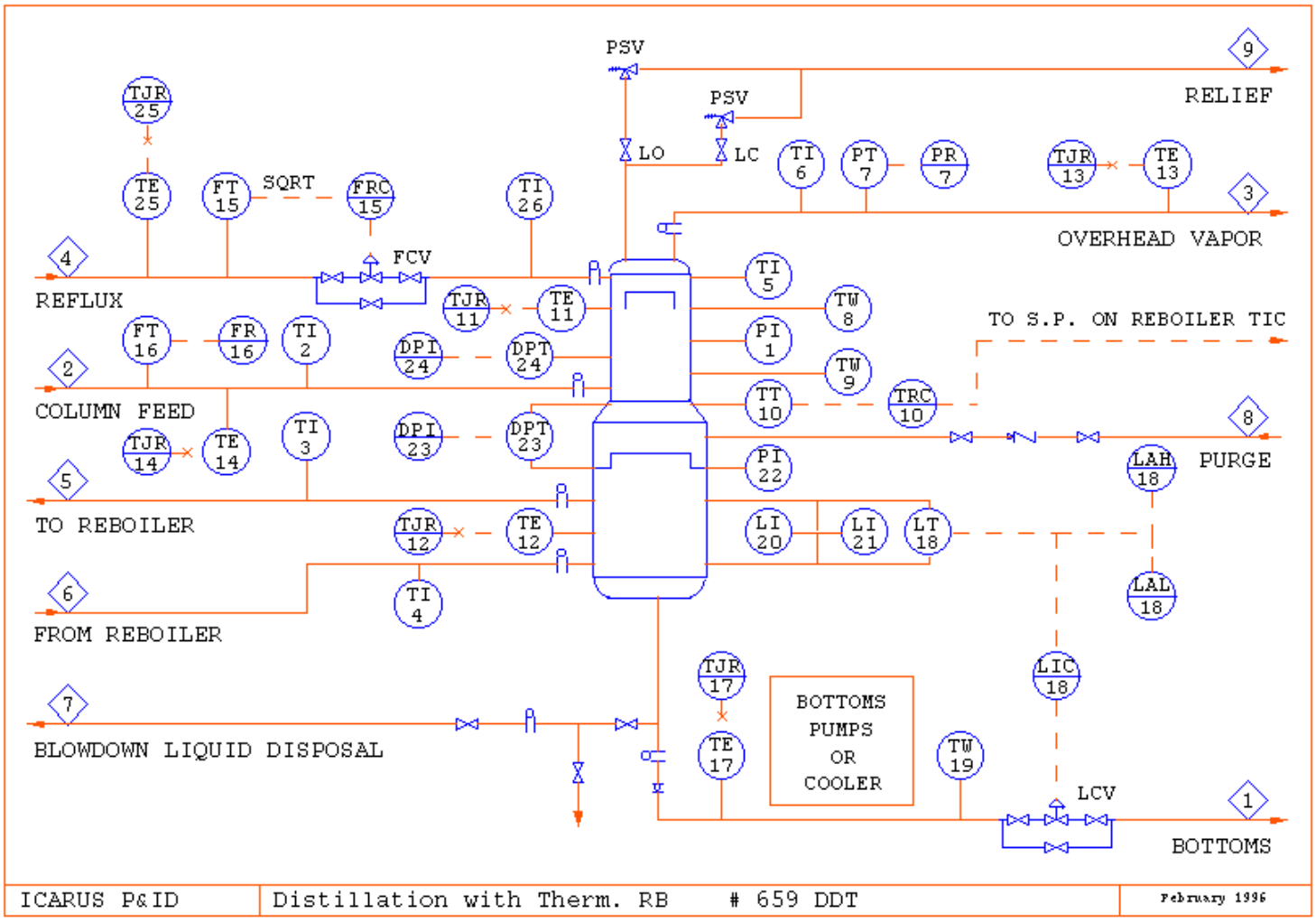
57 Vertical Thermosiphon Reboiler



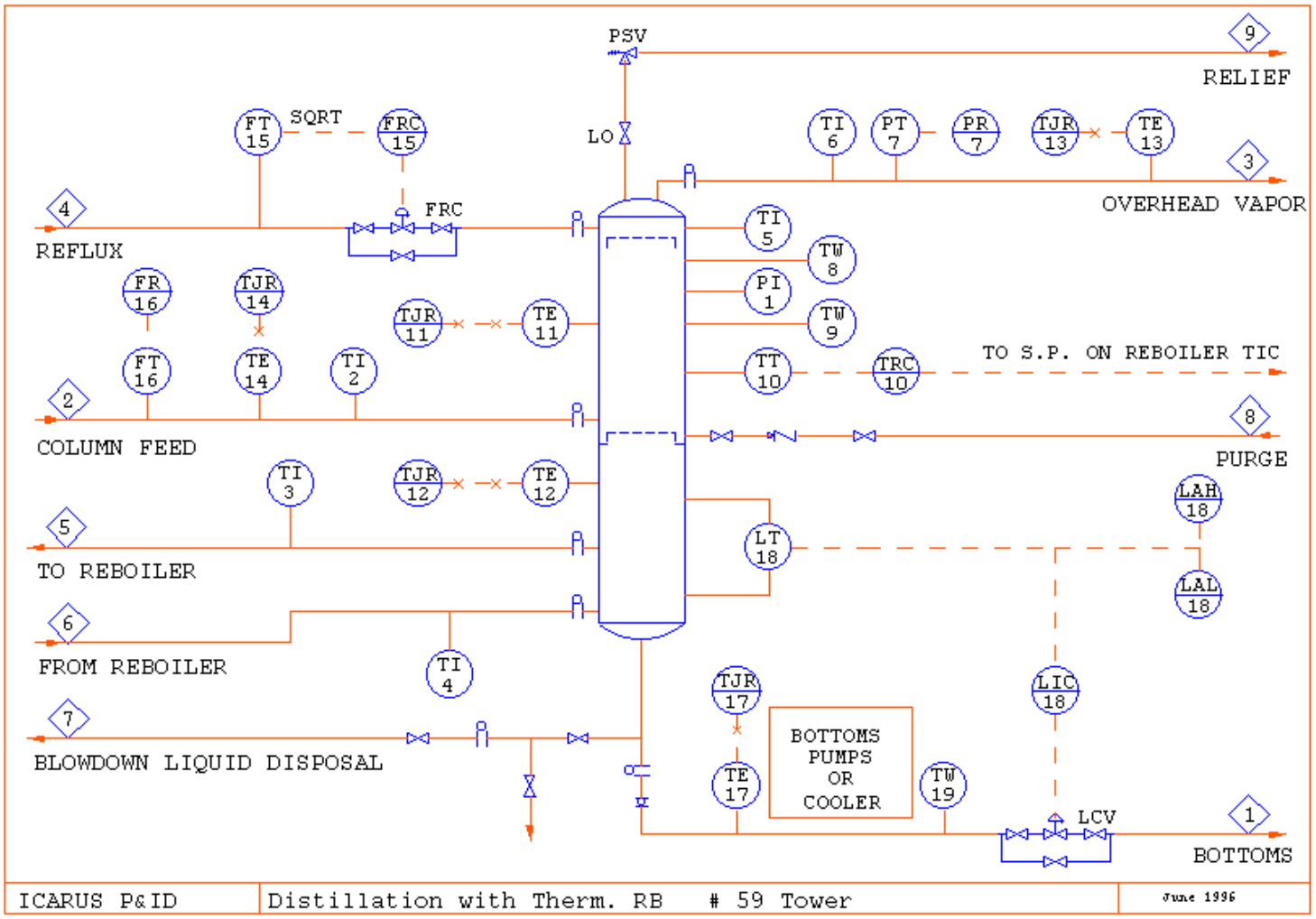
59 DDT – Distillation with Therm. RB



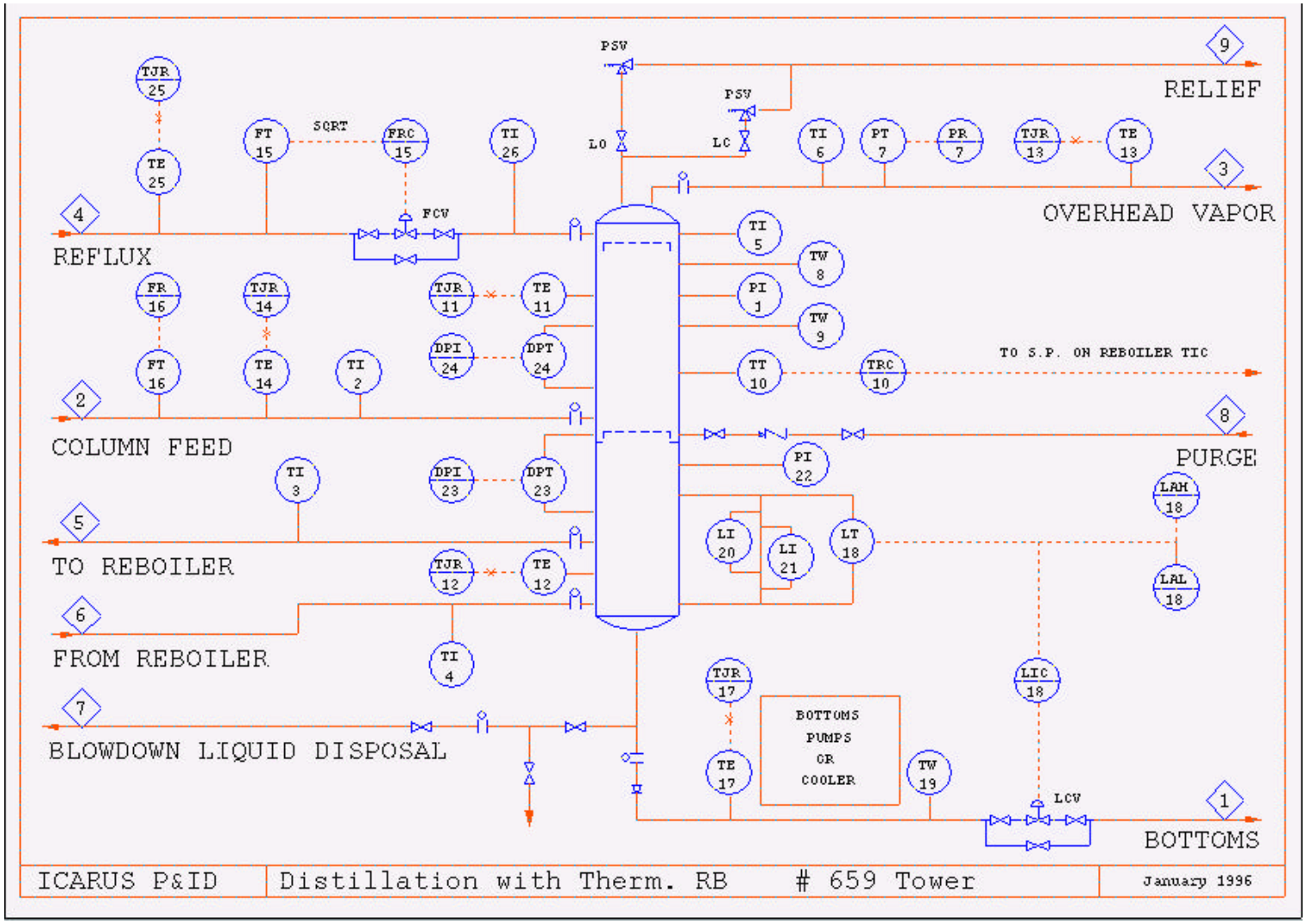
659 DDT – Distillation with Therm. RB



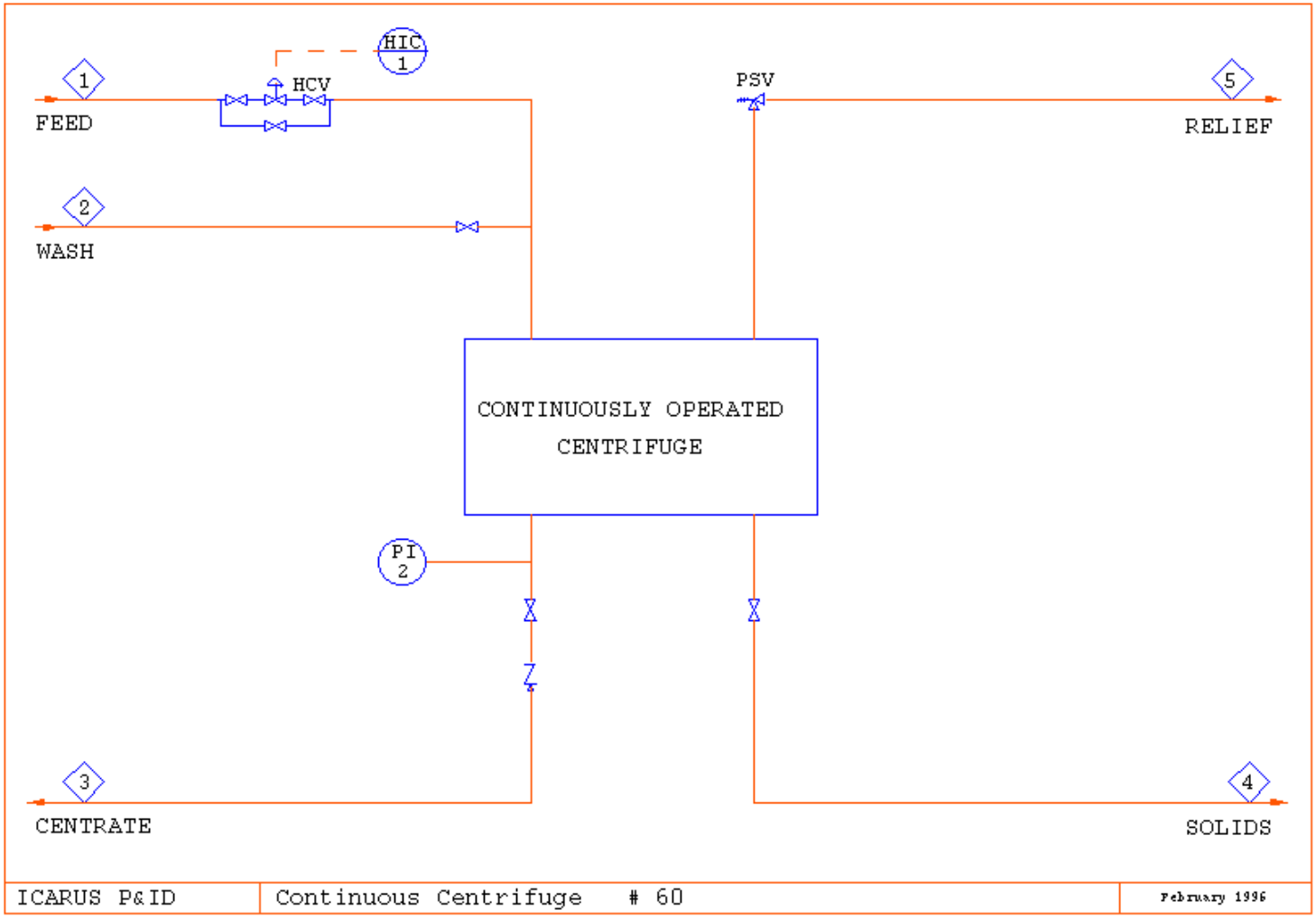
59 Tower – Distillation with Therm. RB



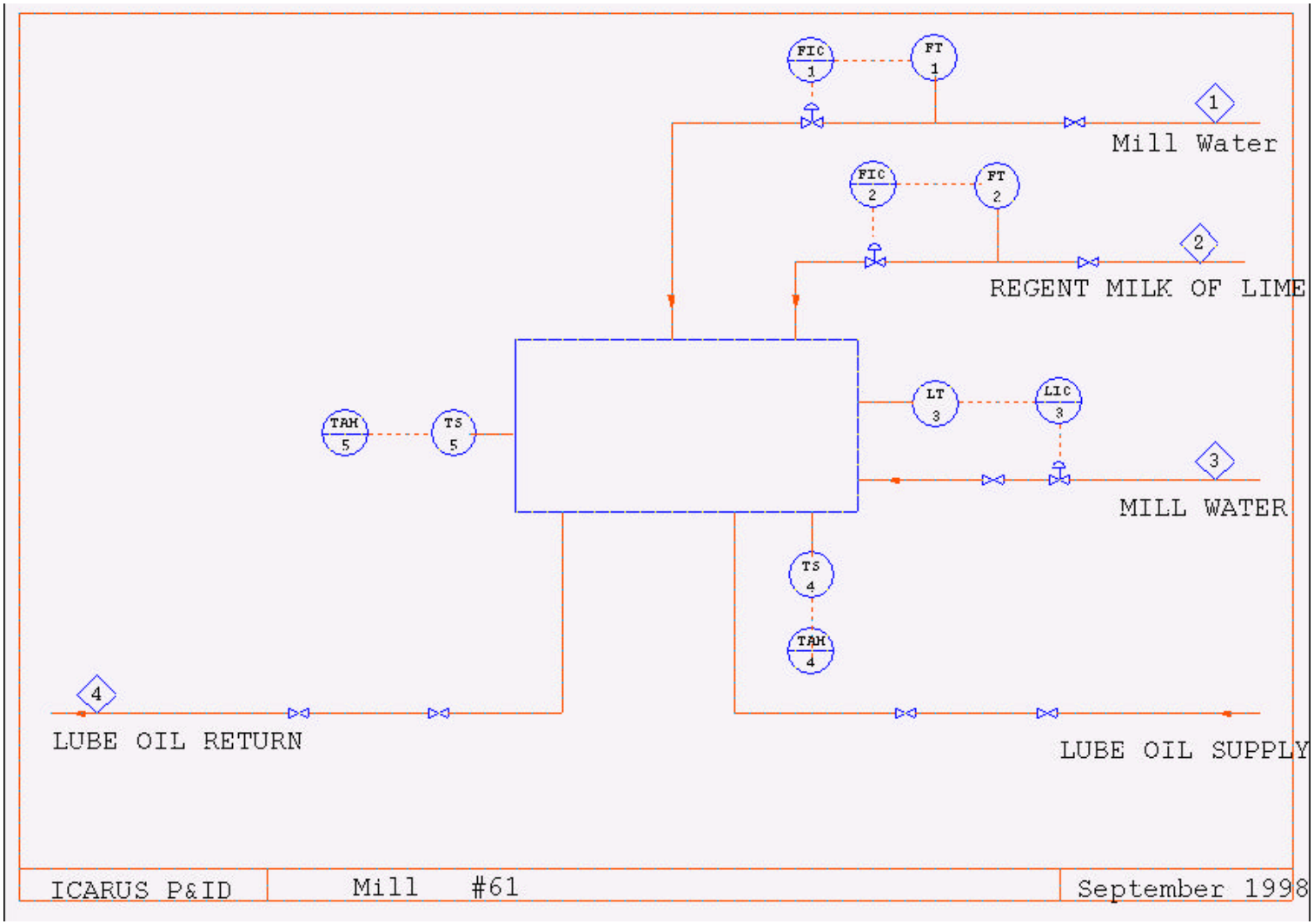
659 Tower – Distillation with Therm. RB



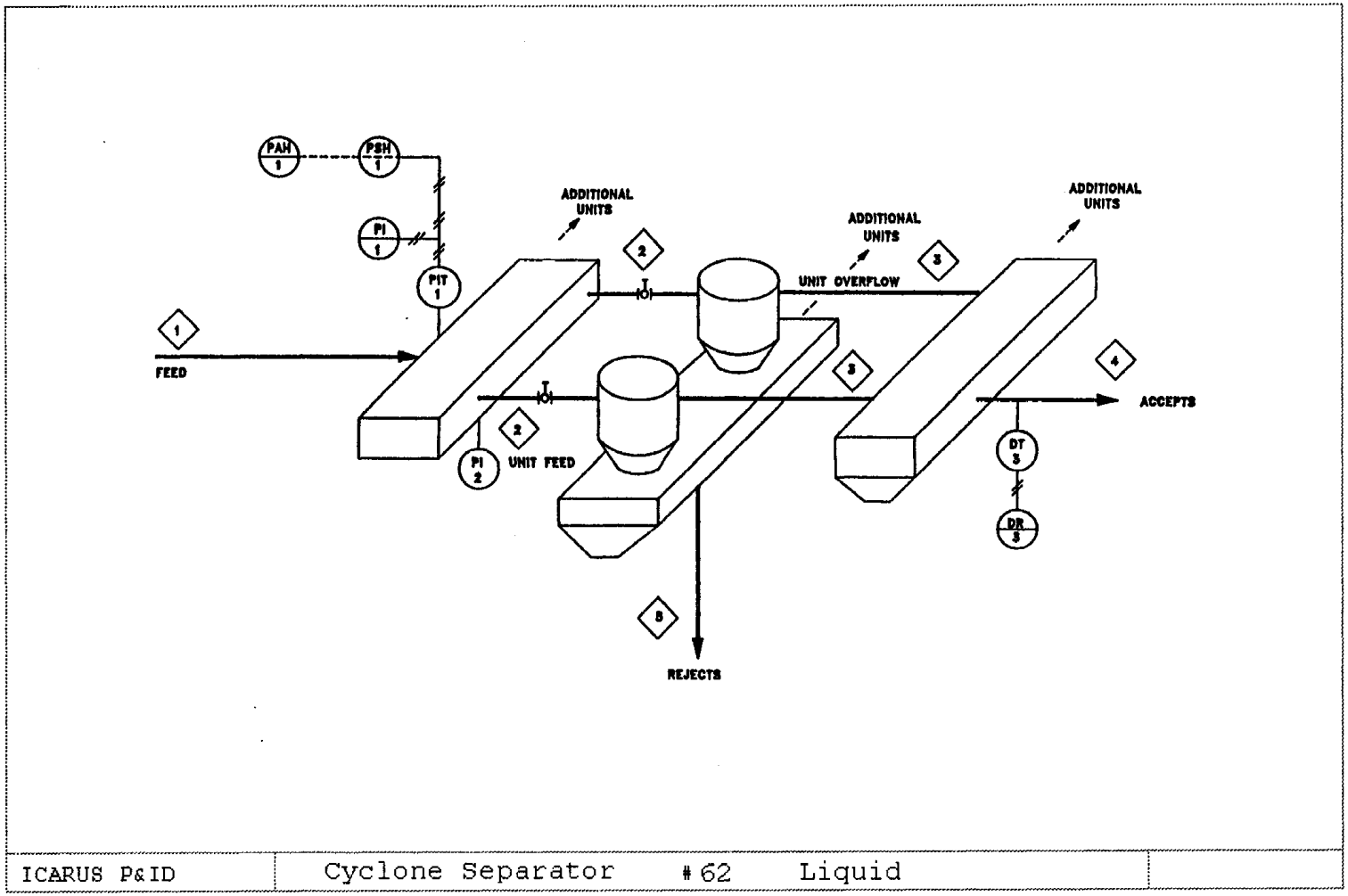
60 Continuous Centrifuge



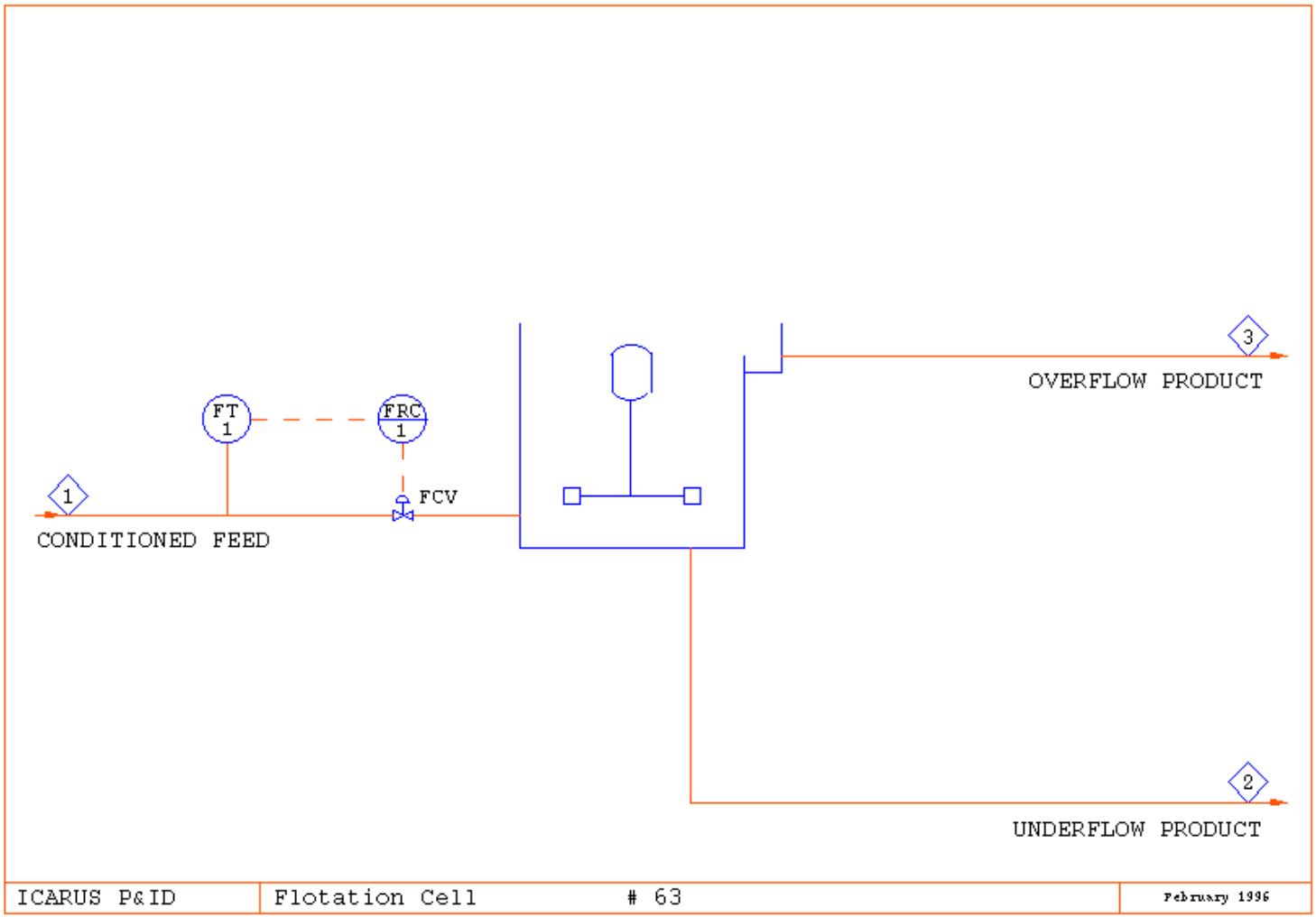
61 Mill


FIC 1
FT 1
1
Mill Water
FIC 2
FT 2
2
REGENT MILK OF LIME
TAH 5
TS 5
LT 3
LIC 3
3
MILL WATER
TS 4
TAH 4
4
LUBE OIL RETURN
LUBE OIL SUPPLY
ICARUS P&ID
Mill #61
September 1998

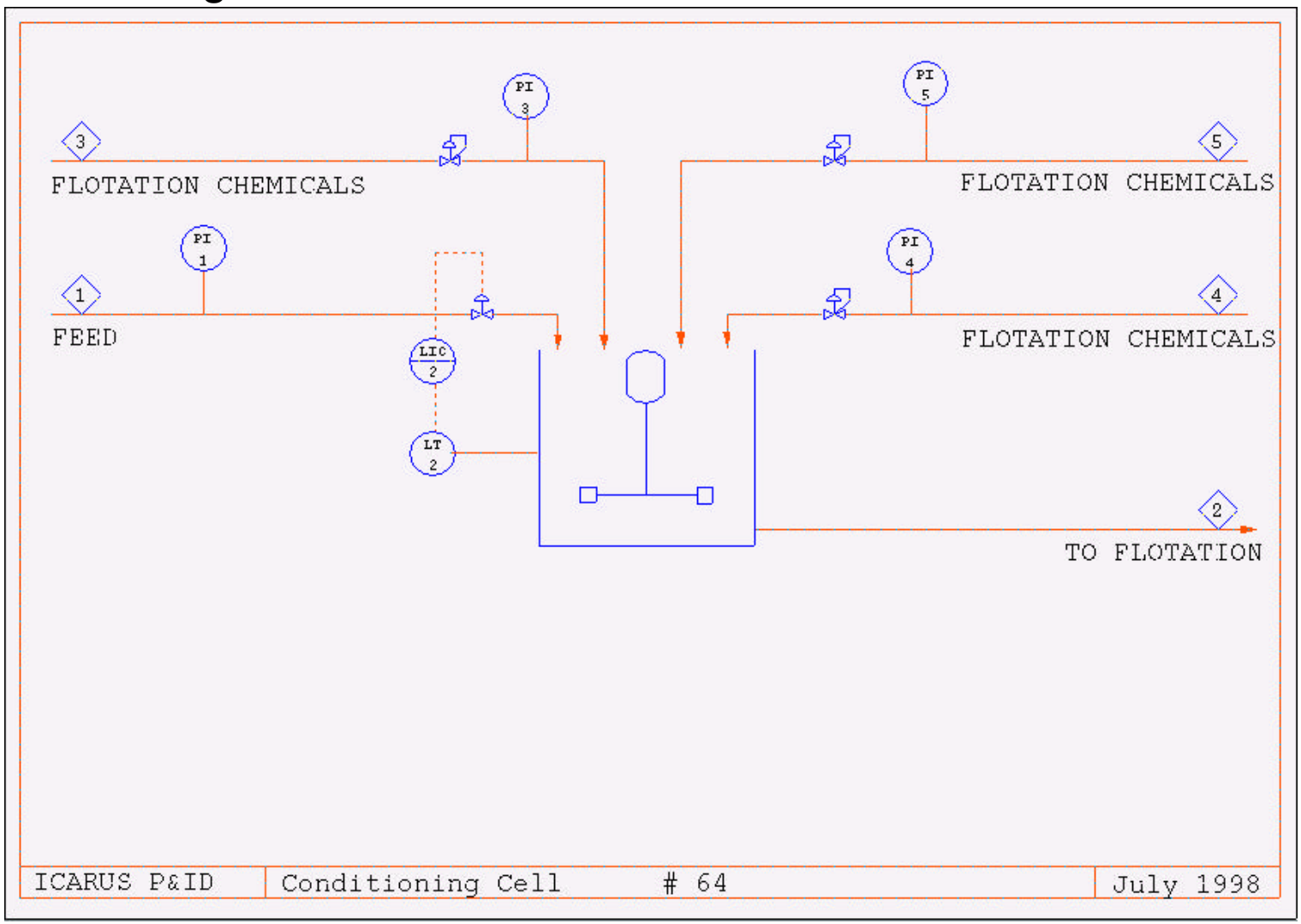
62 Liquid Cyclone Separator



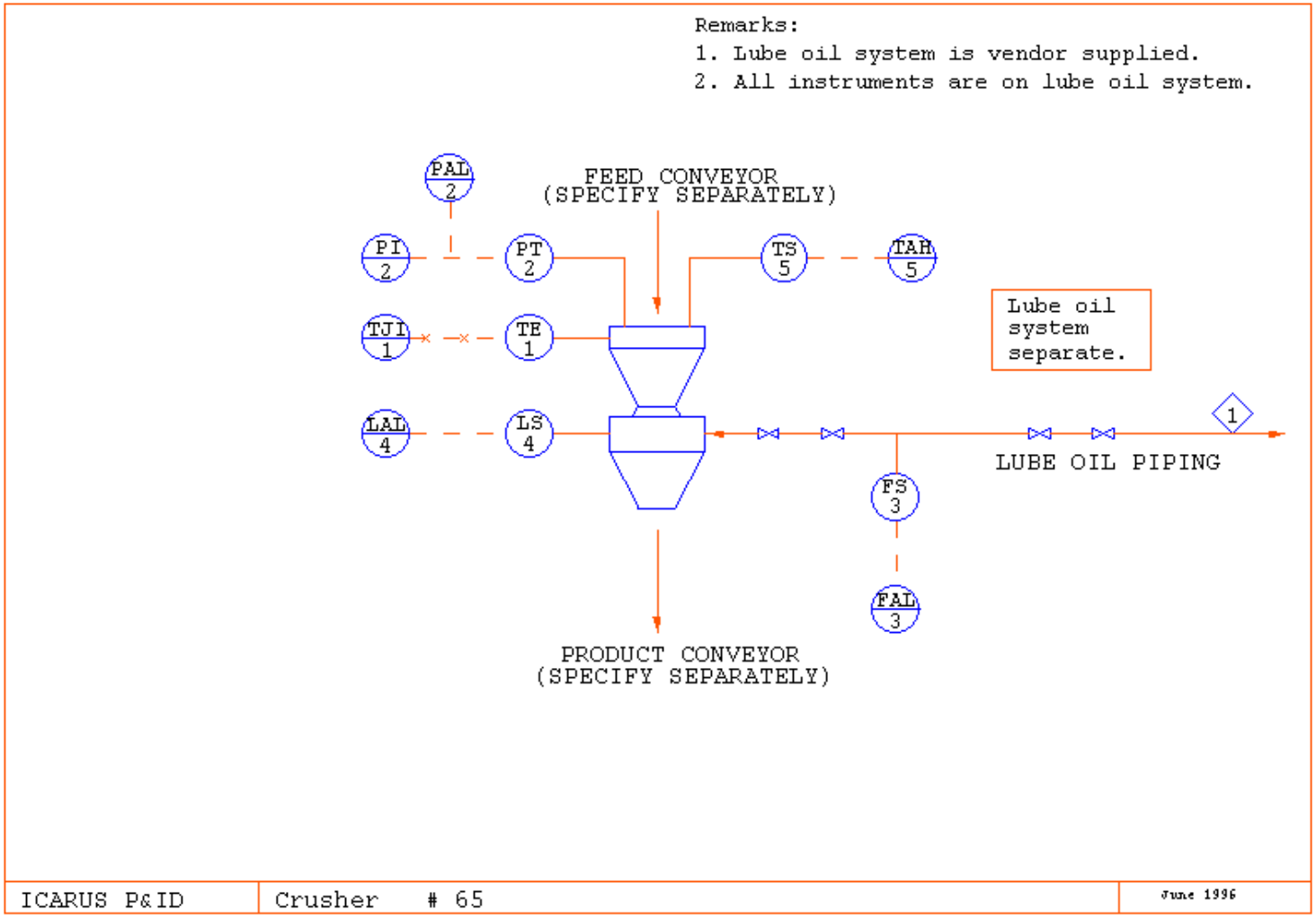
63 Flotation Cell



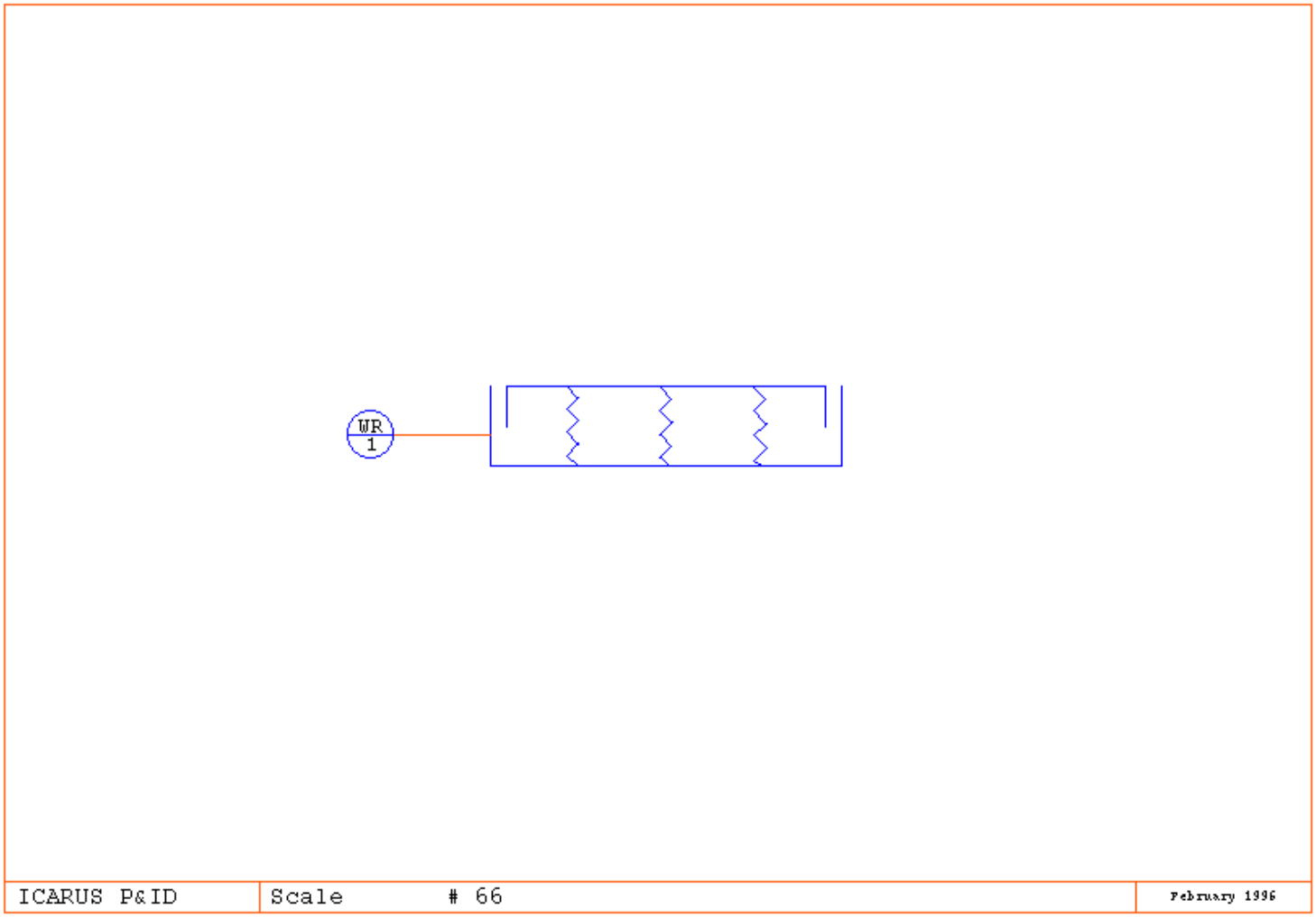
64 Conditioning Cell



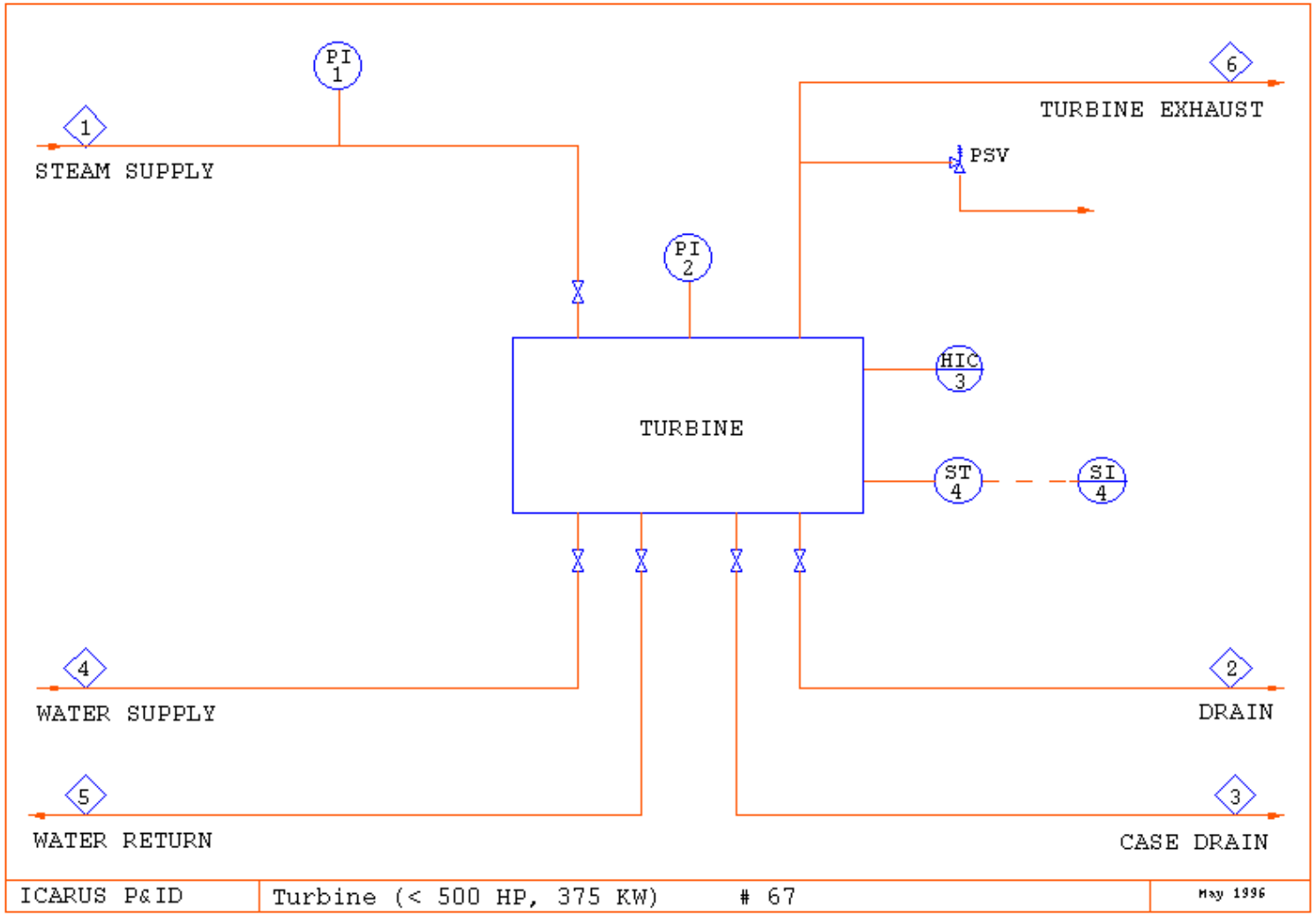
65 Crusher


Remarks:
1. Lube oil system is vendor supplied.
2. All instruments are on lube oil system.
PAL 2
FEED CONVEYOR
(SPECIFY SEPARATELY)
PI 2
PT 2
TS 5
TAH 5
TJI 1
TE 1
Lube oil system separate.
LAL 4
LS 4
1
LUBE OIL PIPING
FS 3
FAL 3
PRODUCT CONVEYOR
(SPECIFY SEPARATELY)
ICARUS P&ID
Crusher # 65
June 1996

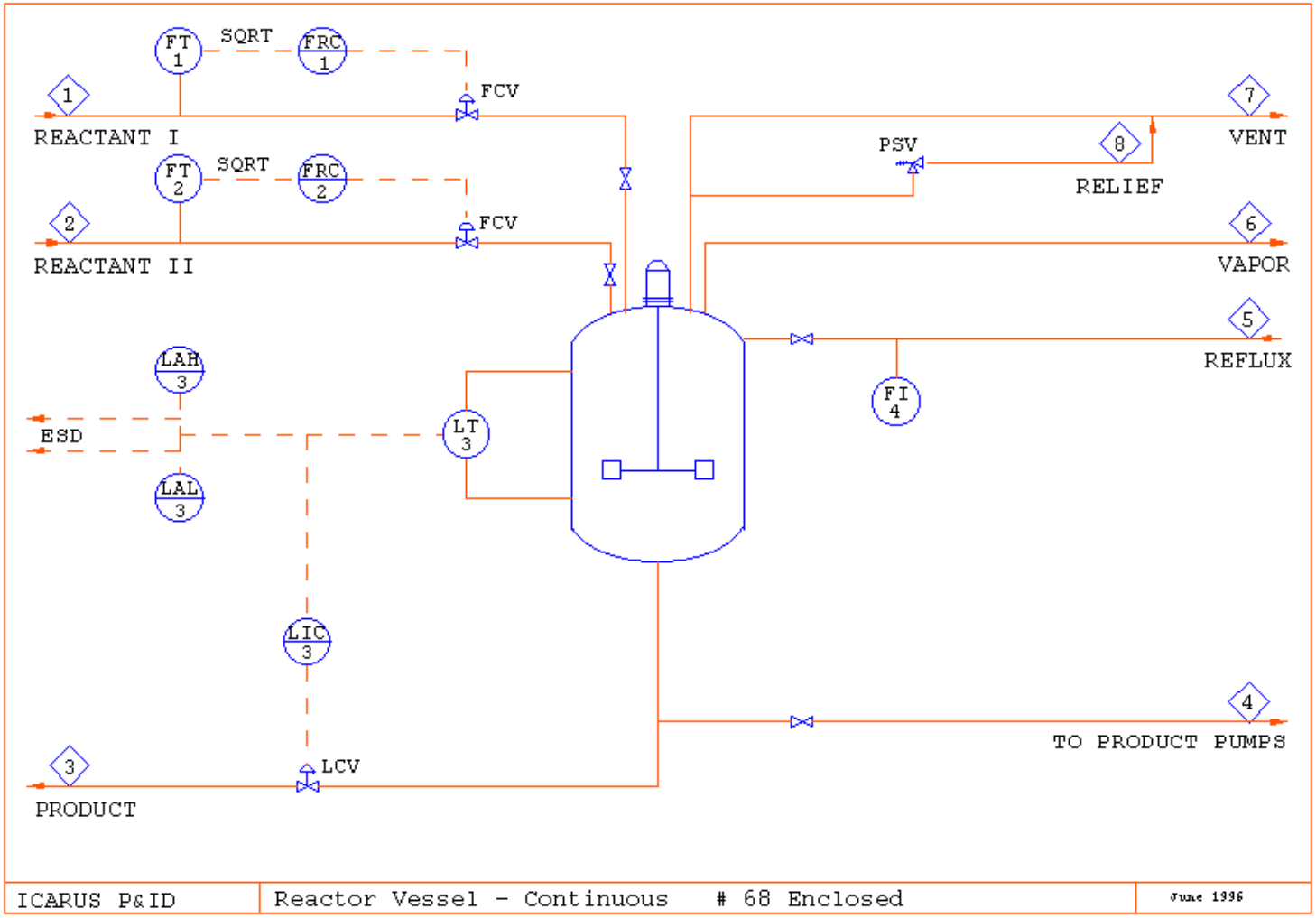
66 Scale



67 Turbine (<500 HP, 375 KW)

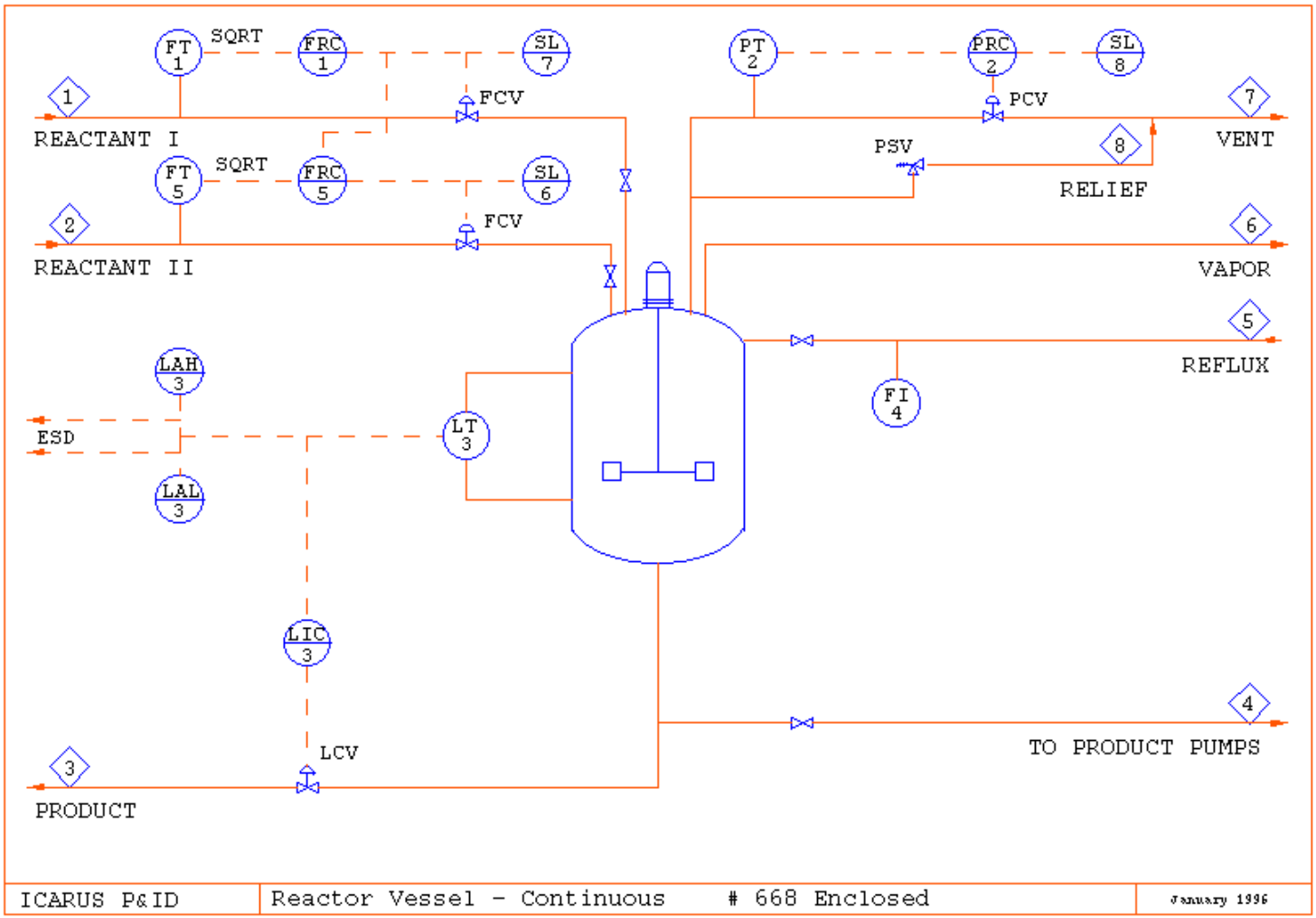


68 Enclosed Reactor Vessel – Continuous



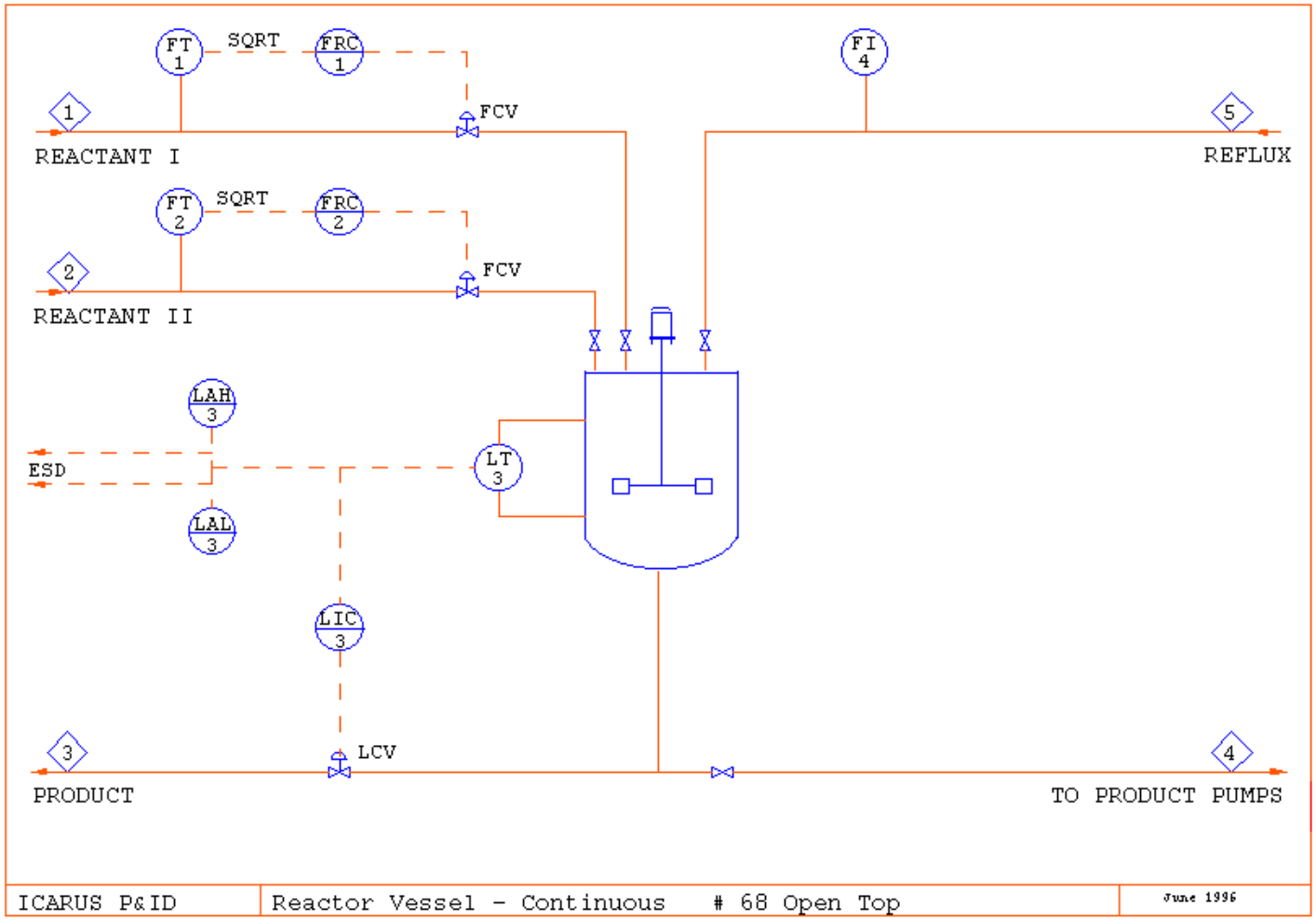
Jacket: See Drawing 23 and 623

668 Enclosed Reactor Vessel – Continuous



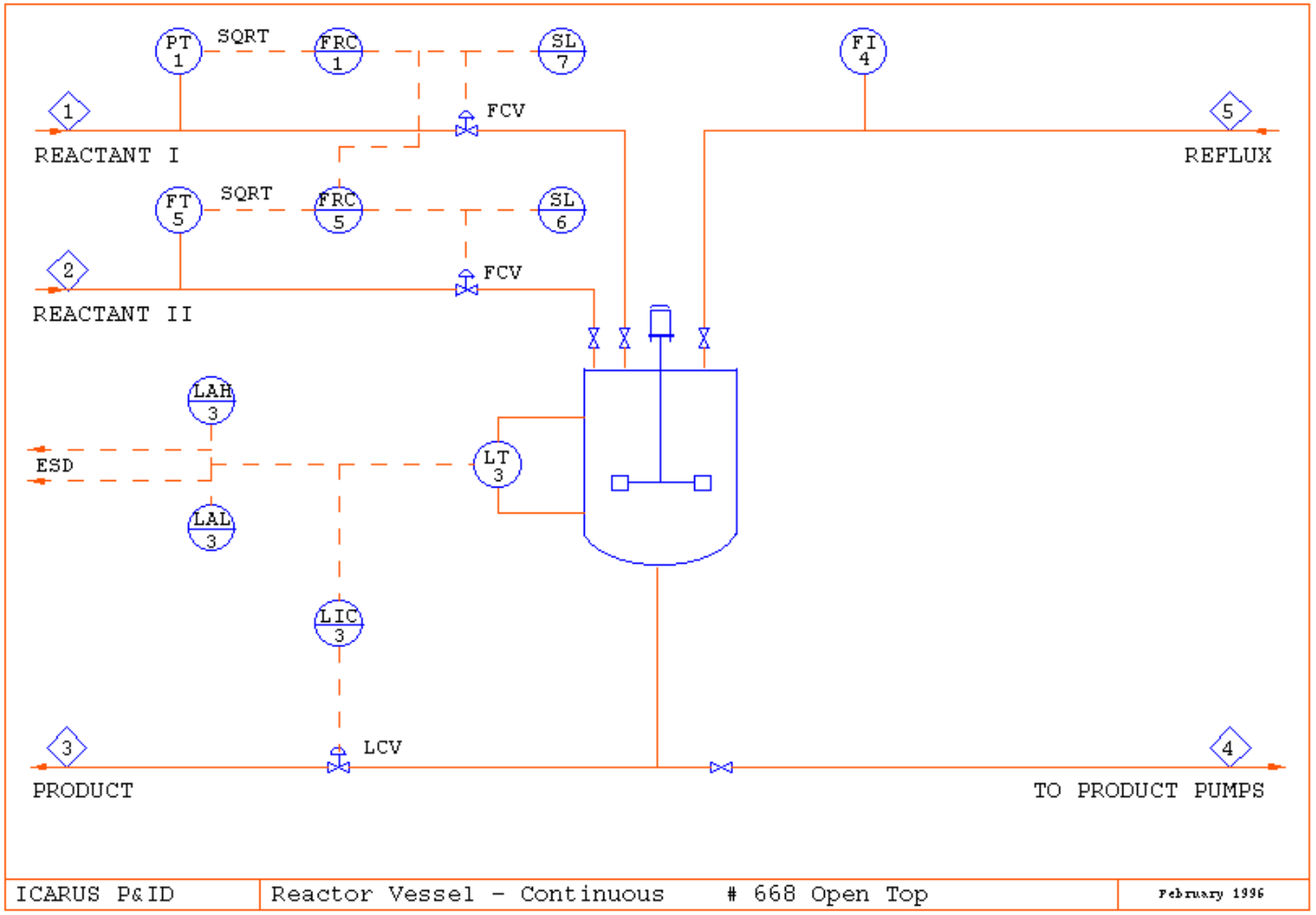
Jacket: See Drawing 23 and 623

68 Open Top Reactor Vessel – Continuous



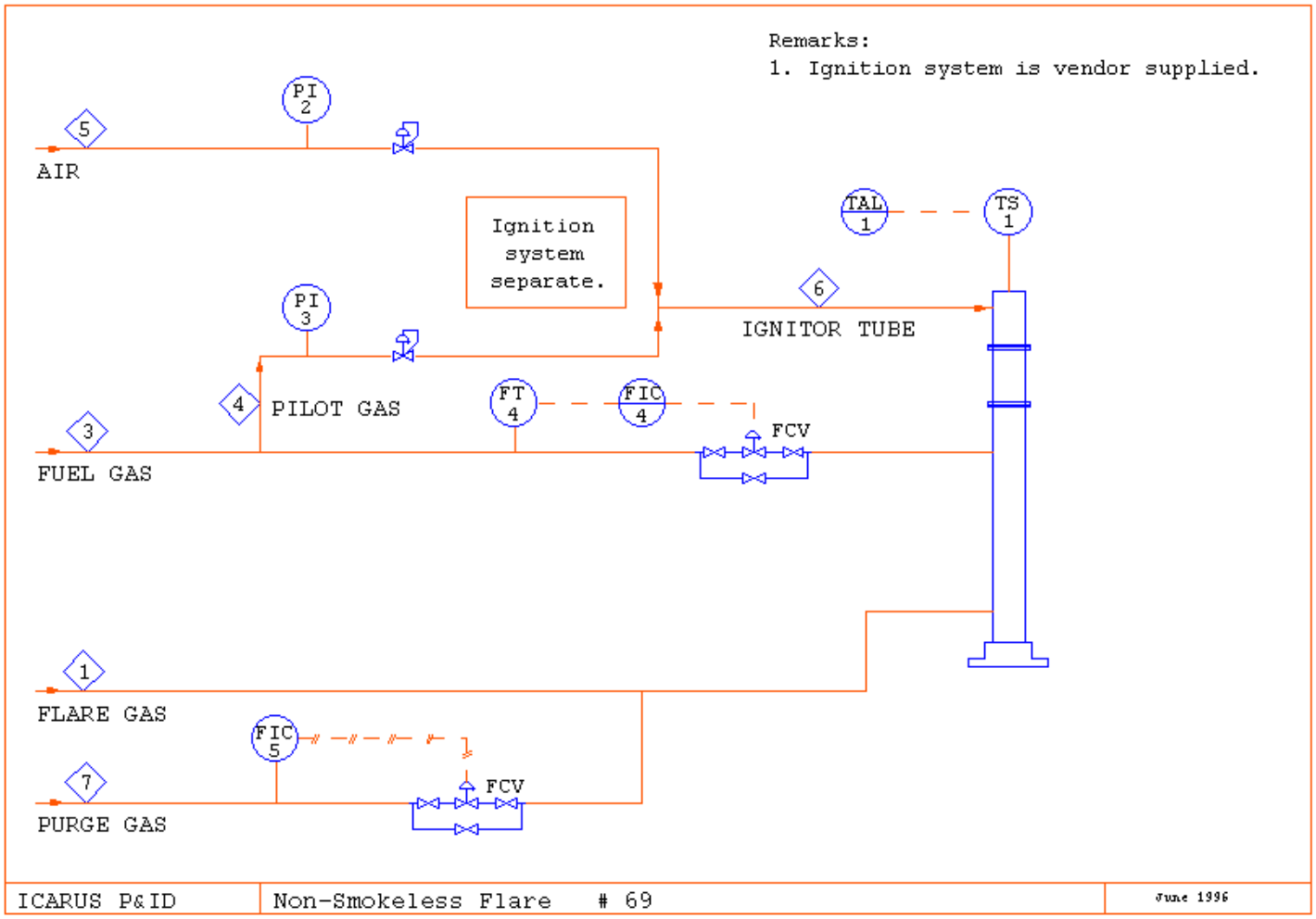
Jacket: See Drawing 23 and 623

668 Open Top Reactor Vessel – Continuous

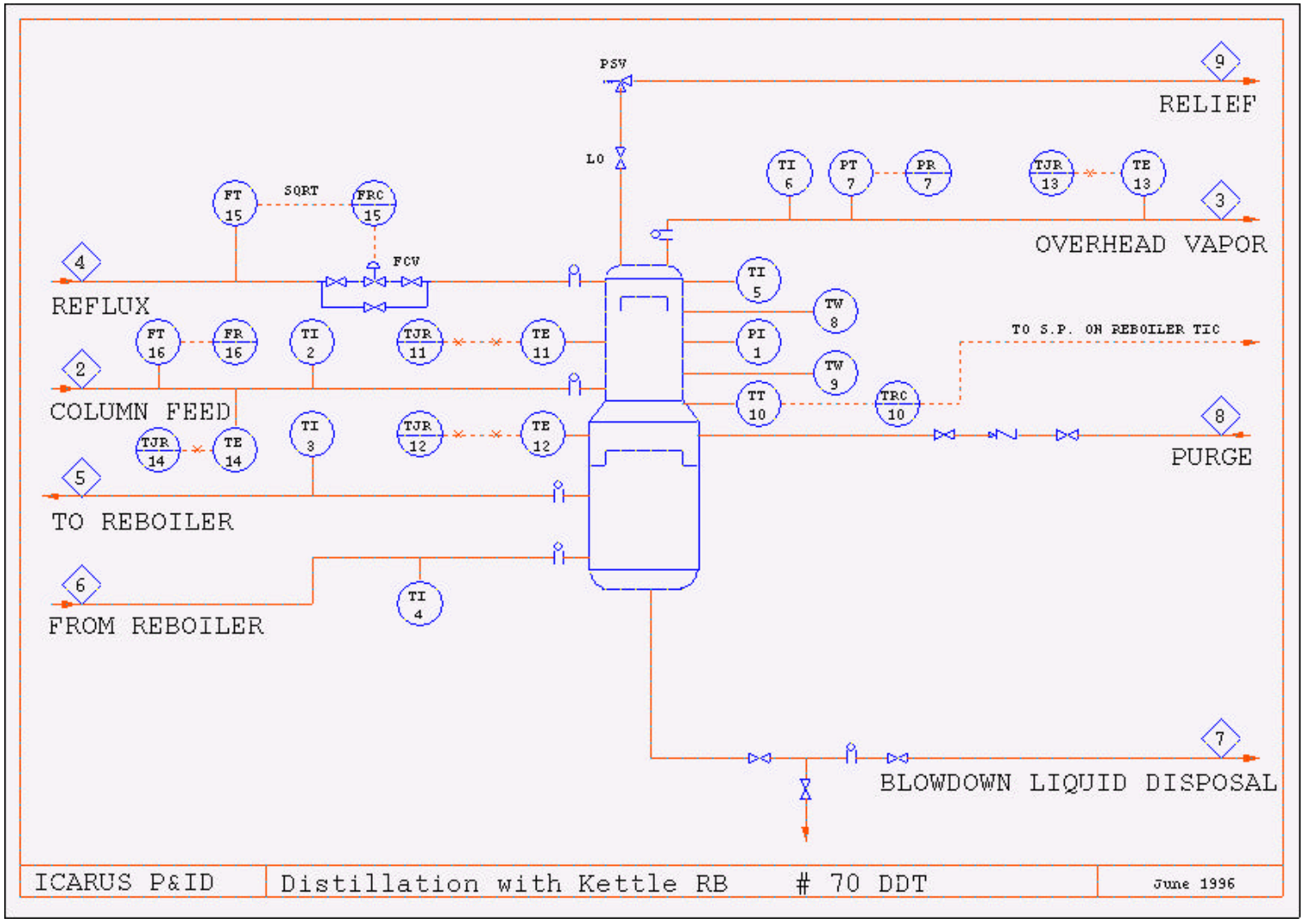


Jacket: See Drawing 23 and 623

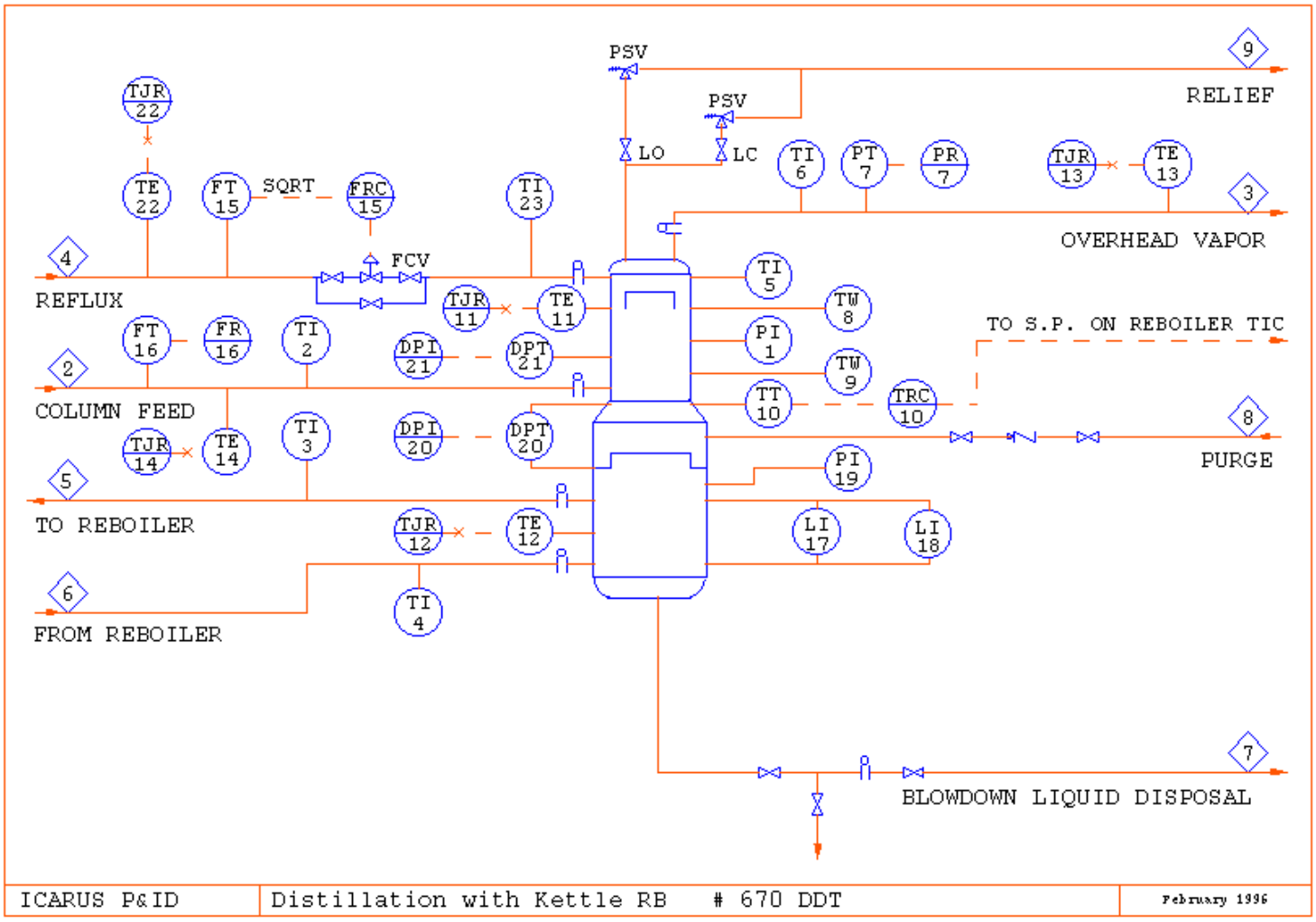
69 Non-Smokeless Flare



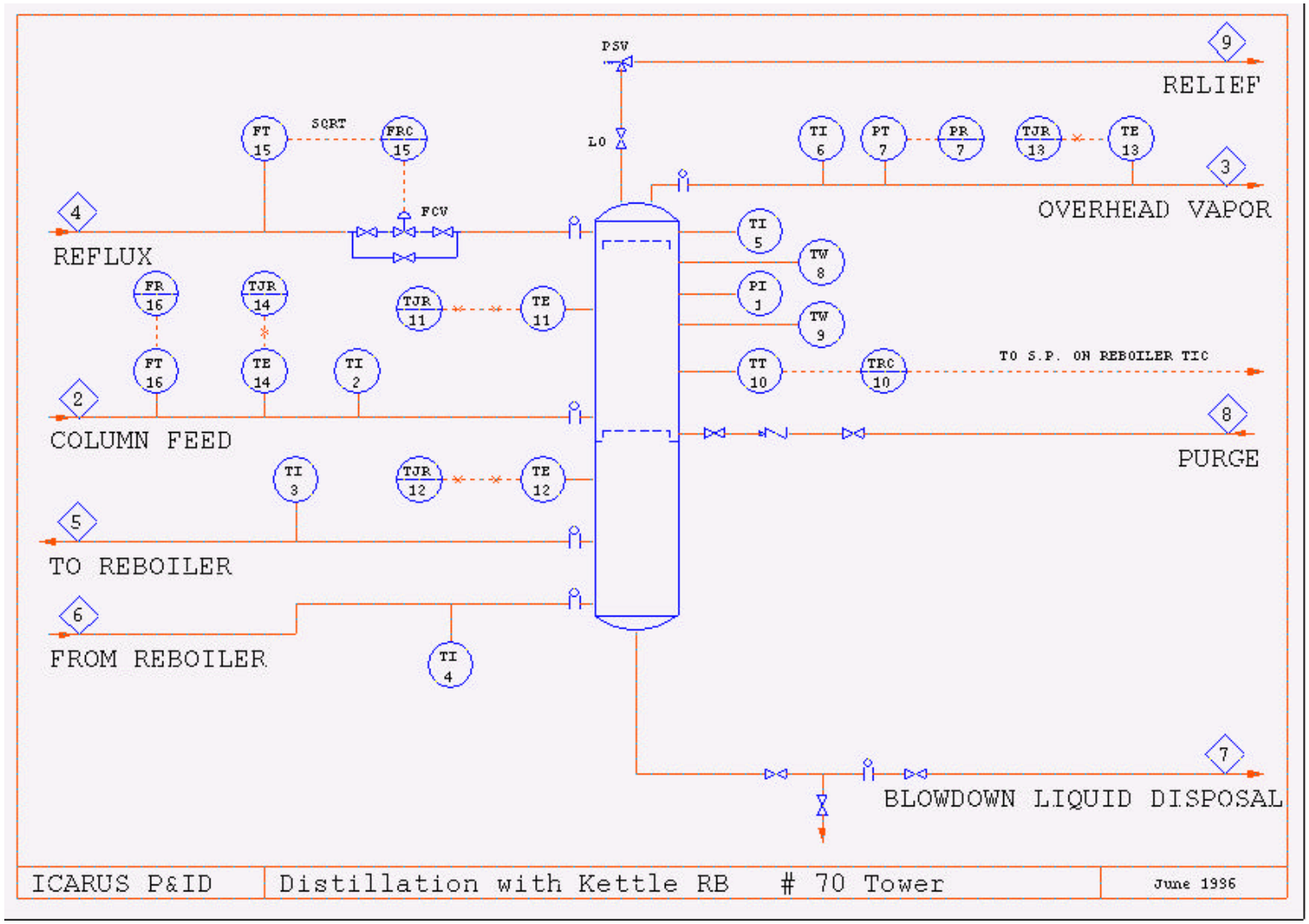
70 DDT – Distillation with Kettle RB



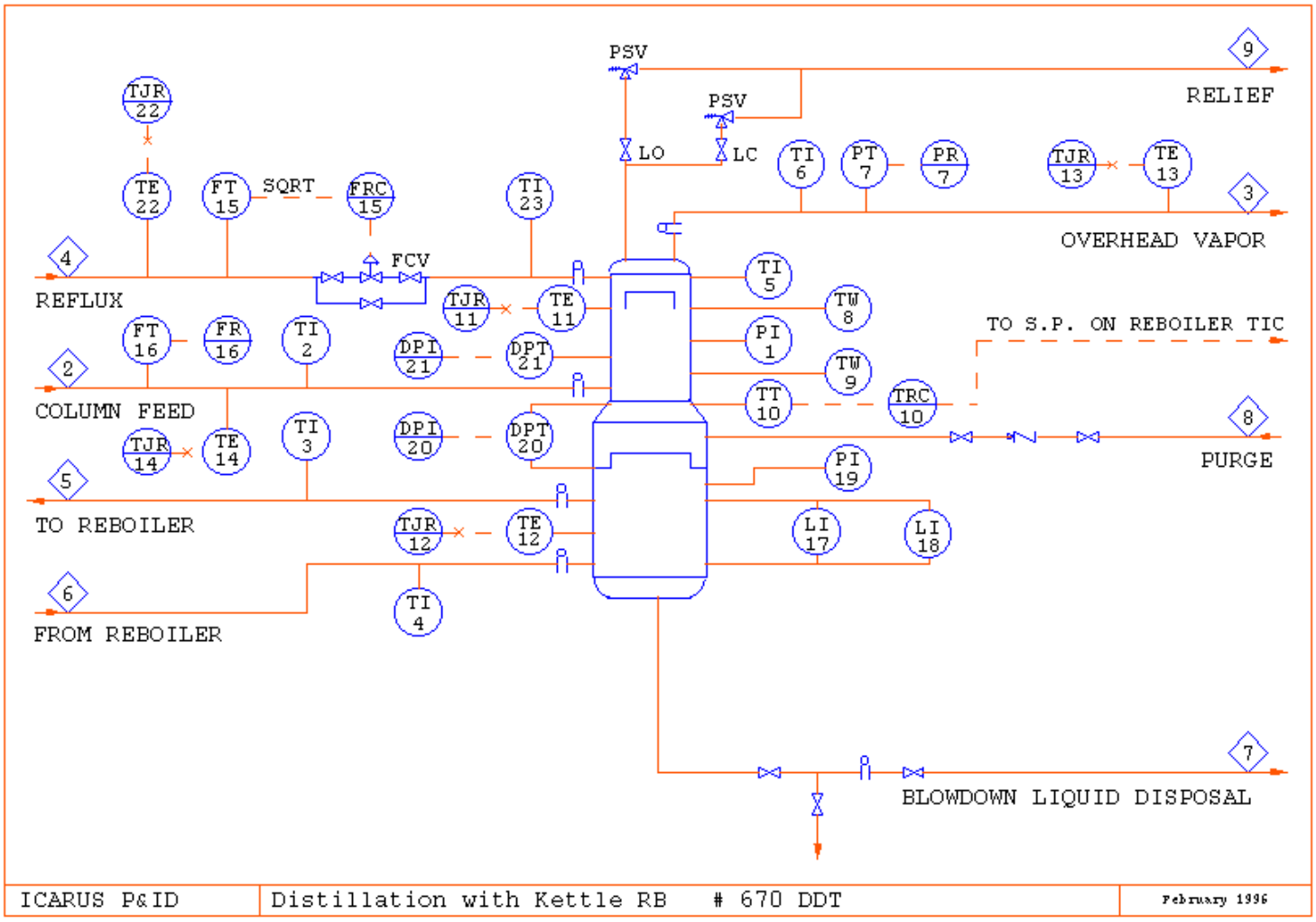
670 DDT – Distillation with Kettle RB



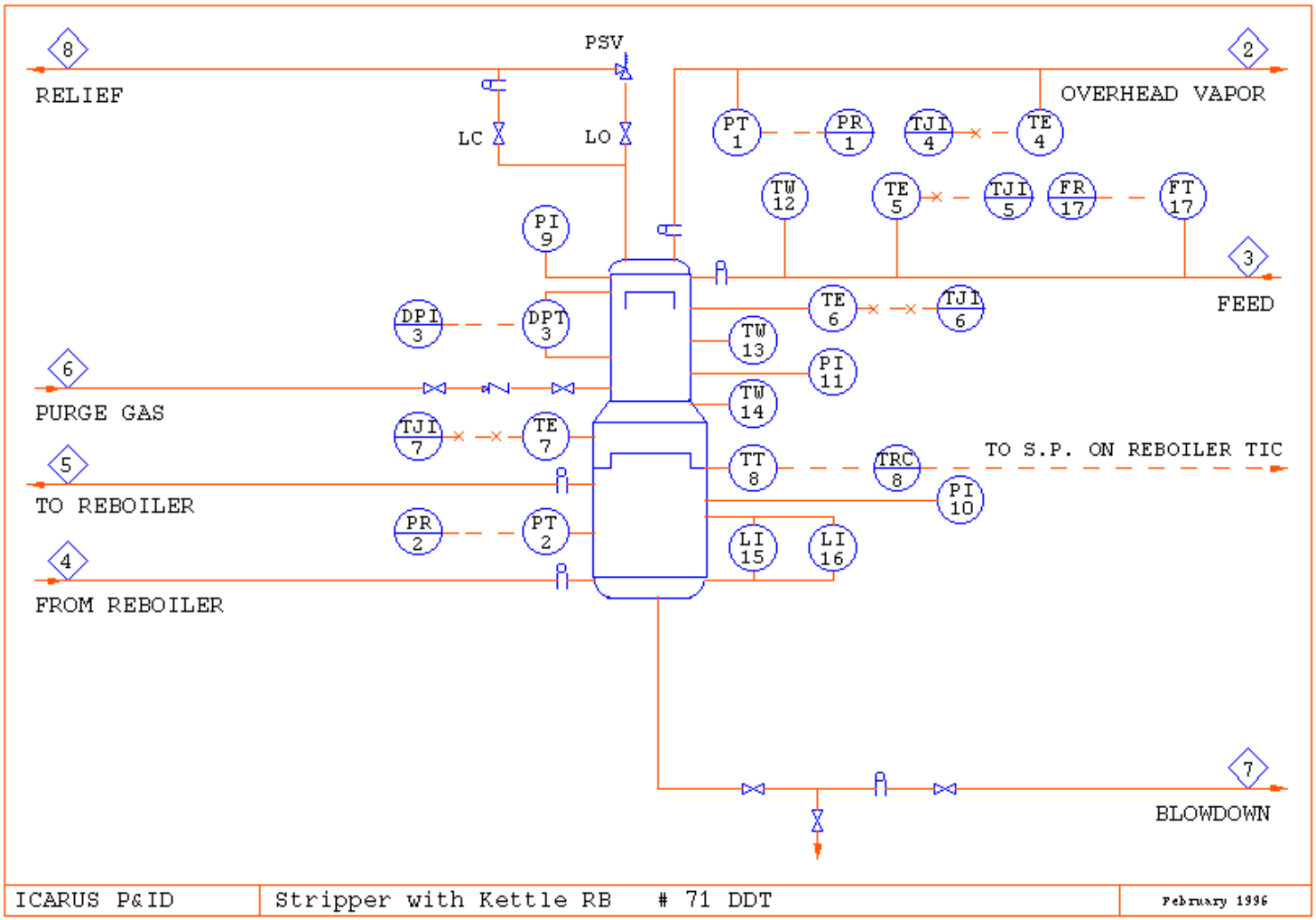
70 Tower – Distillation with Kettle RB



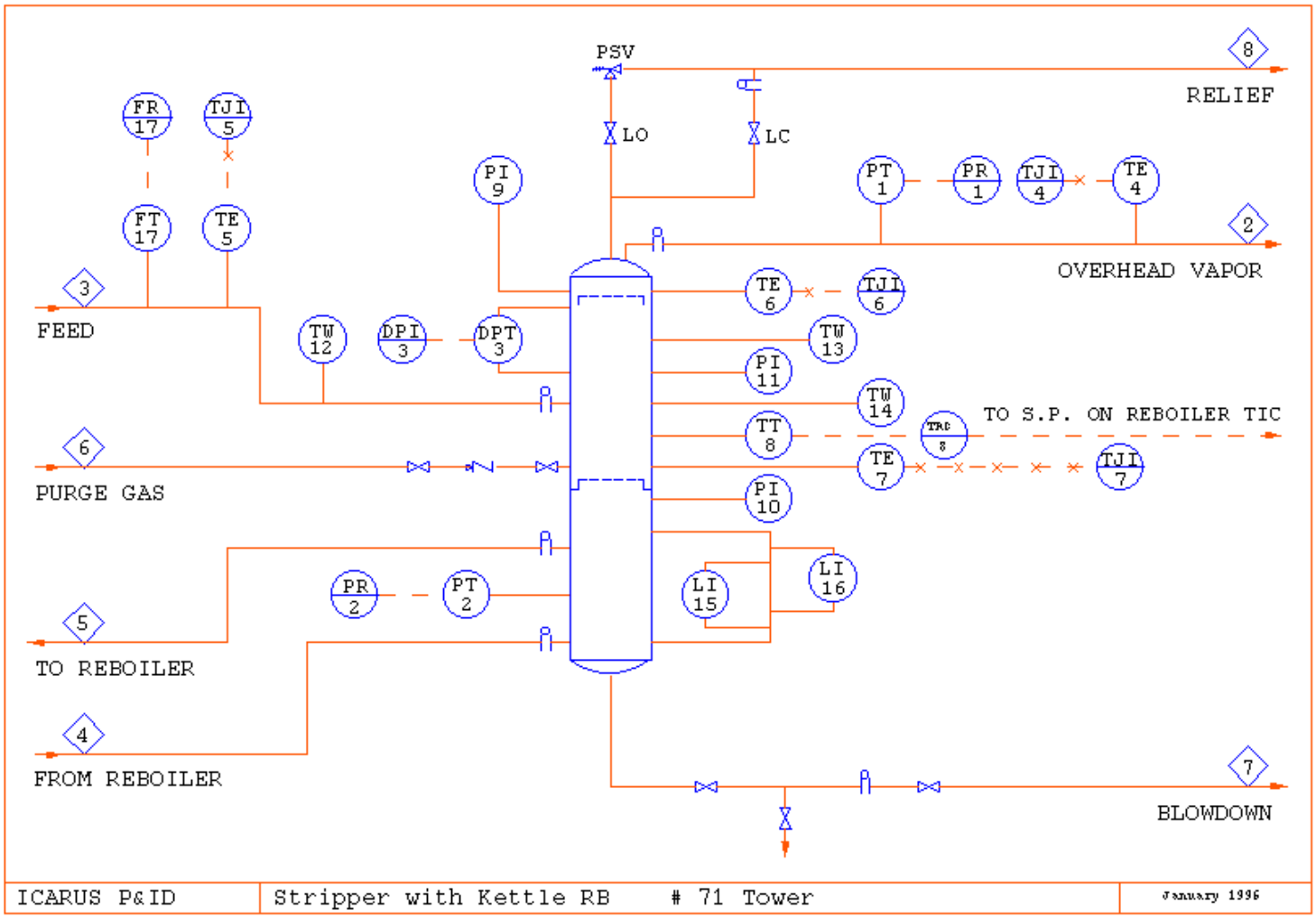
670 Tower – Distillation with Kettle RB



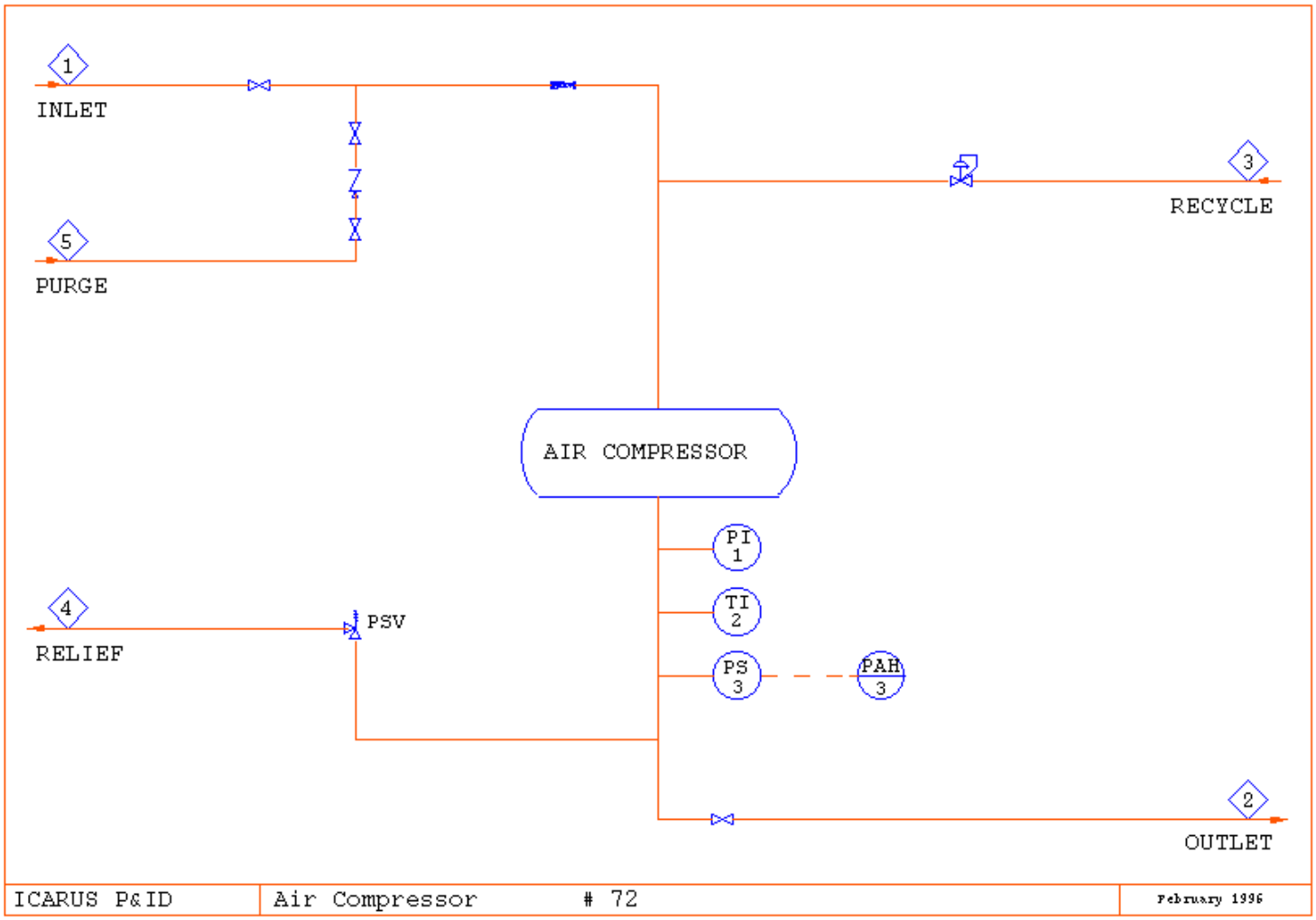
71 DDT – Stripper with Kettle RB



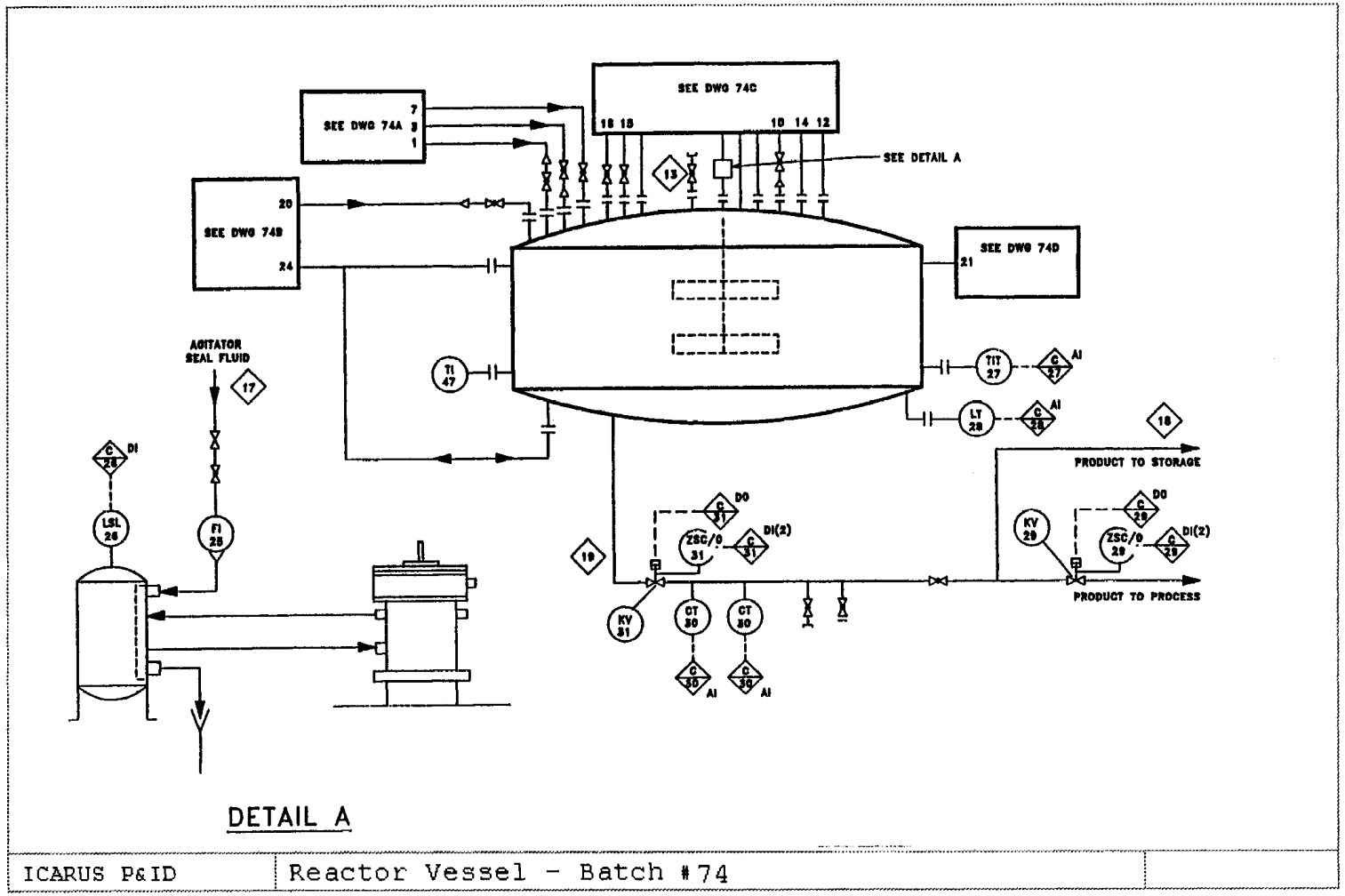
71 Tower – Stripper with Kettle RB



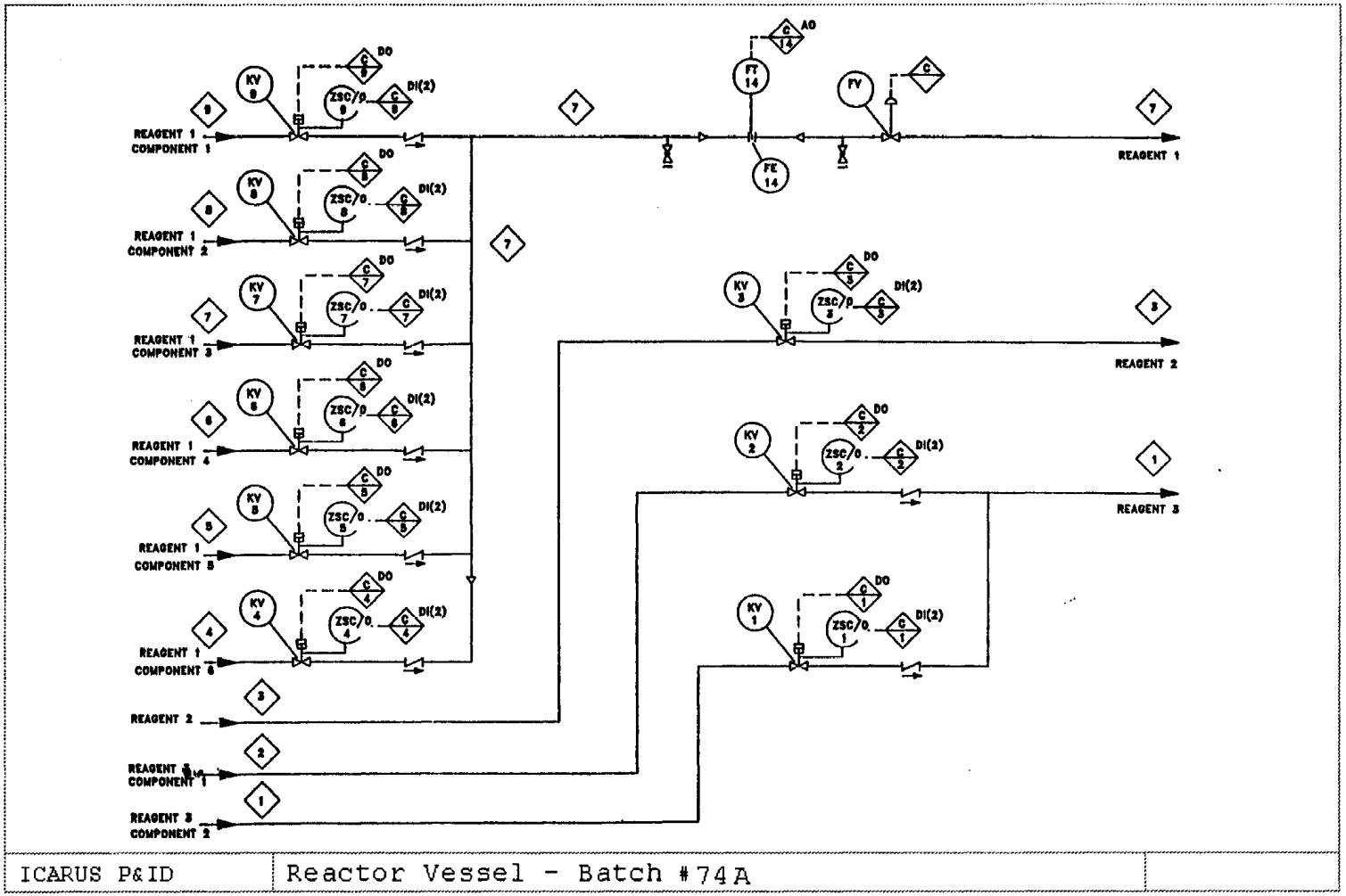
72 Air Compressor



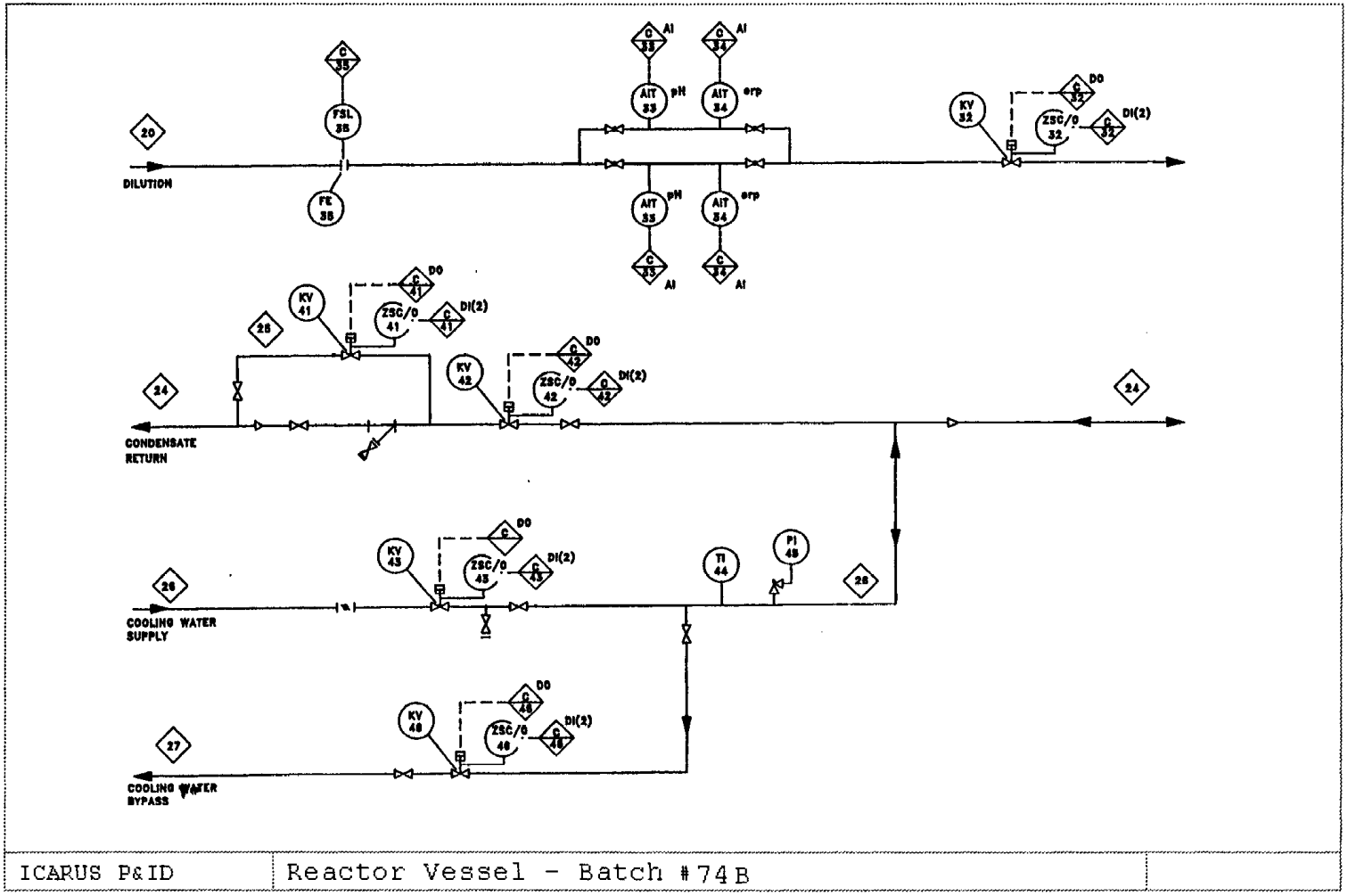
74 Reactor Vessel – Batch



74A Reactor Vessel – Batch

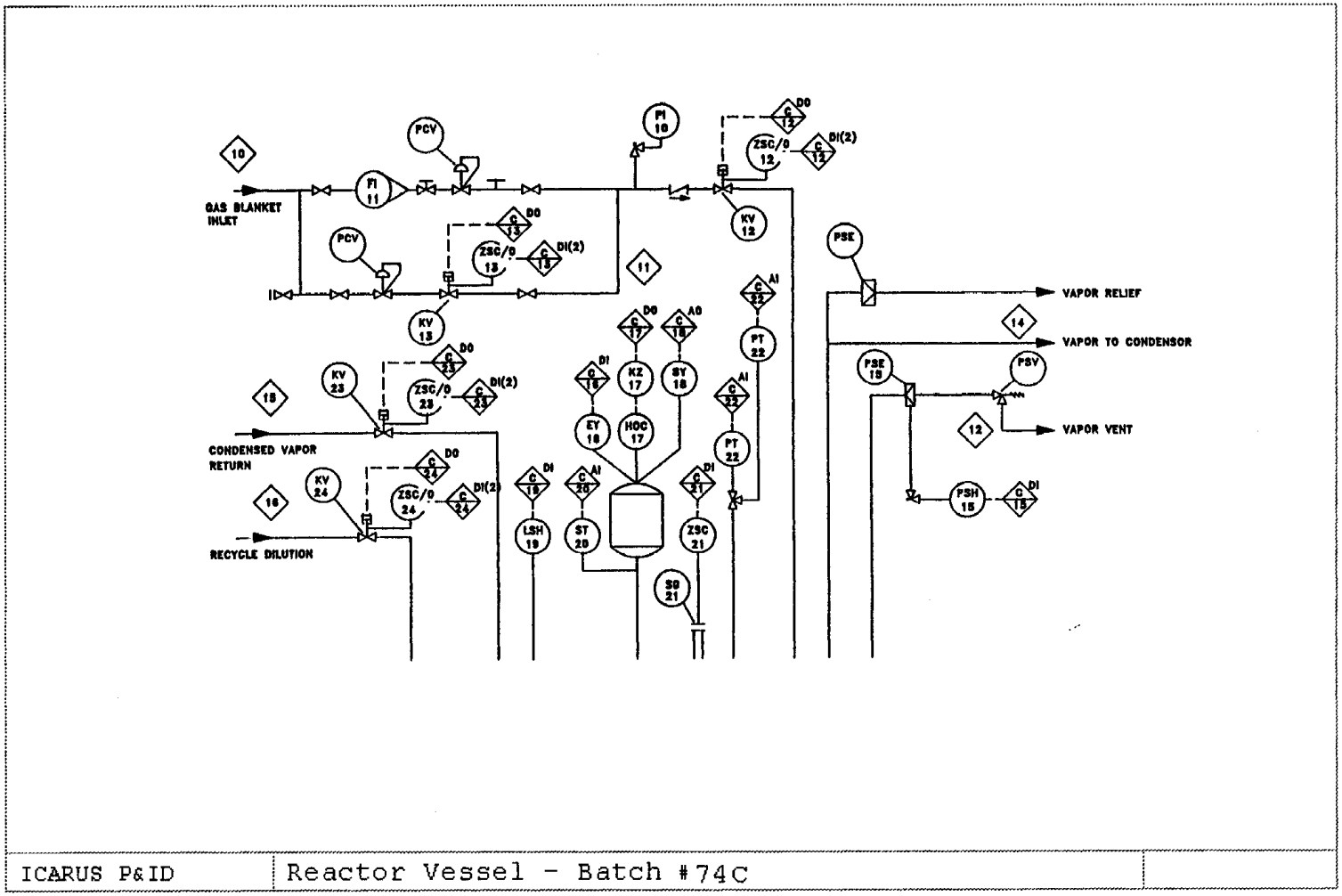


74B Reactor Vessel – Batch



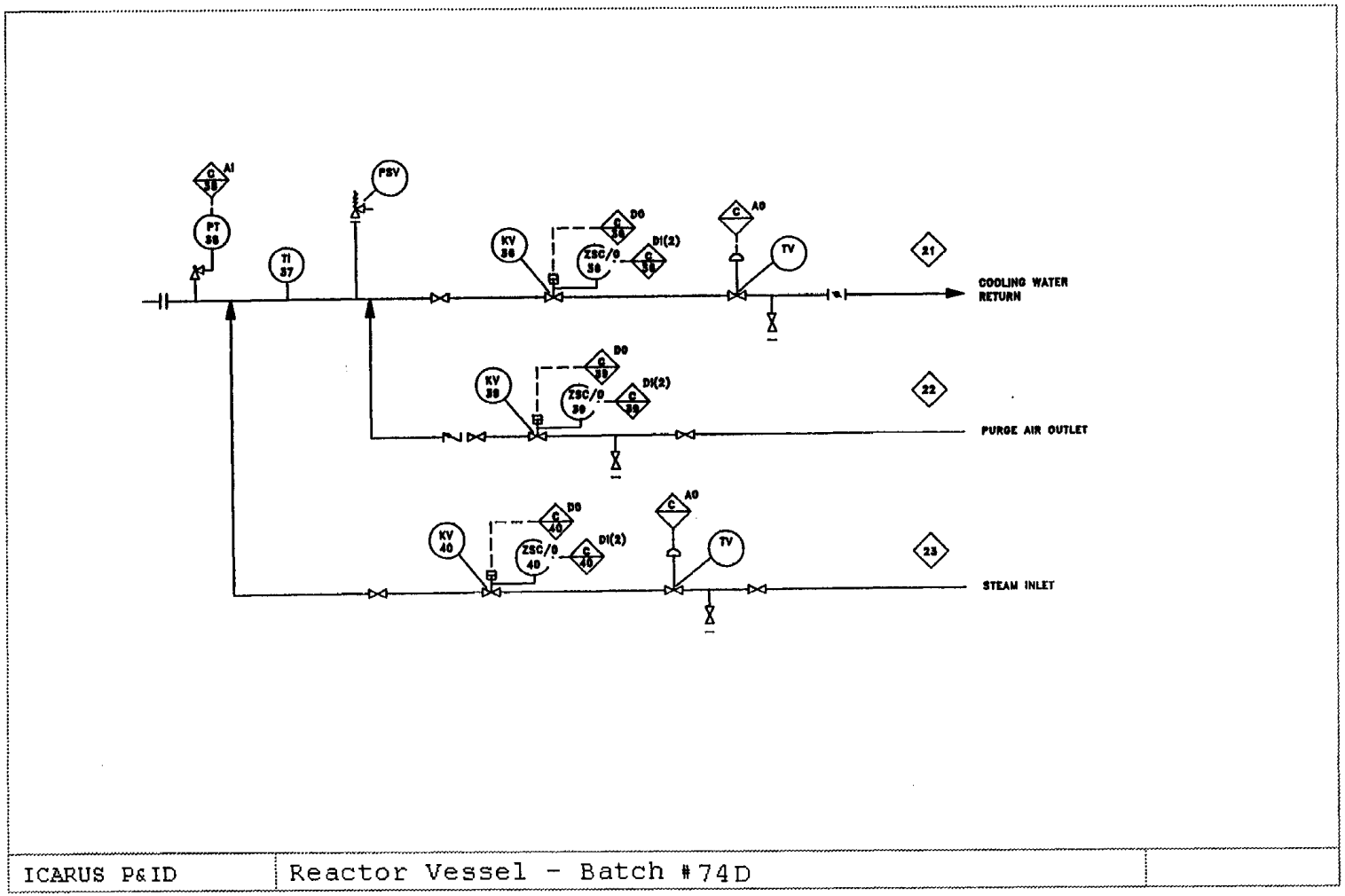
ICARUS P&ID	Reactor Vessel - Batch #74B	

74C Reactor Vessel – Batch

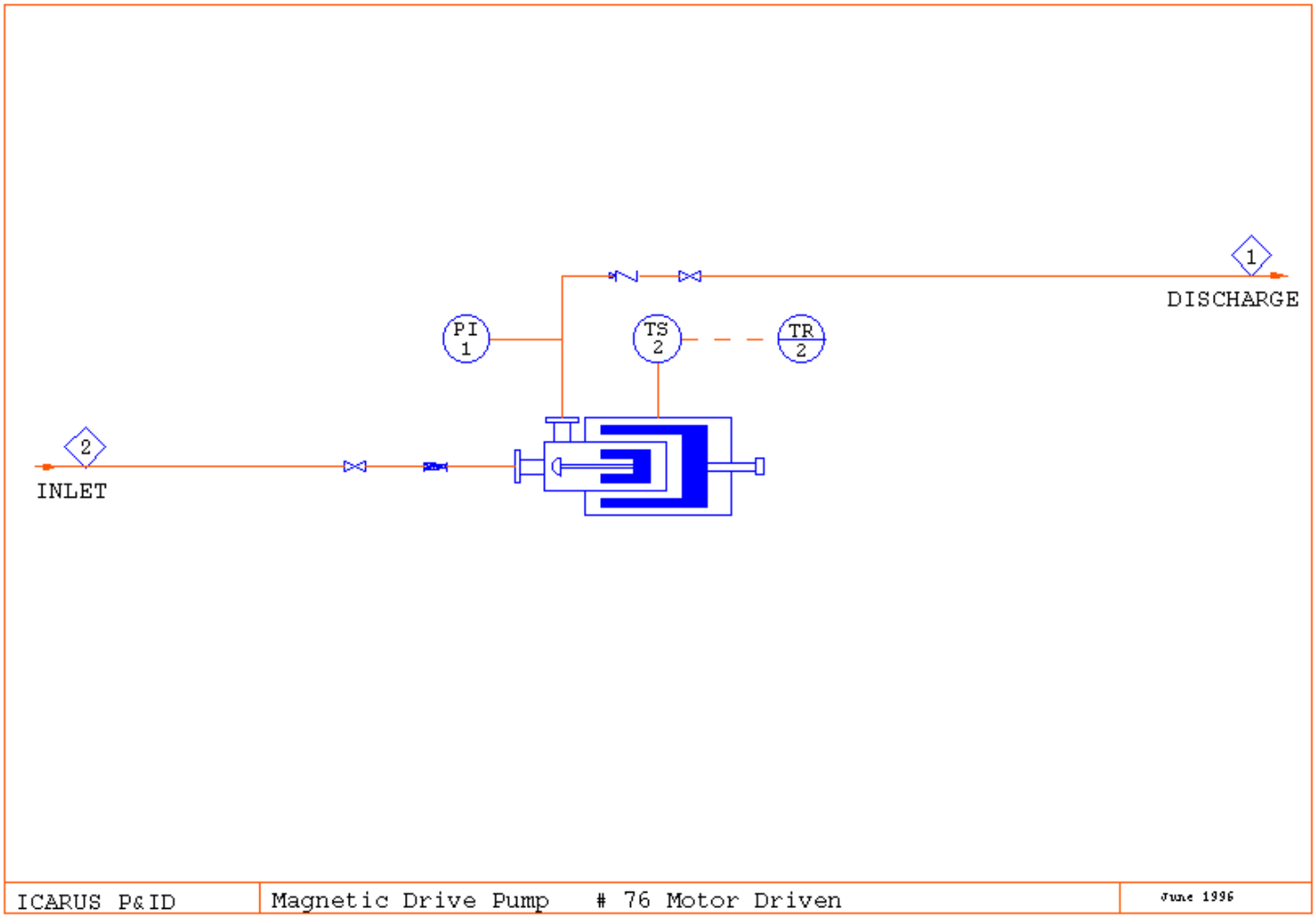


ICARUS P&ID	Reactor Vessel - Batch #74C	

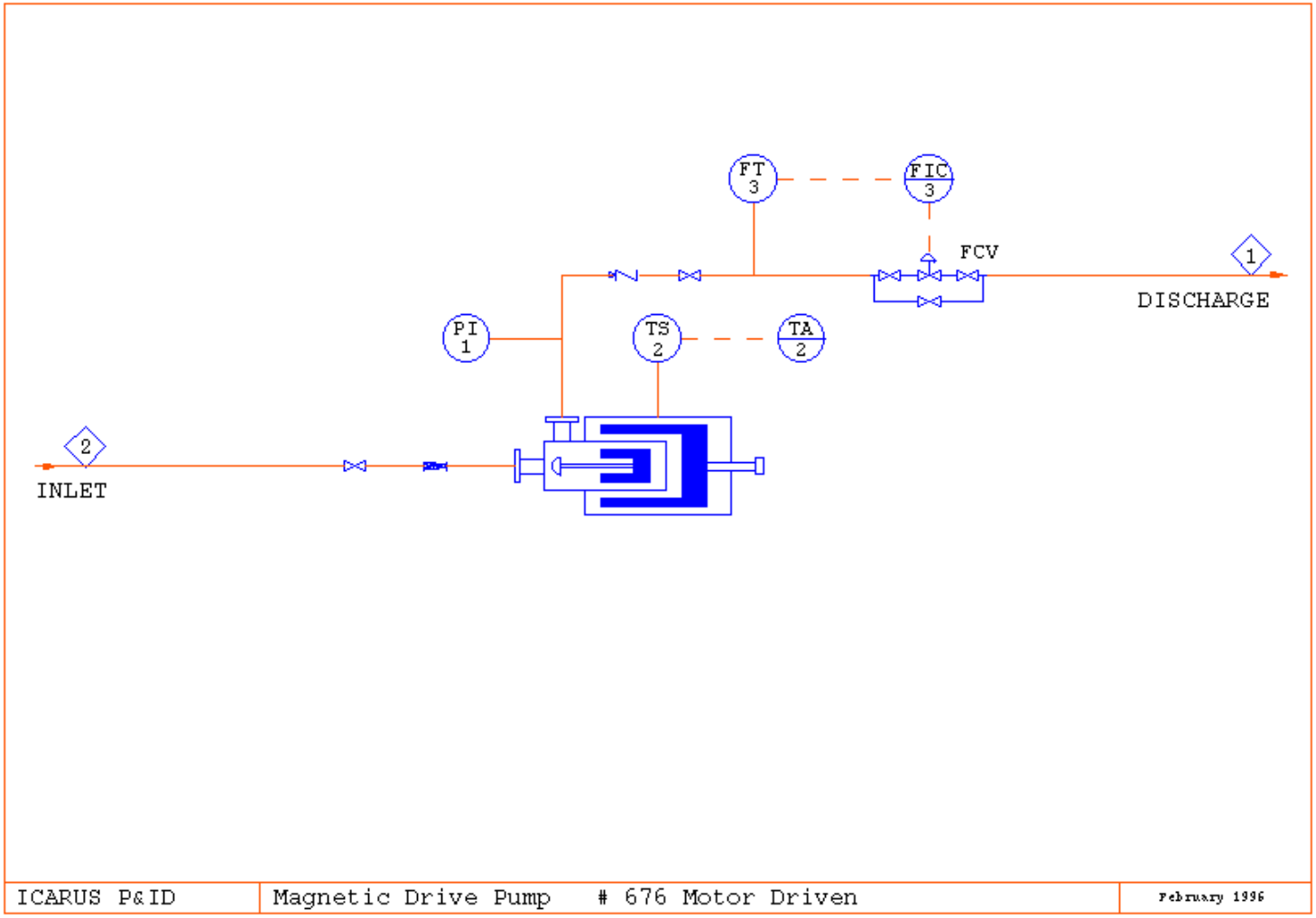
74D Reactor Vessel – Batch



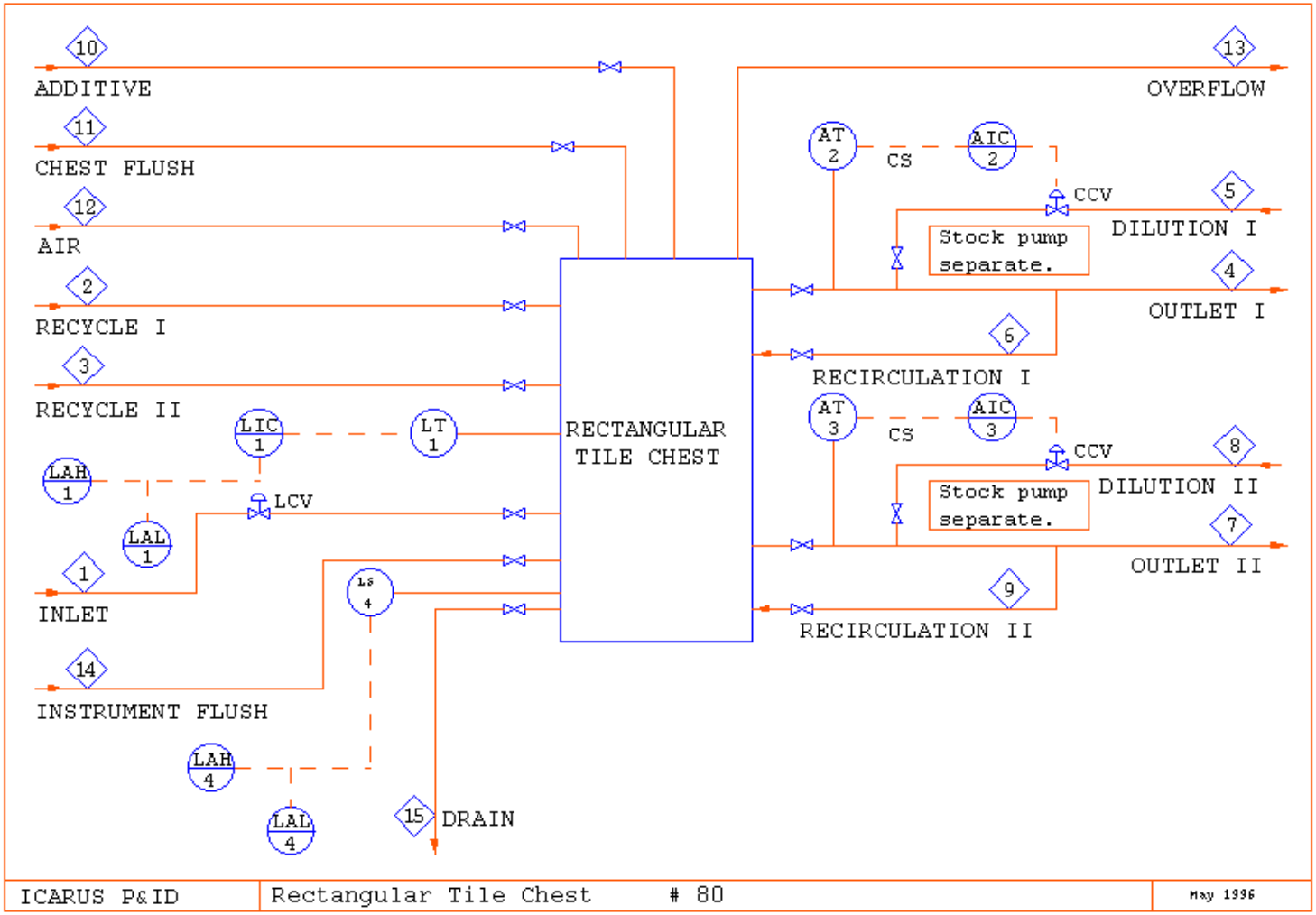
76 Motor Driven Magnetic Drive Pipe



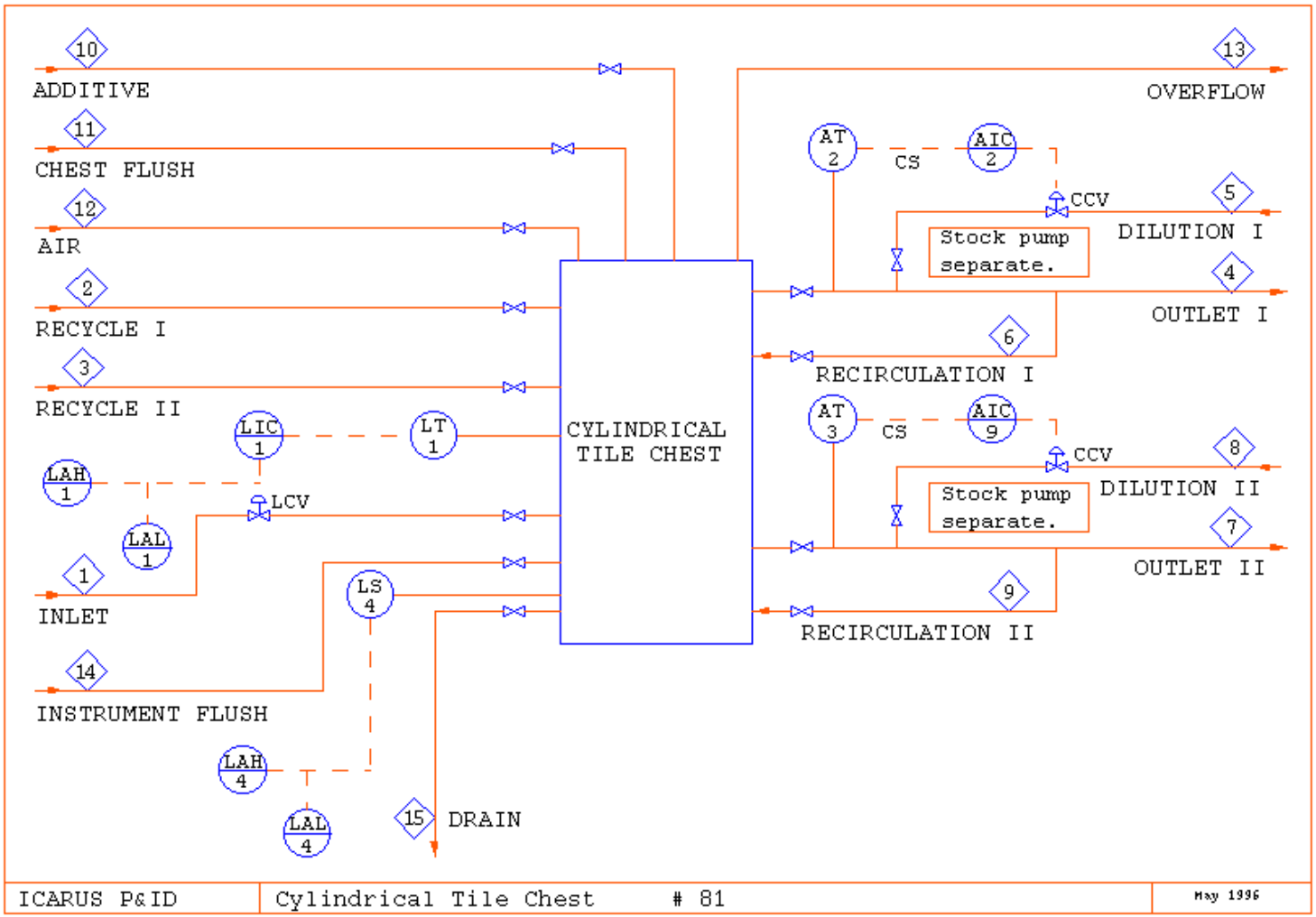
676 Motor Driven Magnetic Drive Pump



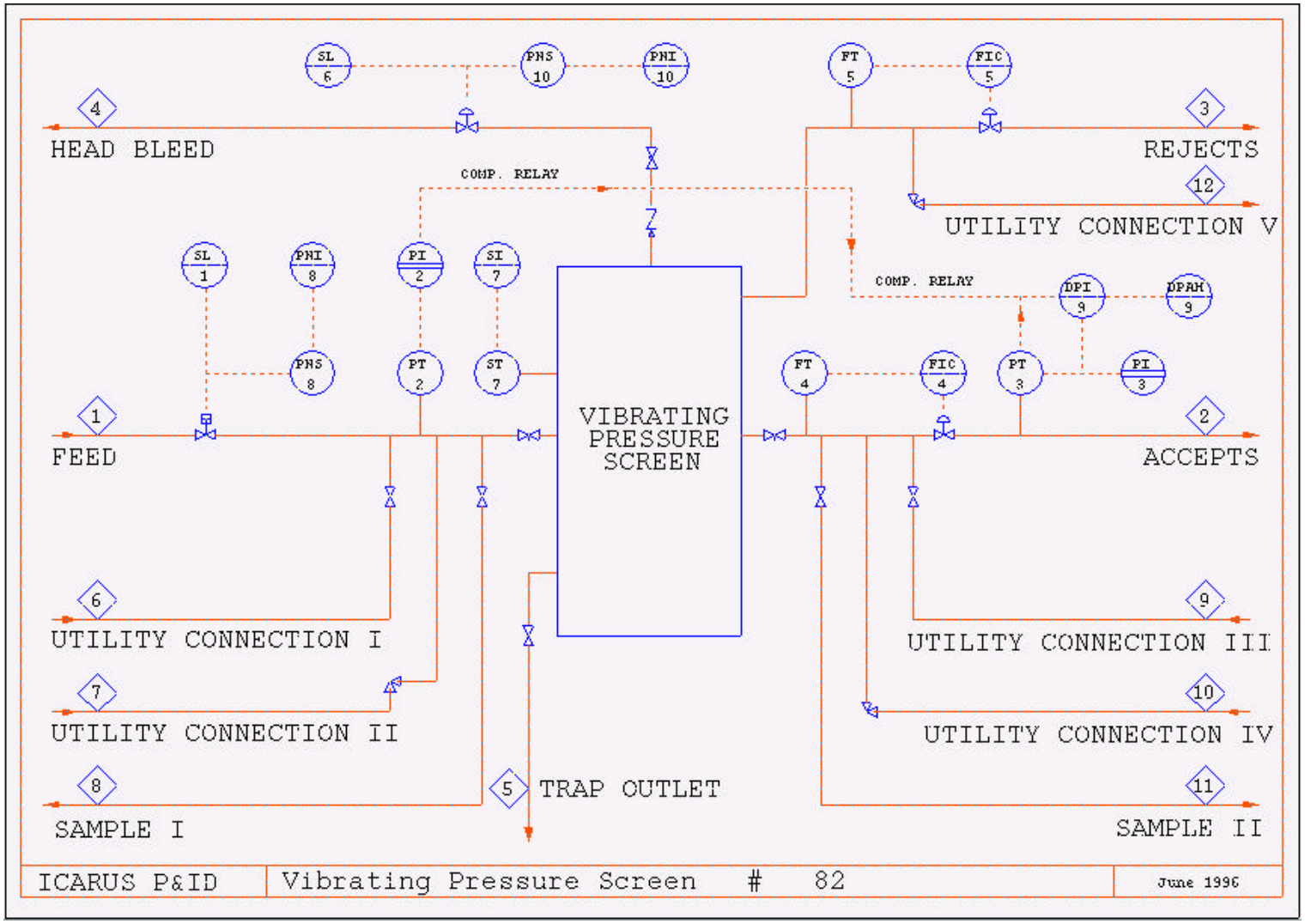
80 Rectangular Tile Chest



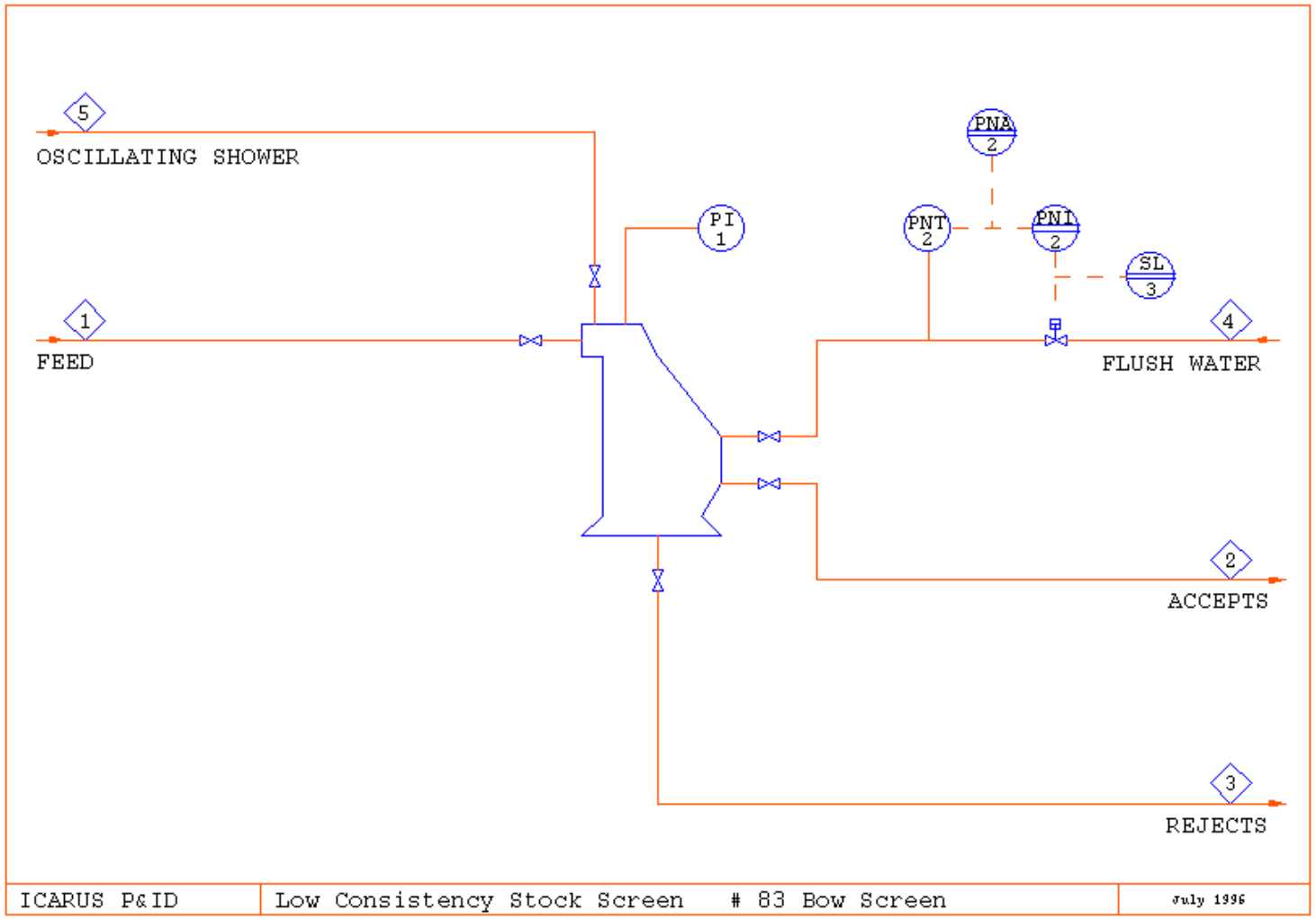
81 Cylindrical Tile Chest



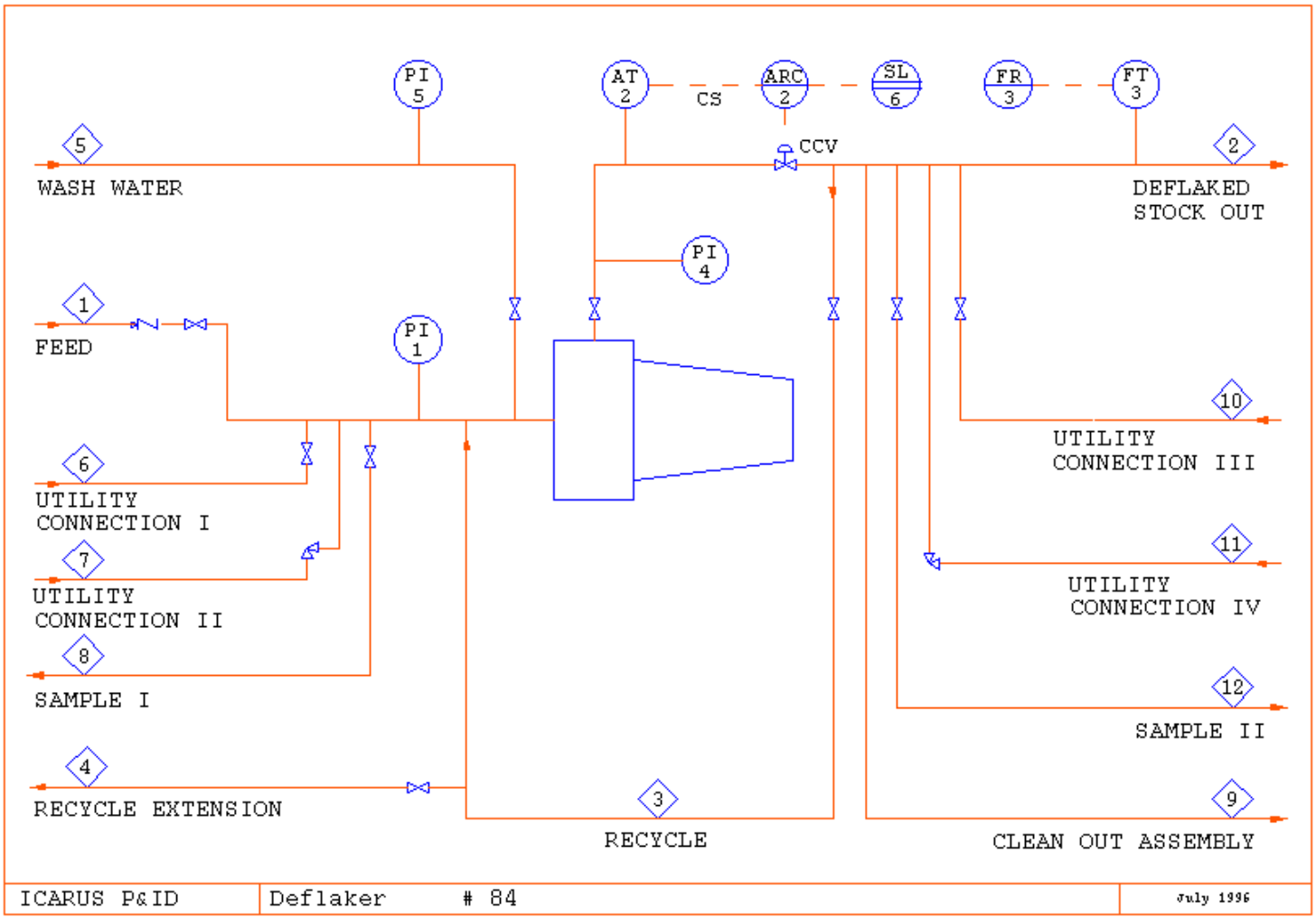
82 Vibrating Pressure Screen



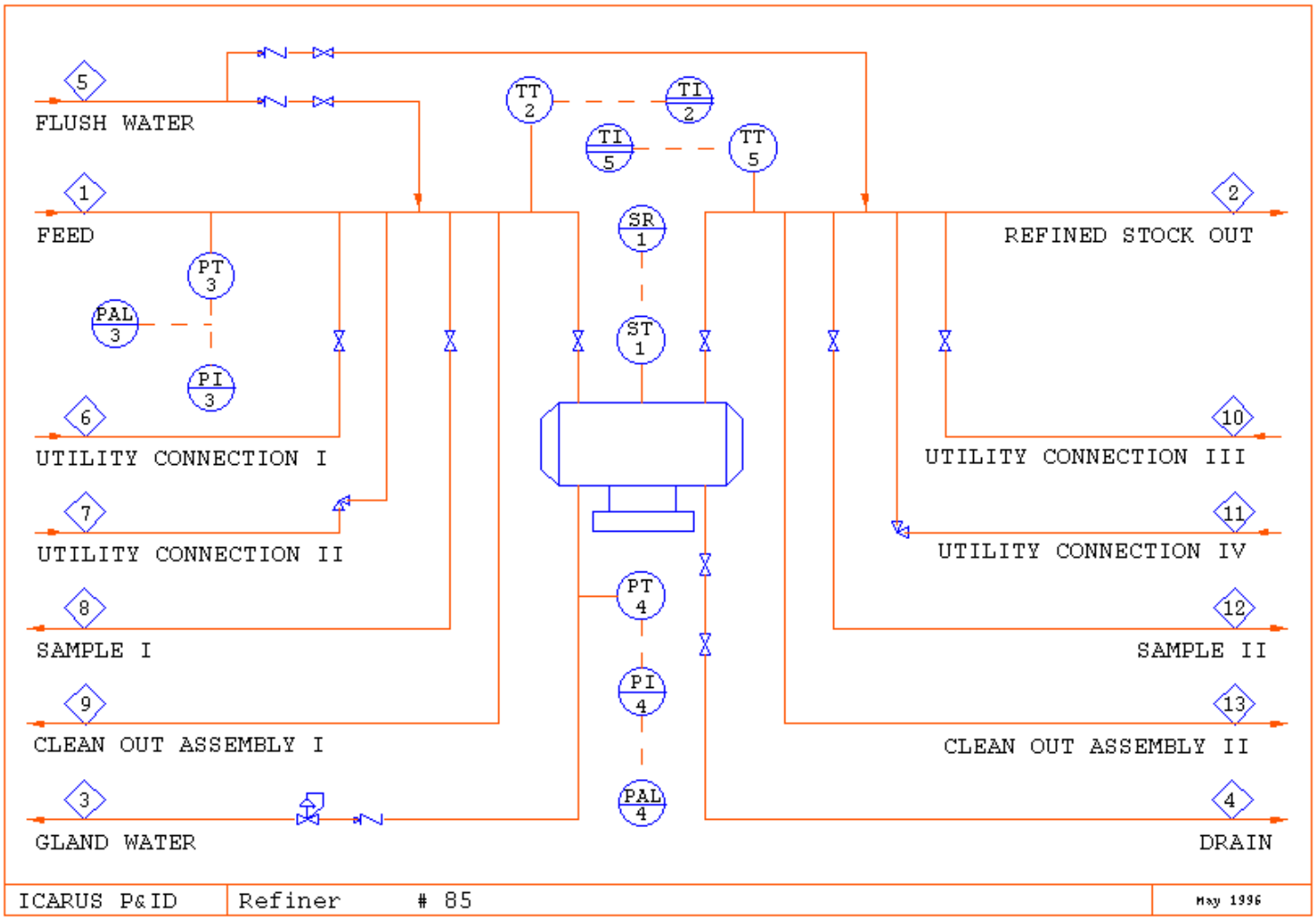
83 Bow Screen – Low Consistency Stock Screen



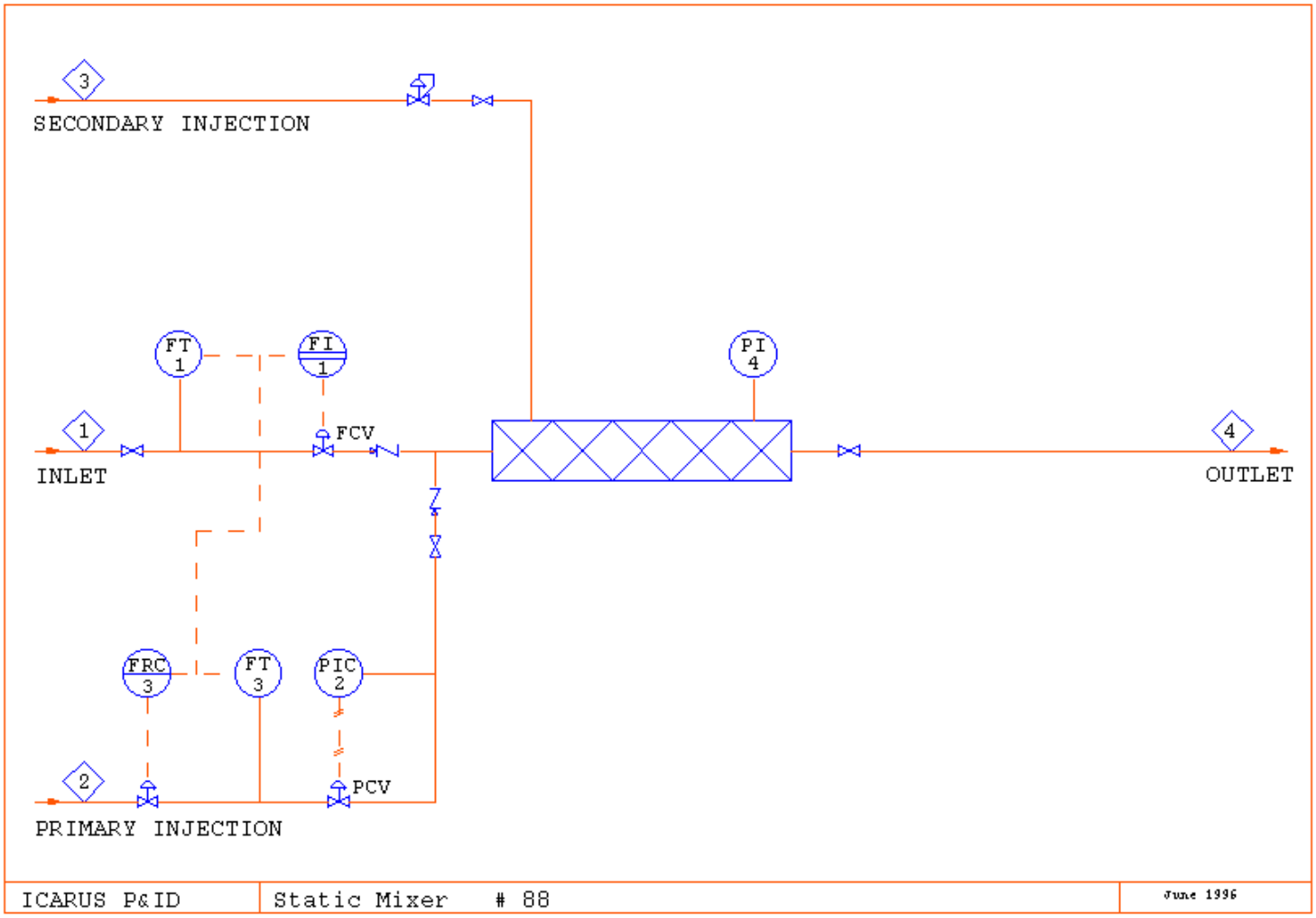
84 Deflaker


PI 5
AT 2
CS
ARC 2
SL 6
FR 3
FT 3
5
WASH WATER
CCV
2
DEFLAKED STOCK OUT
PI 4
1
FEED
PI 1
10
UTILITY CONNECTION III
6
UTILITY CONNECTION I
11
UTILITY CONNECTION IV
7
UTILITY CONNECTION II
8
SAMPLE I
12
SAMPLE II
4
RECYCLE EXTENSION
3
RECYCLE
9
CLEAN OUT ASSEMBLY
ICARUS P&ID
Deflaker # 84
July 1996

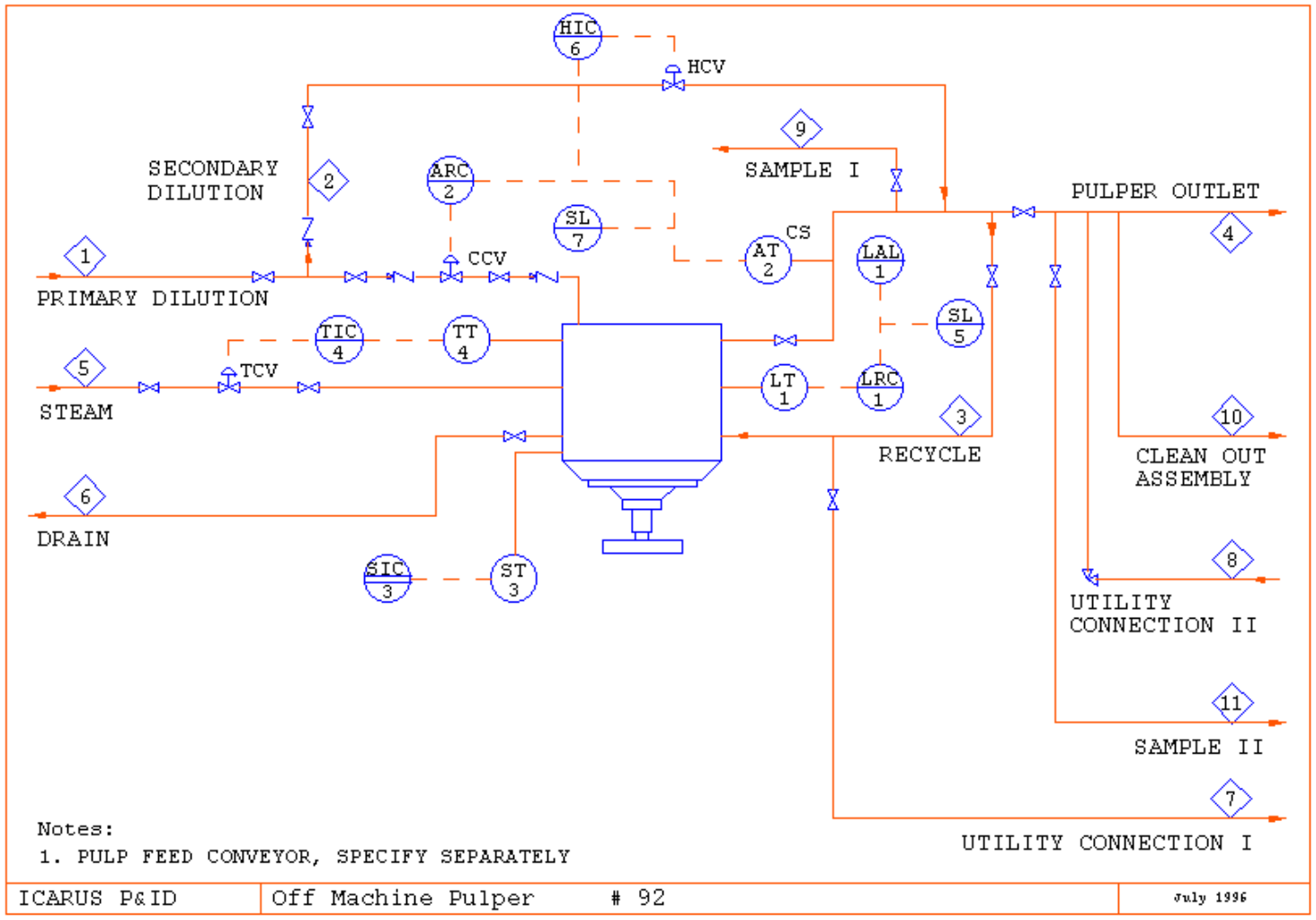
85 Refiner


5
FLUSH WATER
1
FEED
PT 3
PAL 3
PI 3
6
UTILITY CONNECTION I
7
UTILITY CONNECTION II
8
SAMPLE I
9
CLEAN OUT ASSEMBLY I
3
GLAND WATER
TT 2
TI 2
TI 5
TT 5
SR 1
ST 1
PT 4
PI 4
PAL 4
2
REFINED STOCK OUT
10
UTILITY CONNECTION III
11
UTILITY CONNECTION IV
12
SAMPLE II
13
CLEAN OUT ASSEMBLY II
4
DRAIN
ICARUS P&ID
Refiner # 85
May 1996

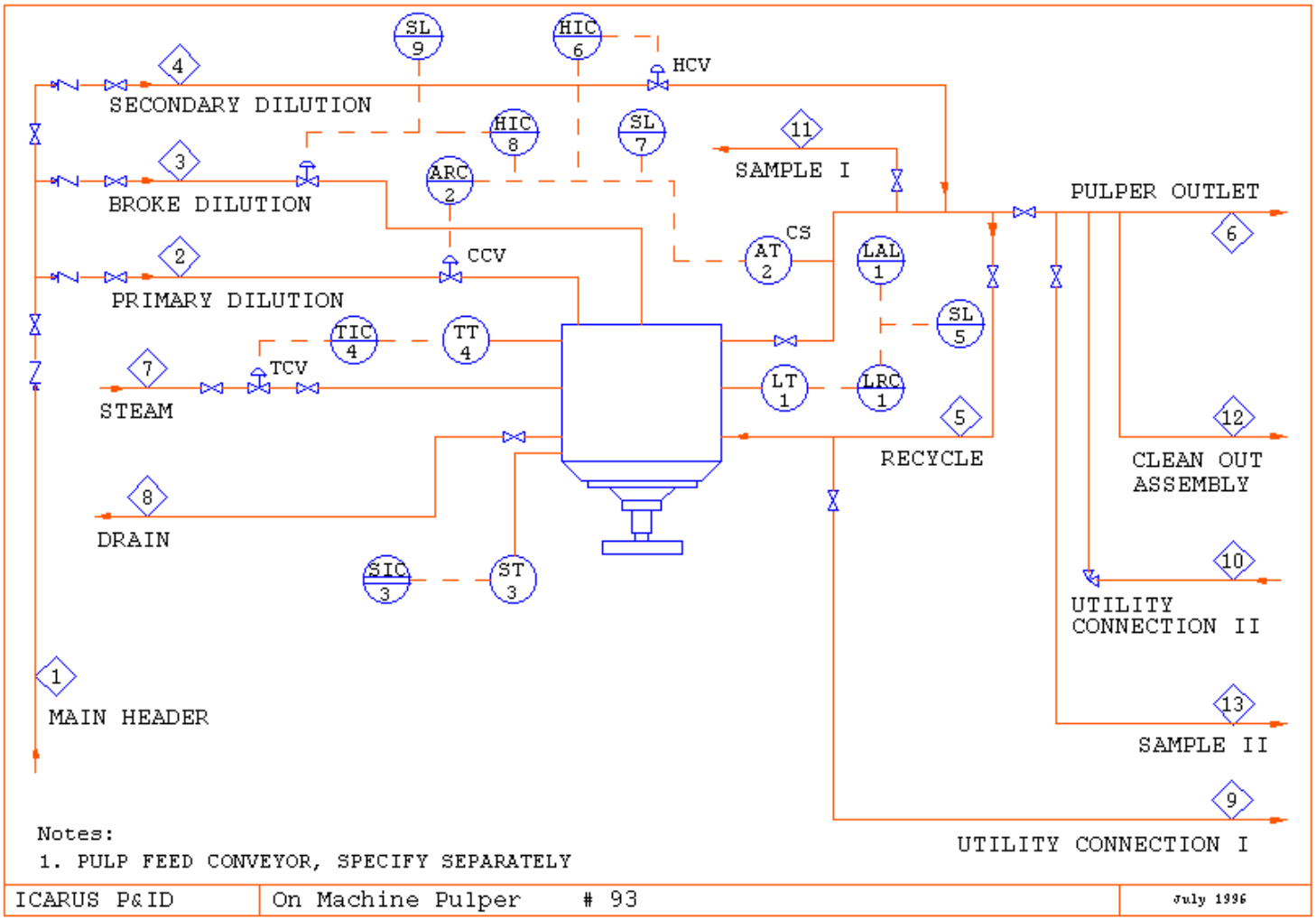
88 Static Mixer



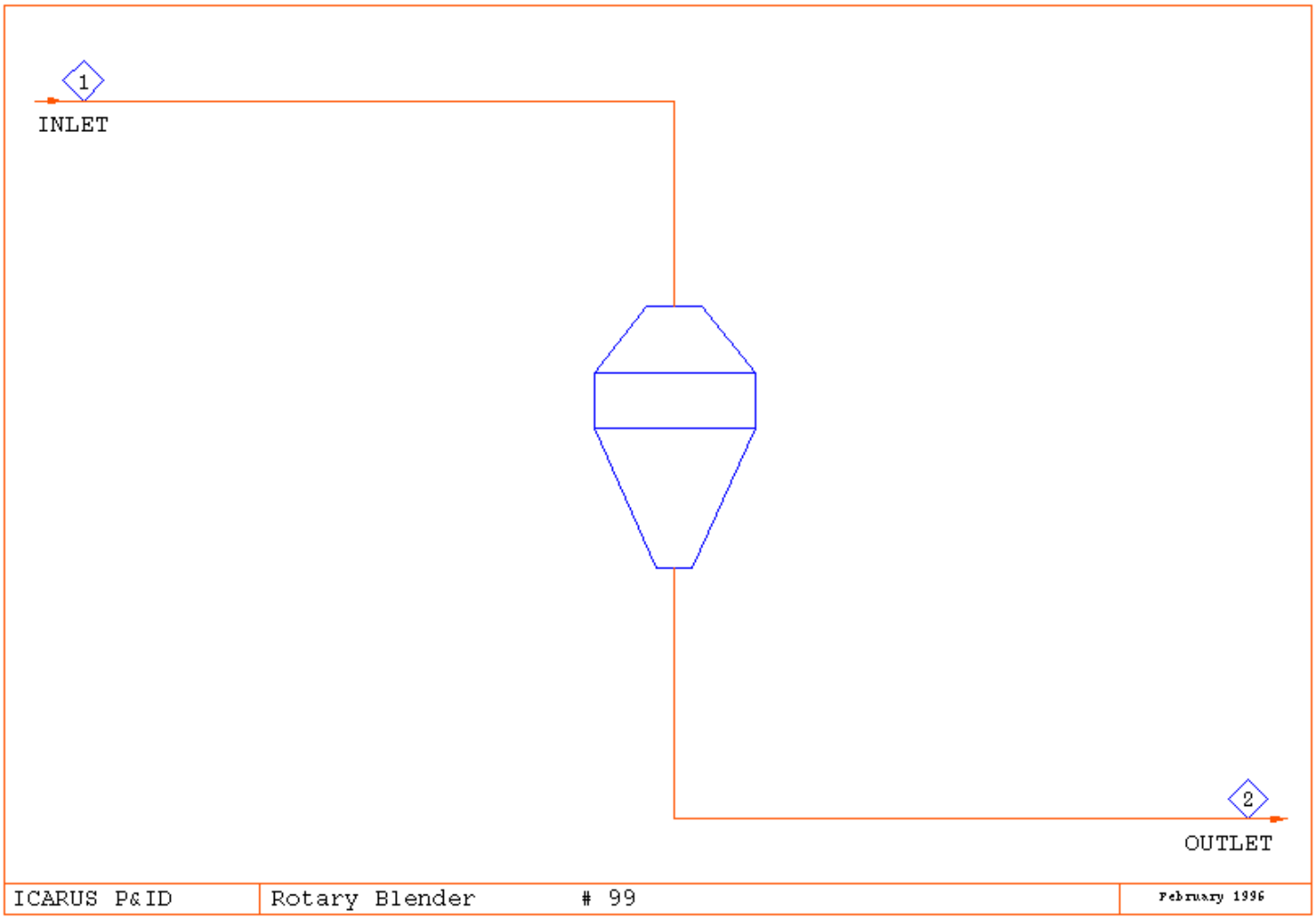
92 Off Machine Pulper



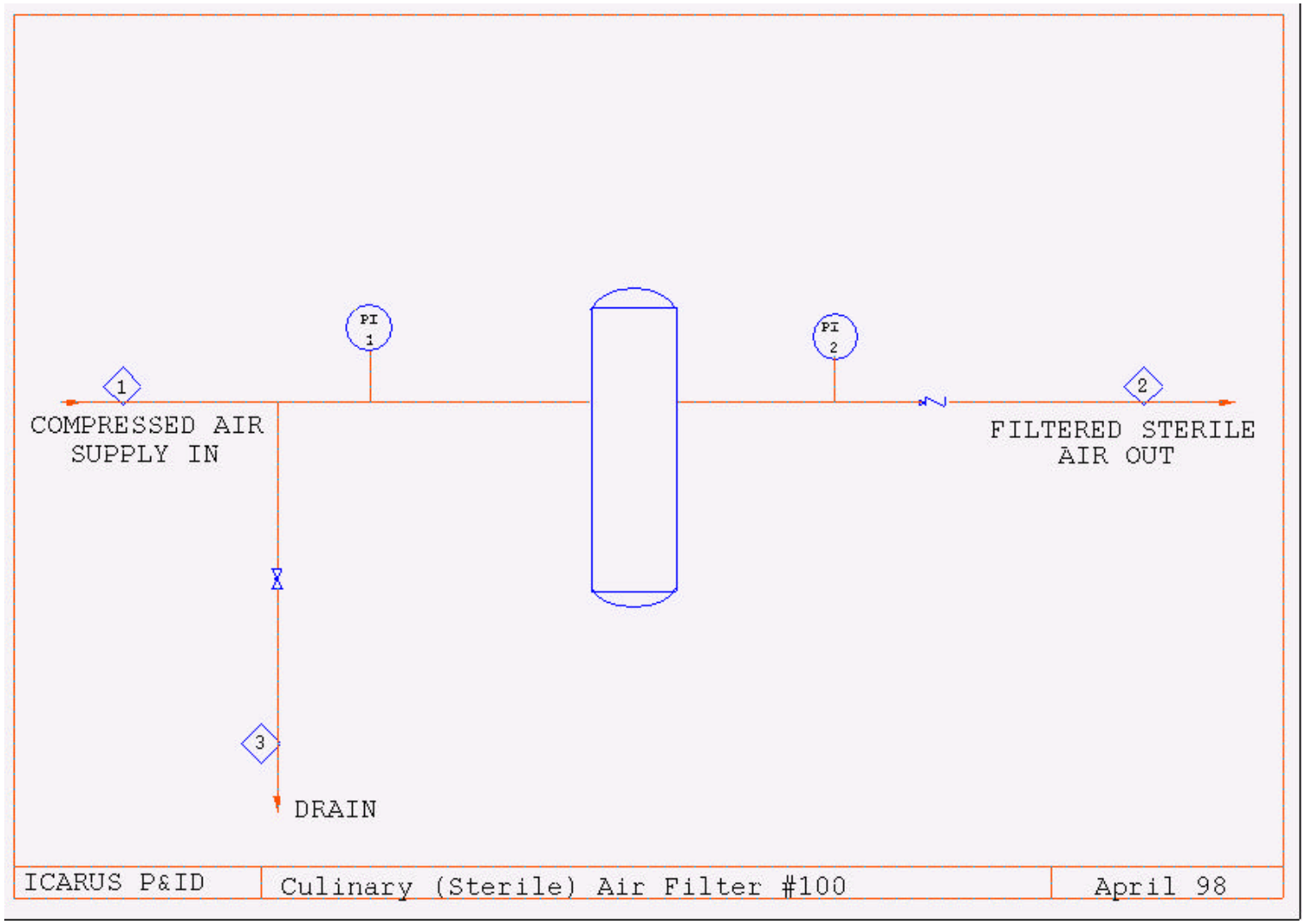
93 On Machine Pulper



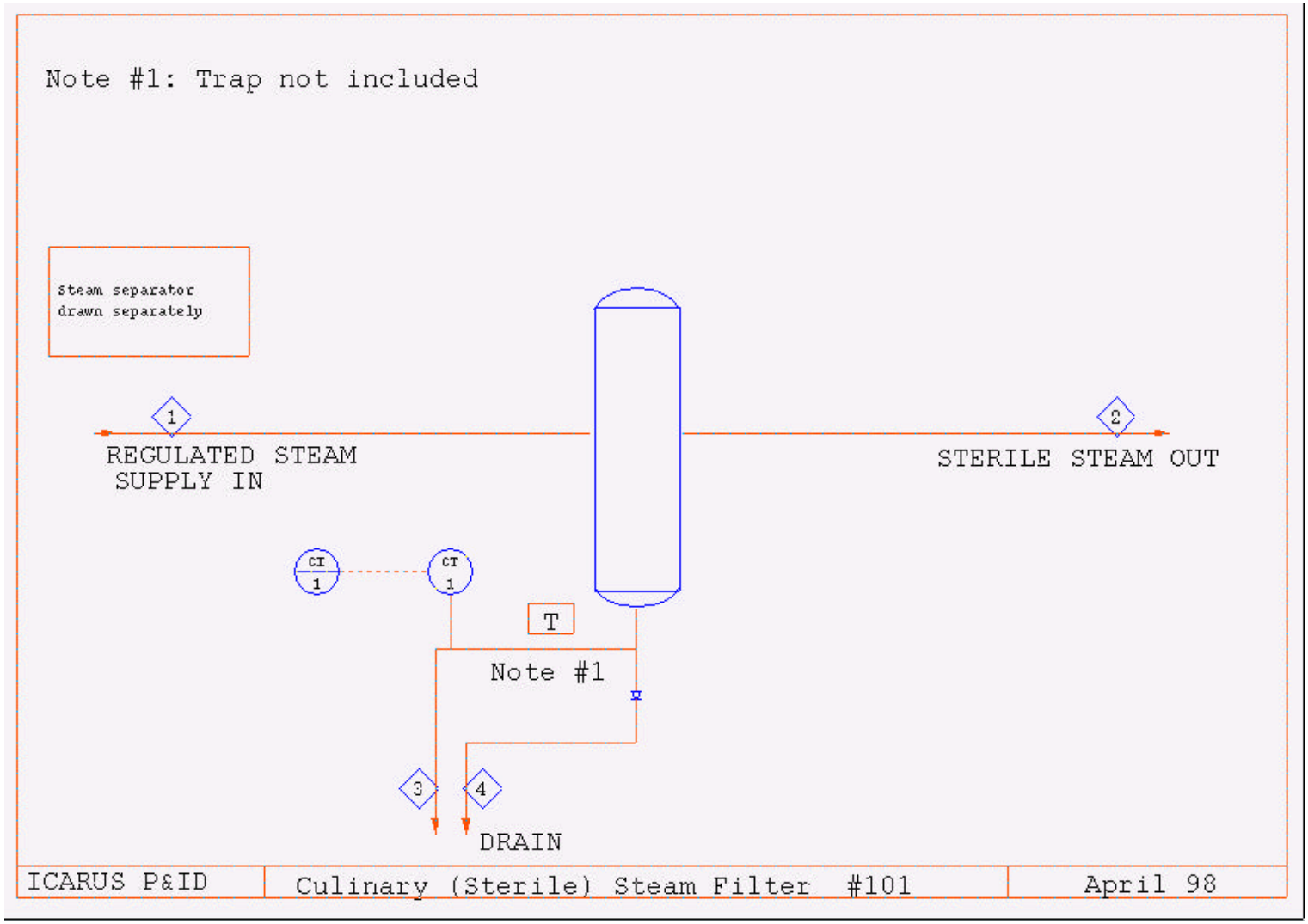
99 Rotary Blender



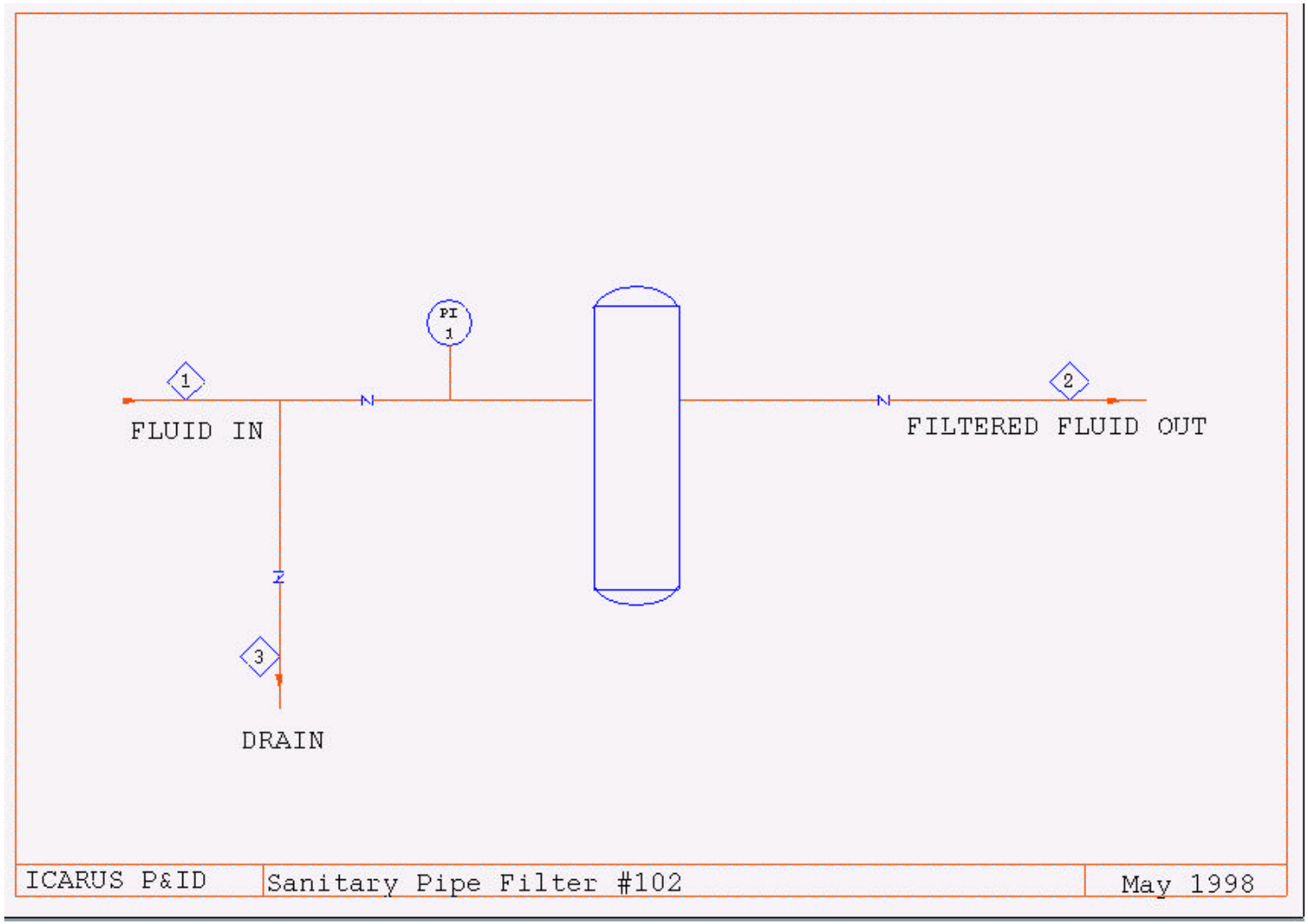
100 Culinary Air Filter



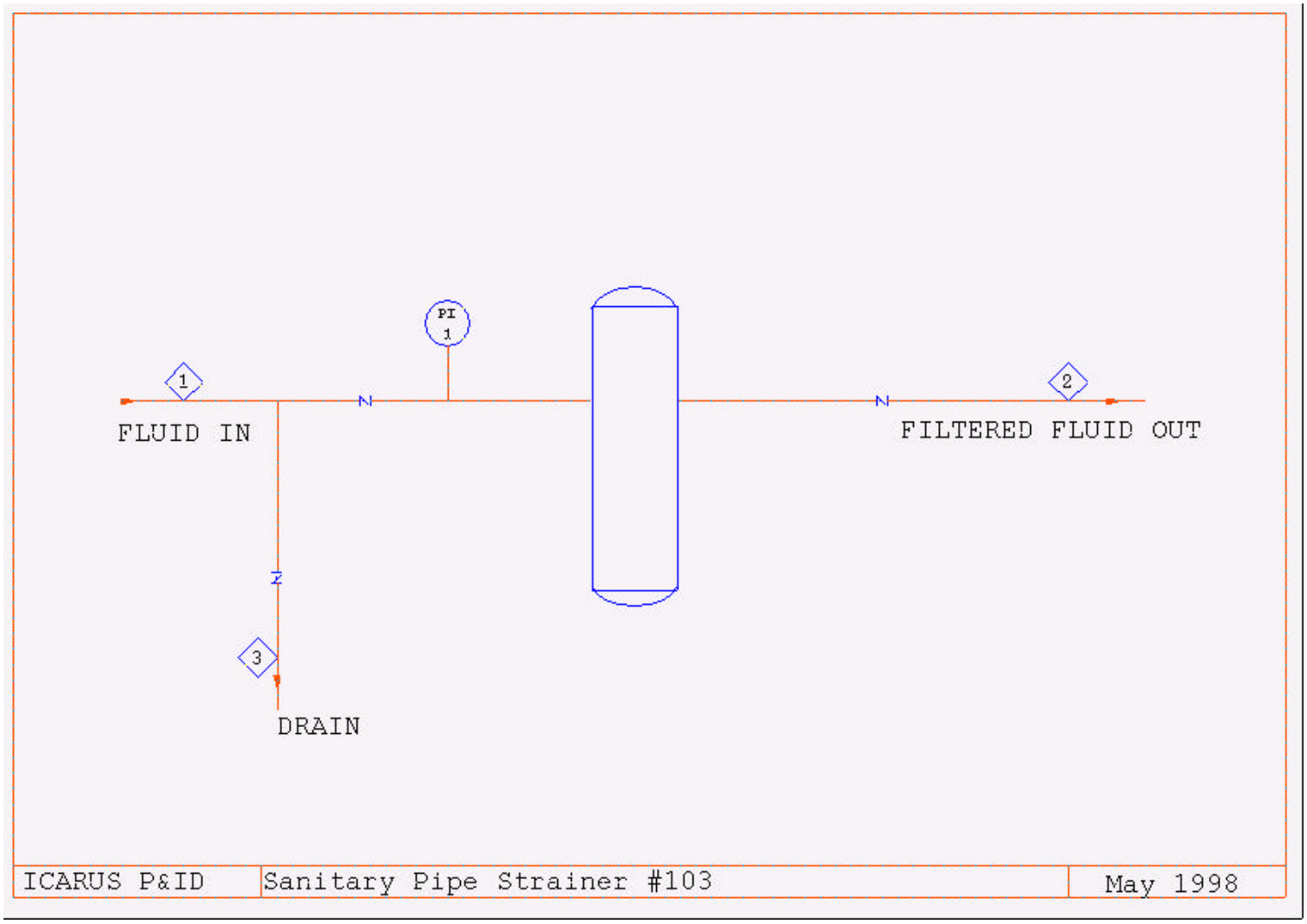
101 Culinary (Sterile) Steam Filter F-6



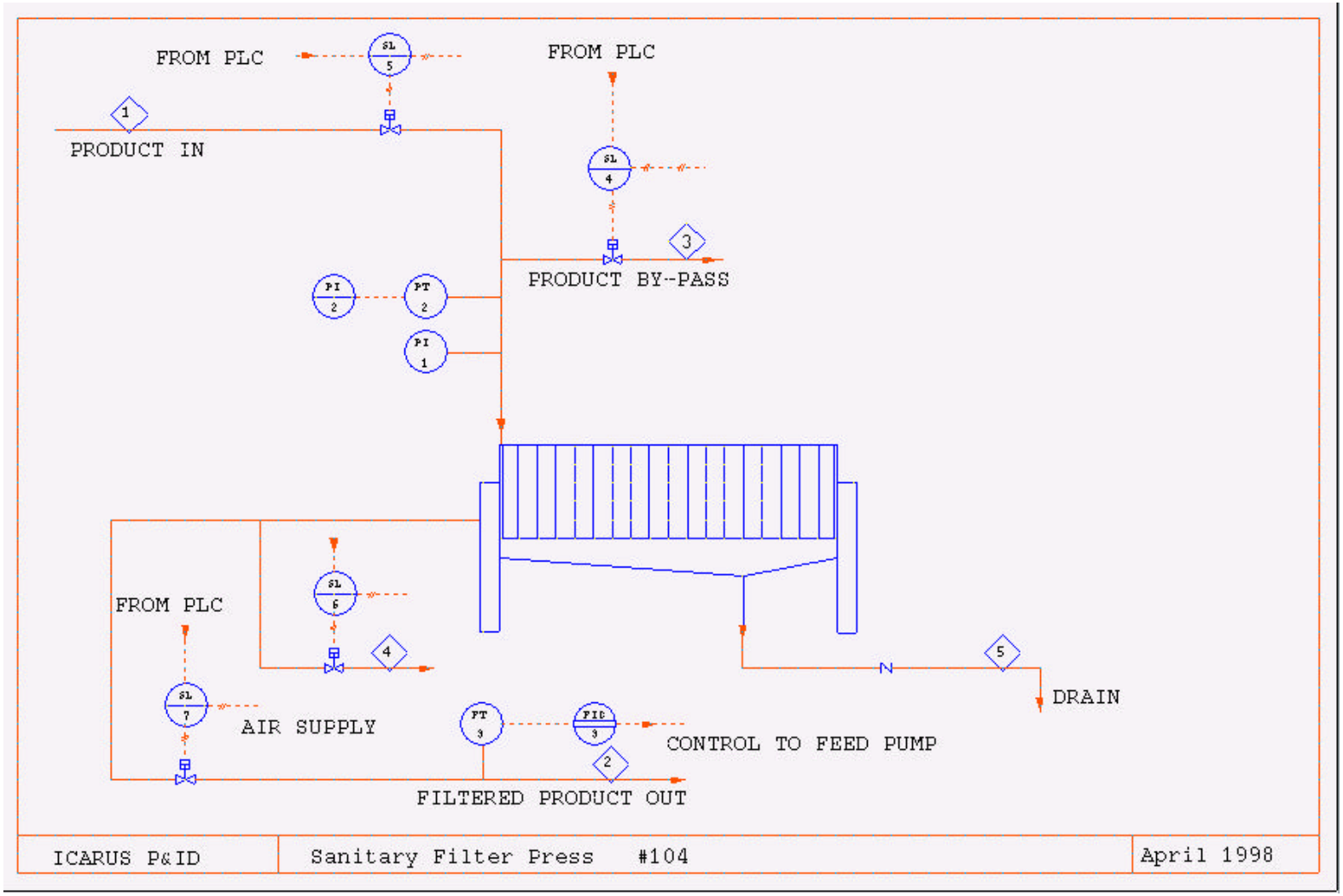
102 Sanitary Pipe Filter



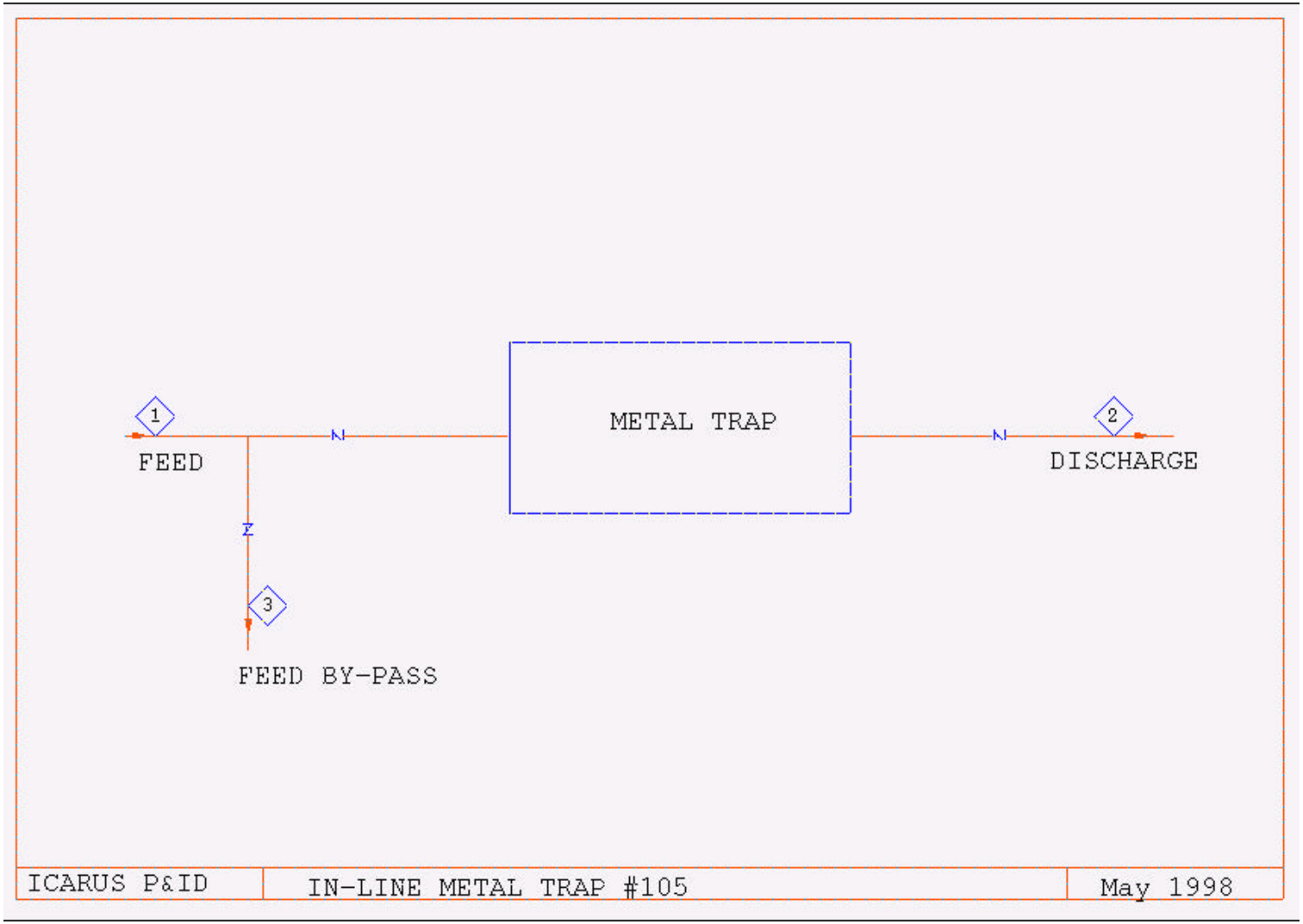
103 Sanitary Pipe Strainer



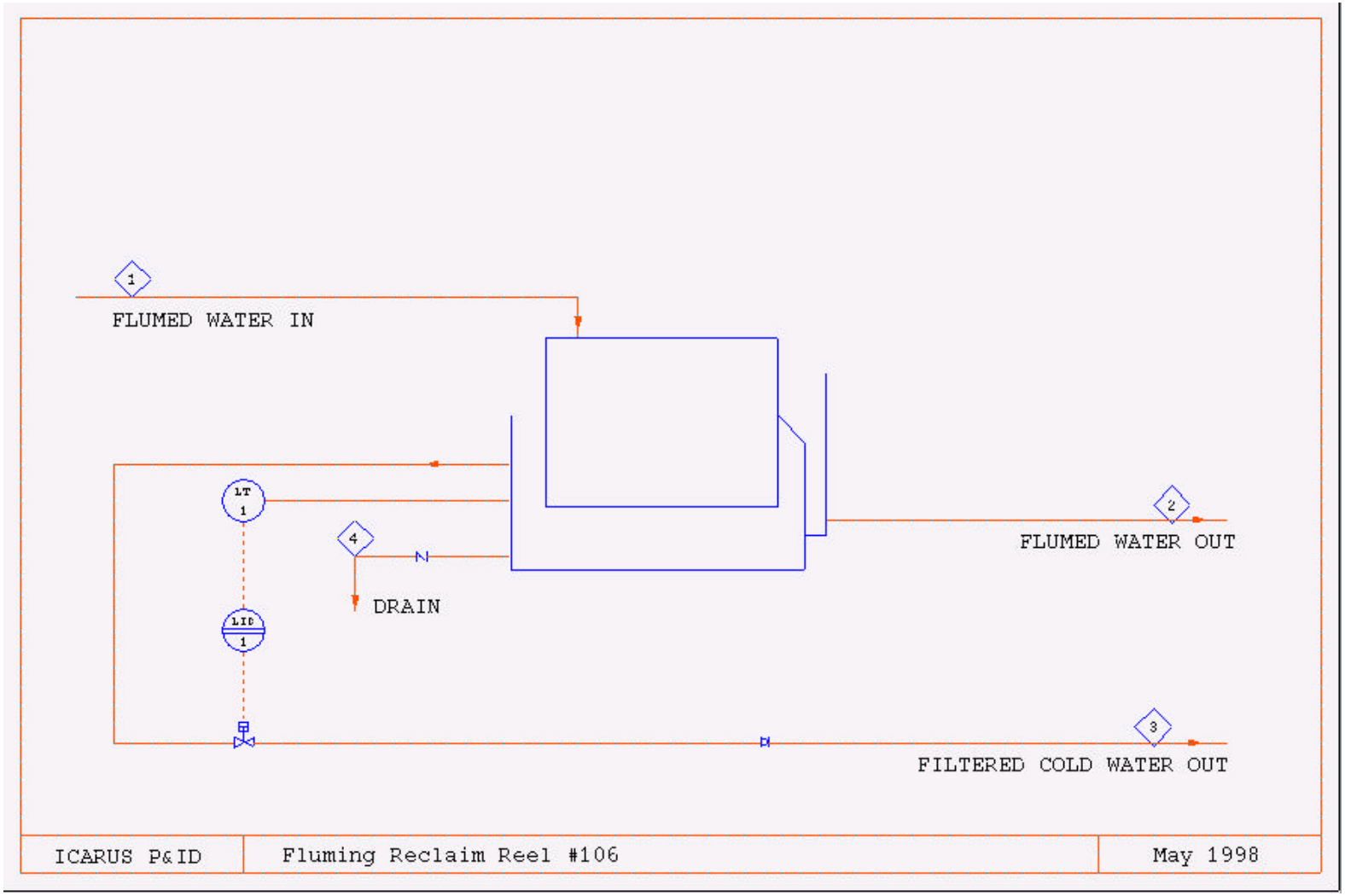
104 Sanitary Filter Press



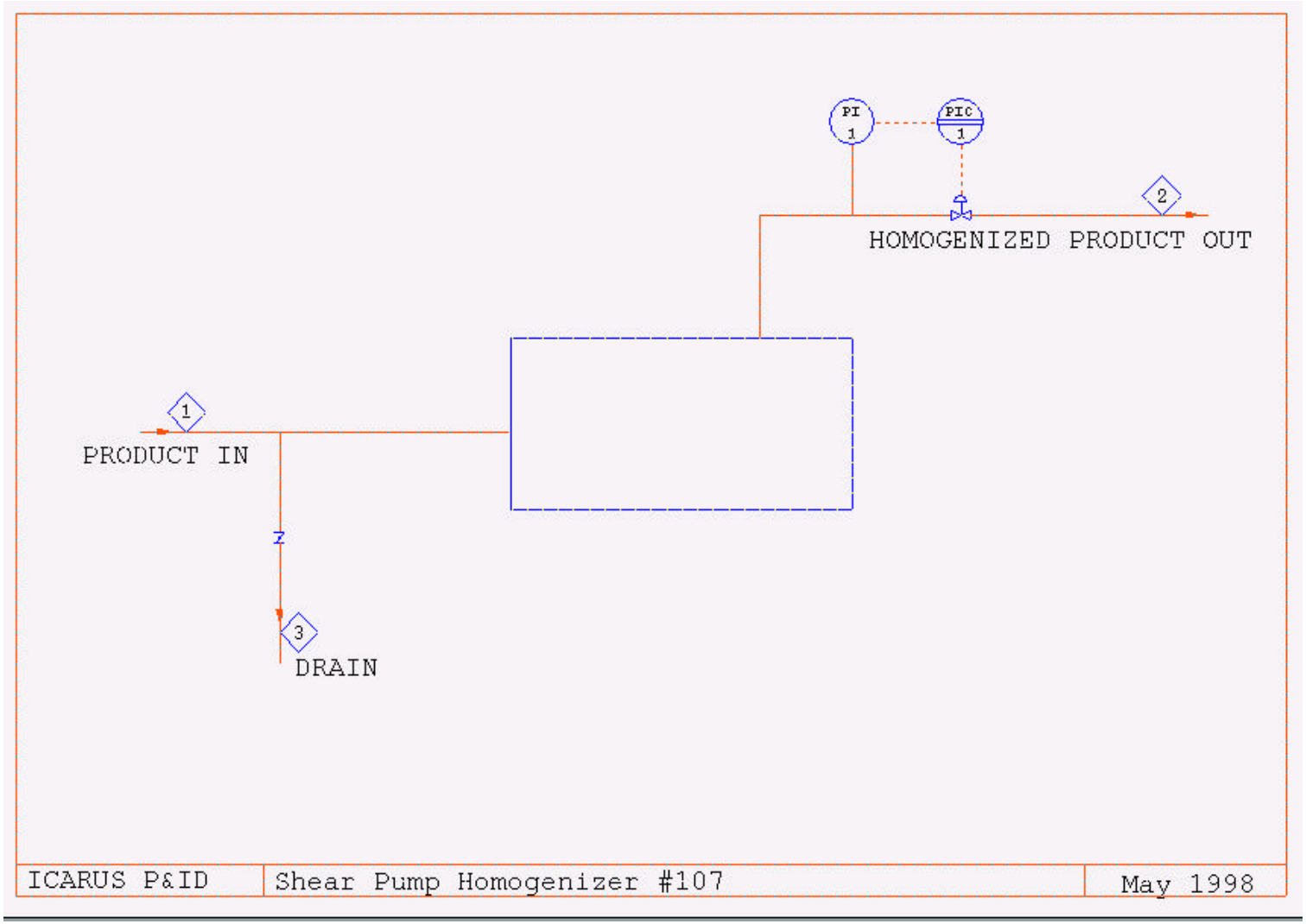
105 In-Line Metal Trap



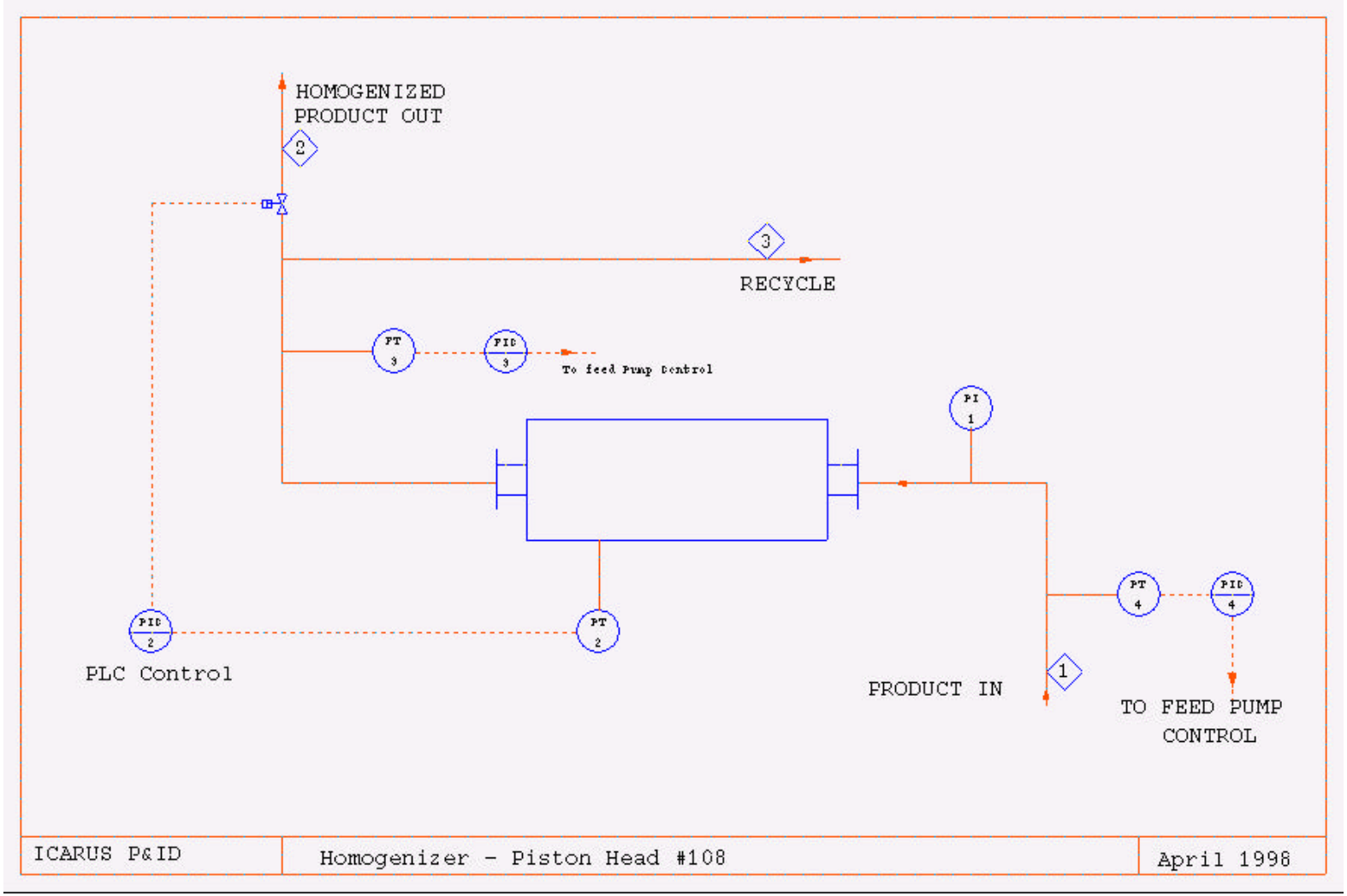
106 Fluming Reclaim Reel



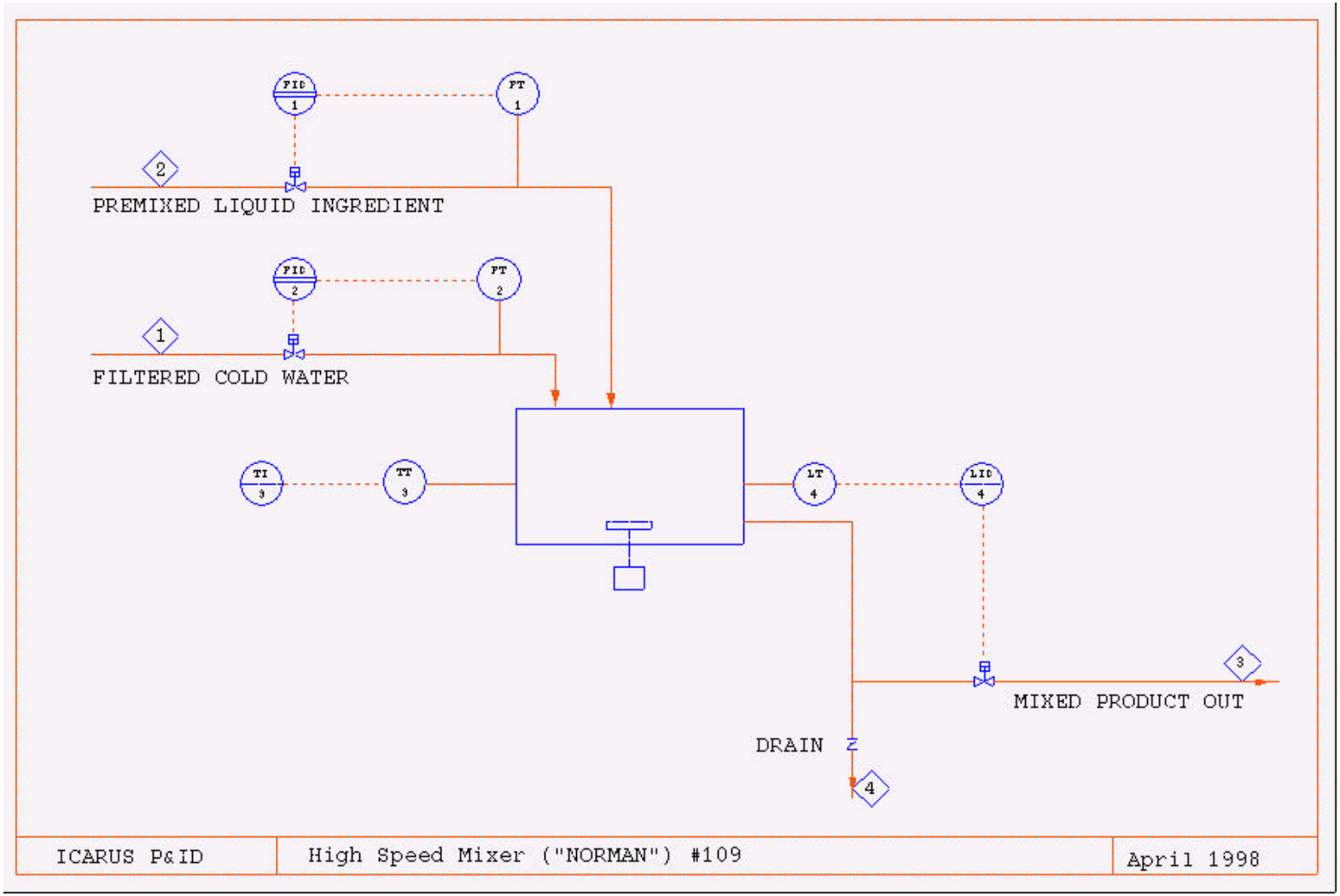
107 Shear Pump Homogenizer



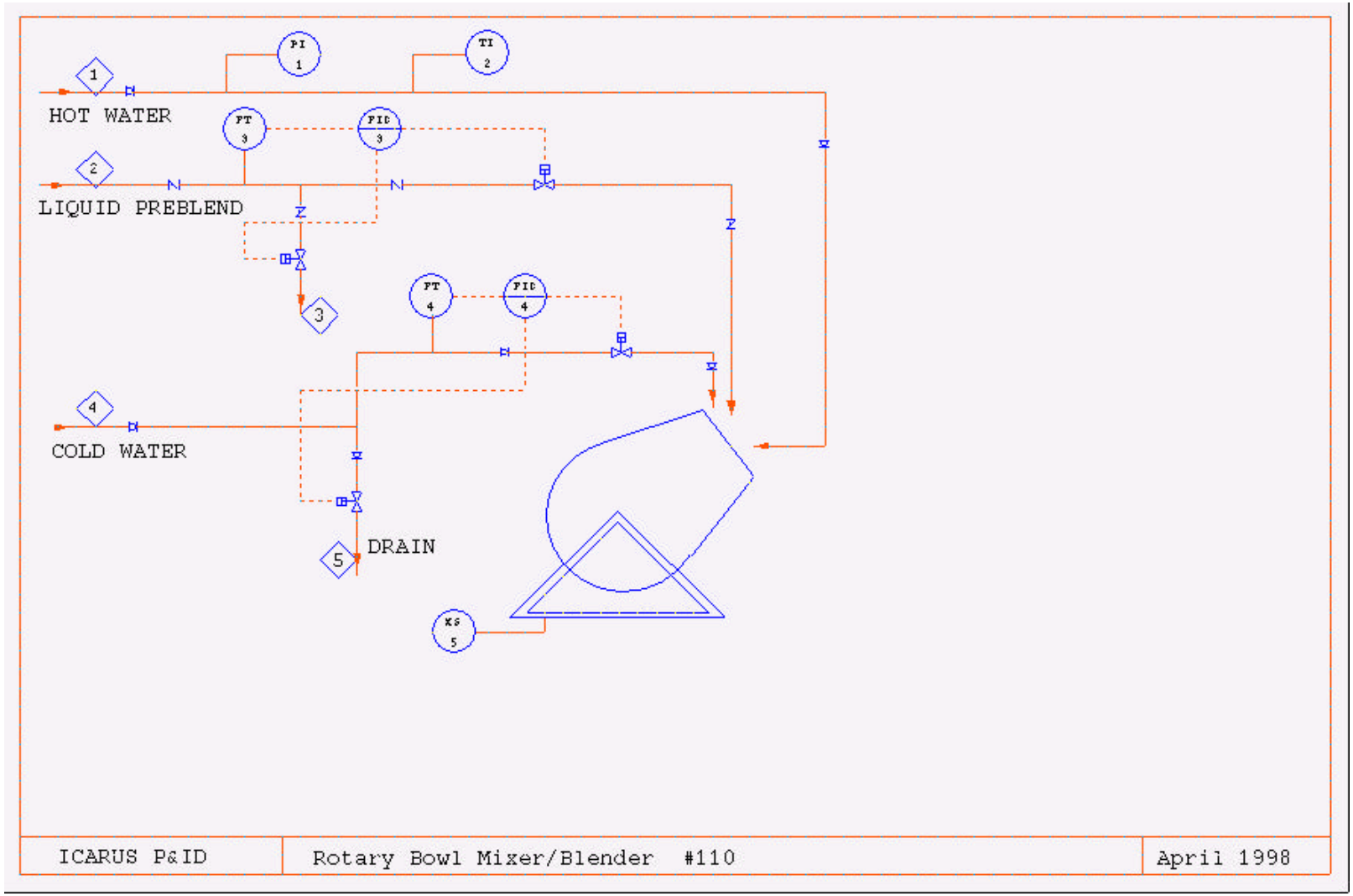
108 Homogenizer – Piston Head



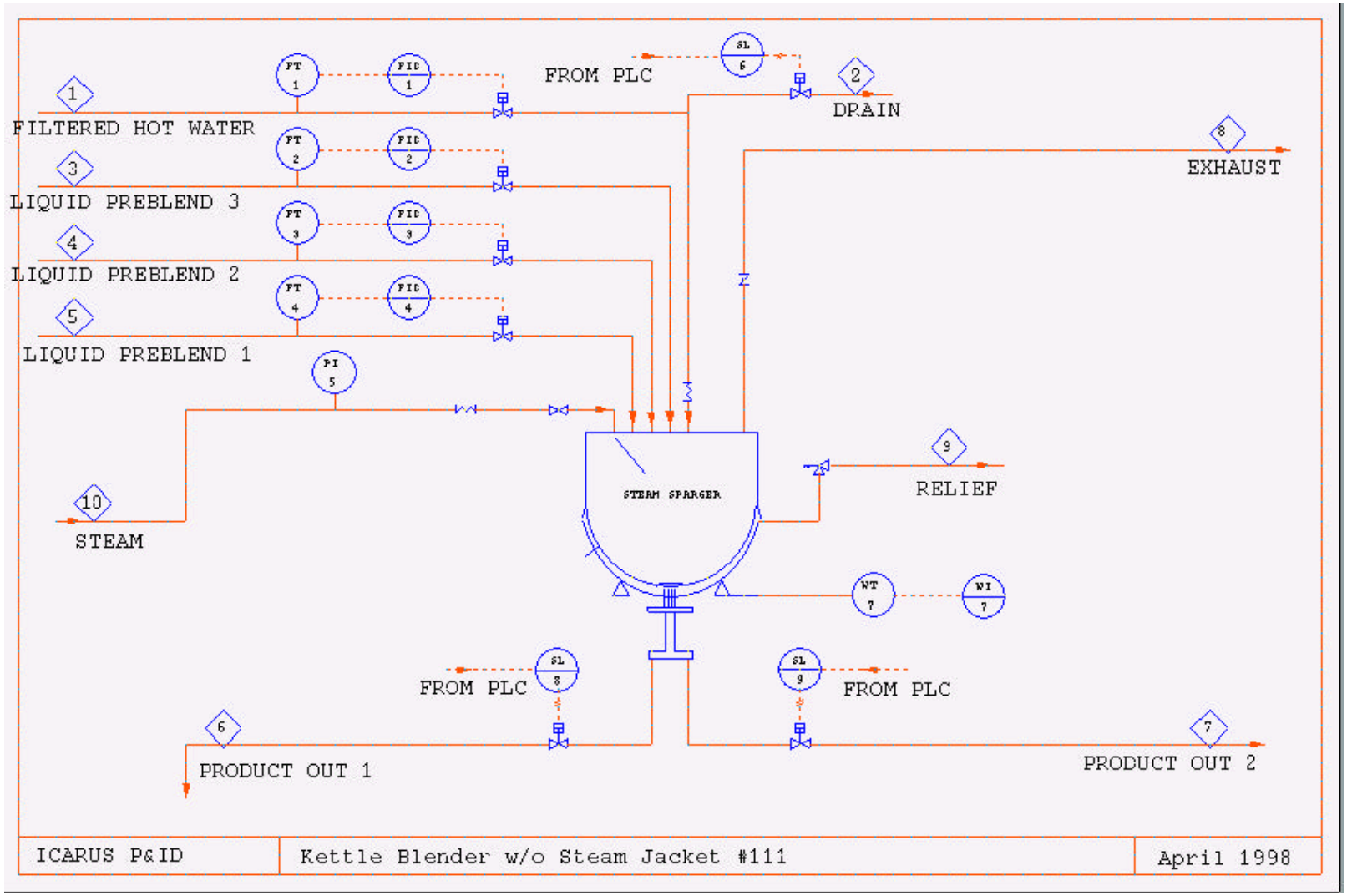
109 High-Speed Mixer (“Norman”)



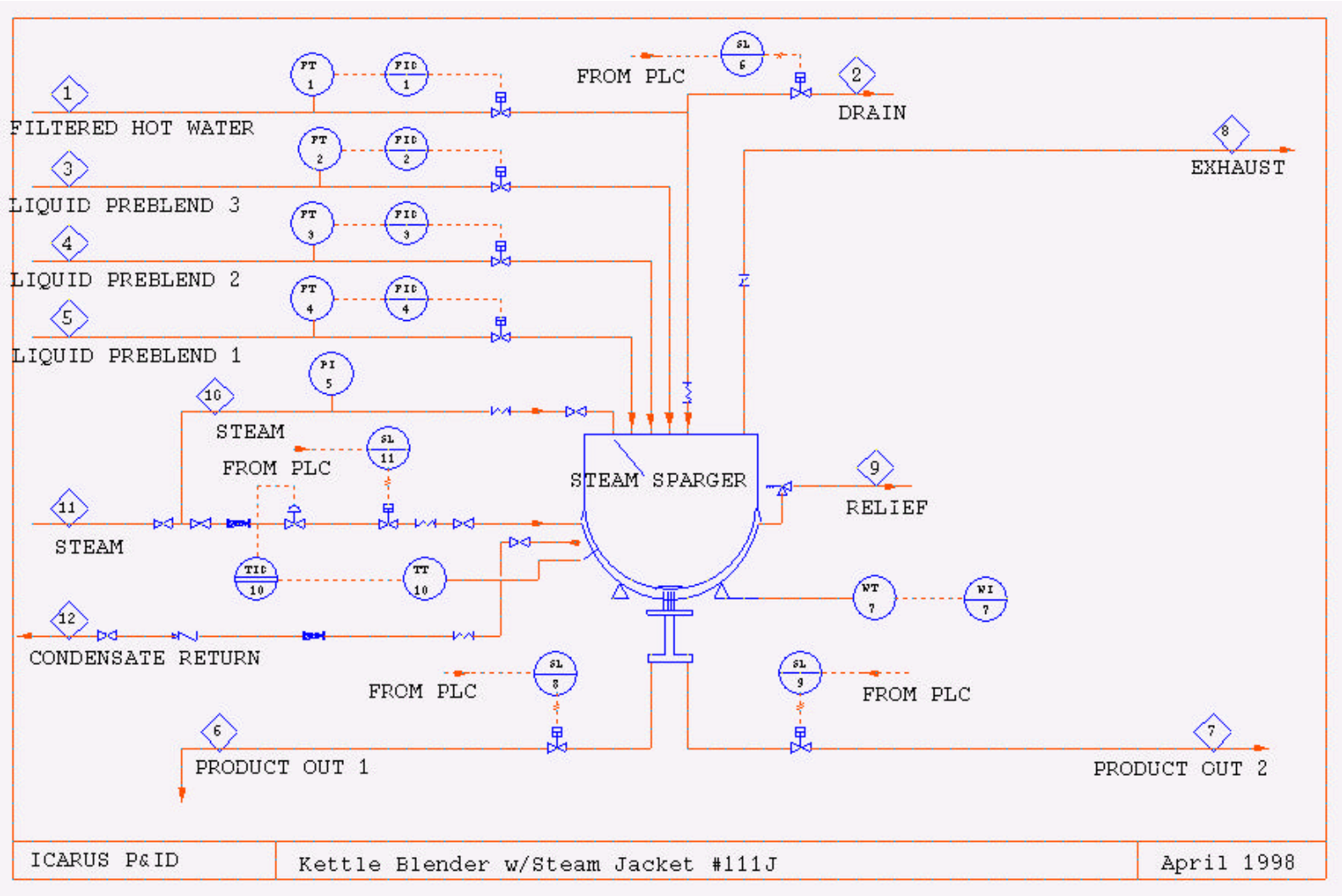
110 Rotary Bowl/Mixer Blender



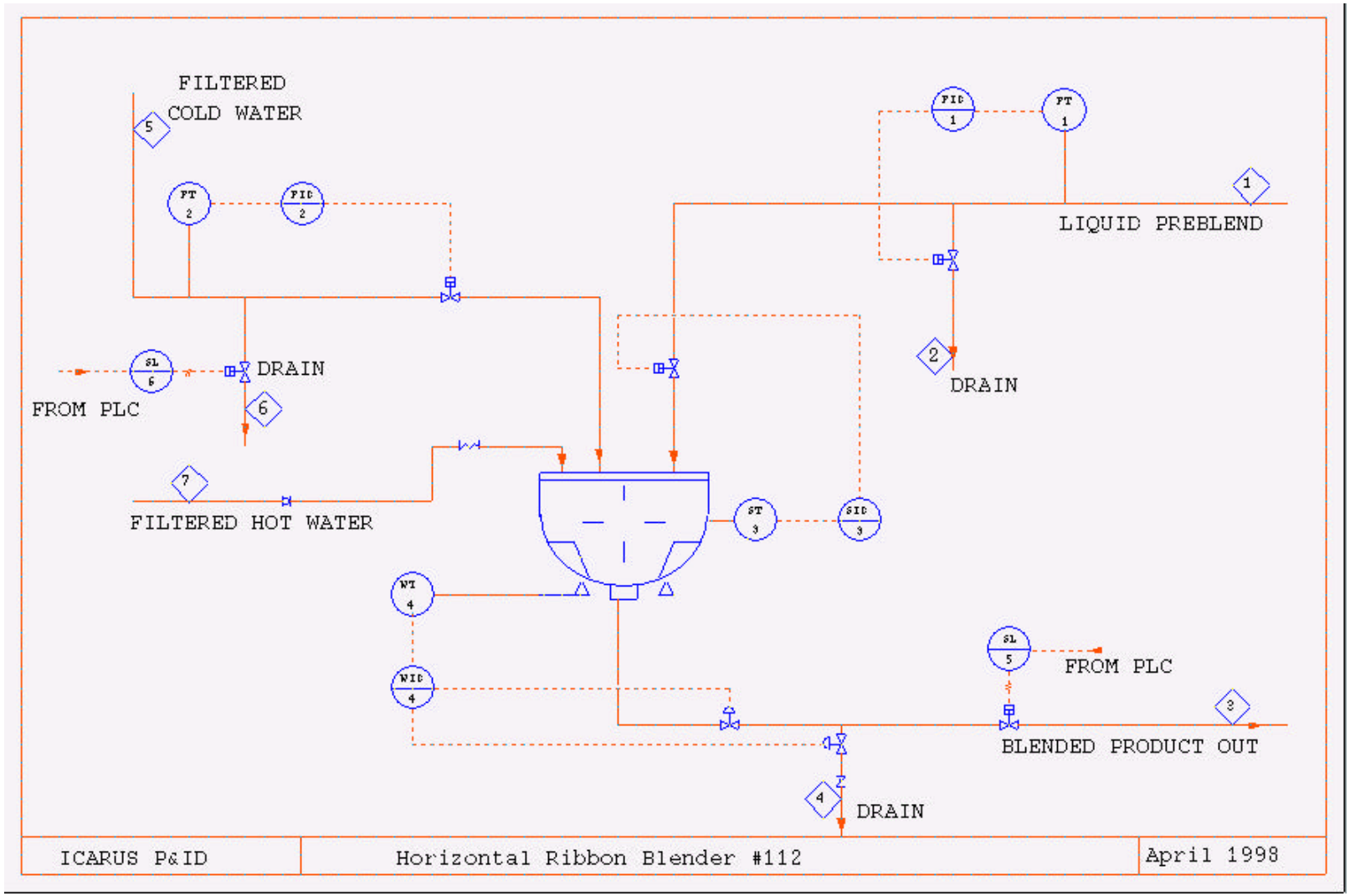
111 Kettle Blender Without Steam Jacket



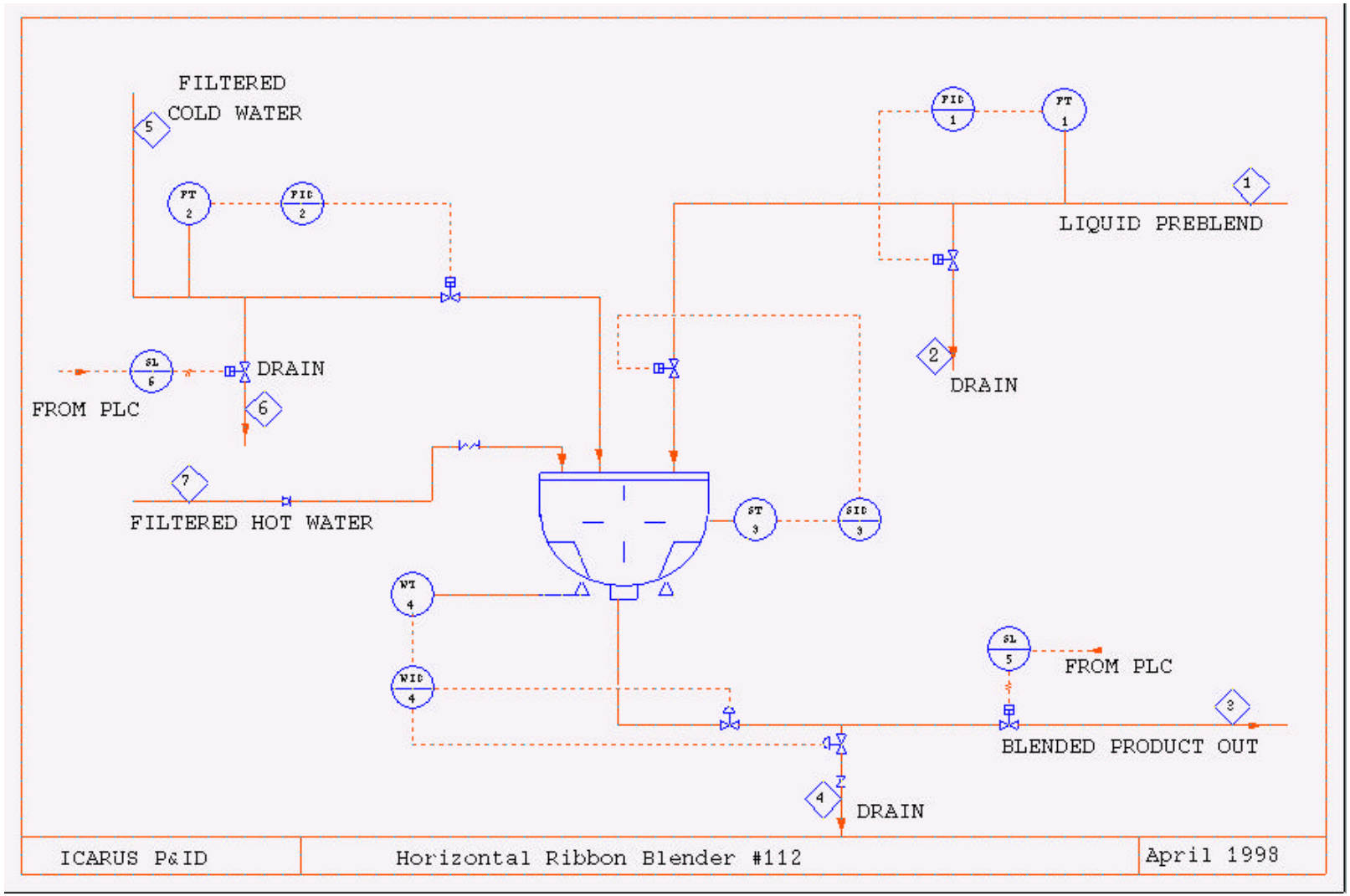
111 Kettle Blender With Steam Jacket



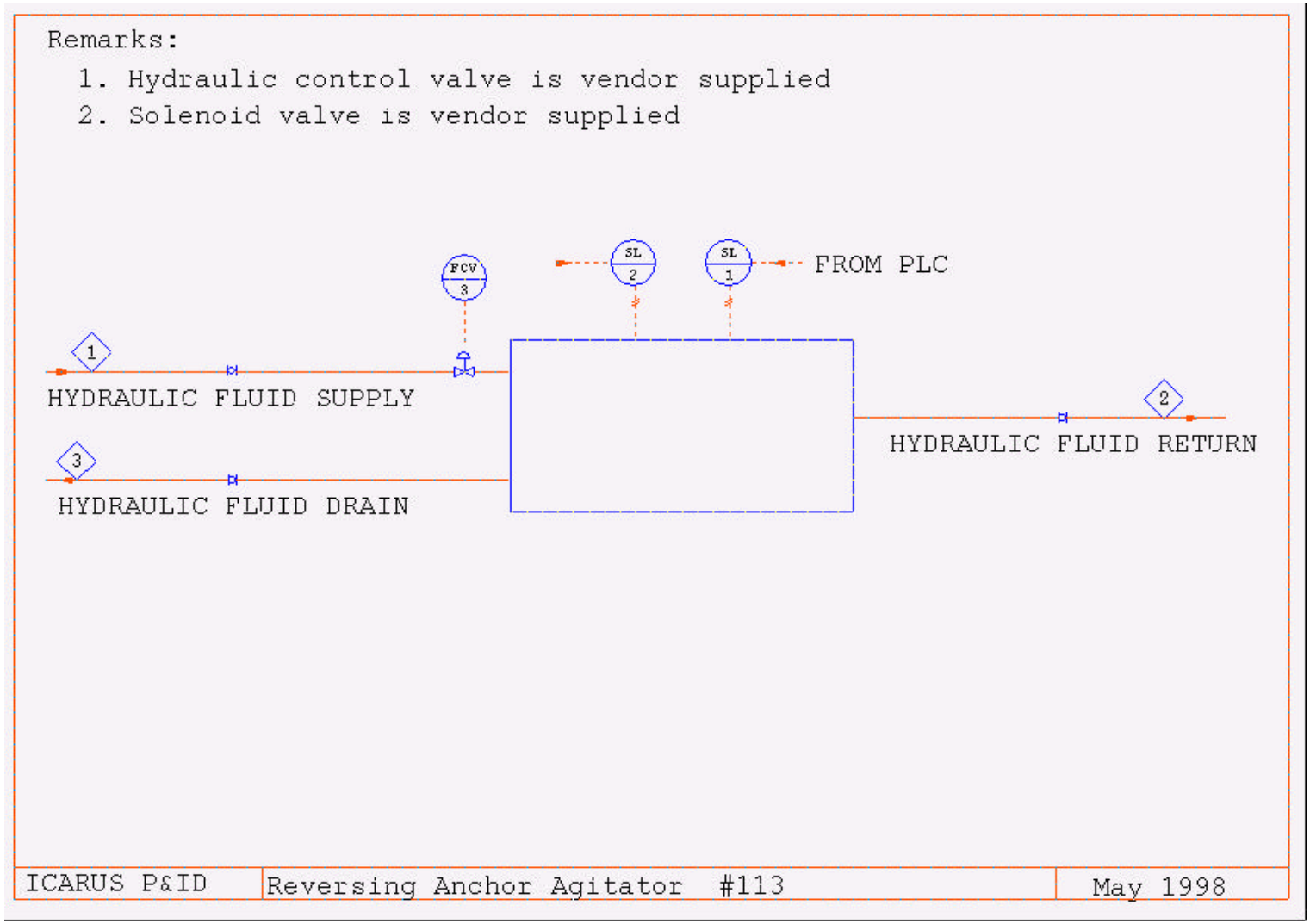
112 Horizontal Ribbon Blender



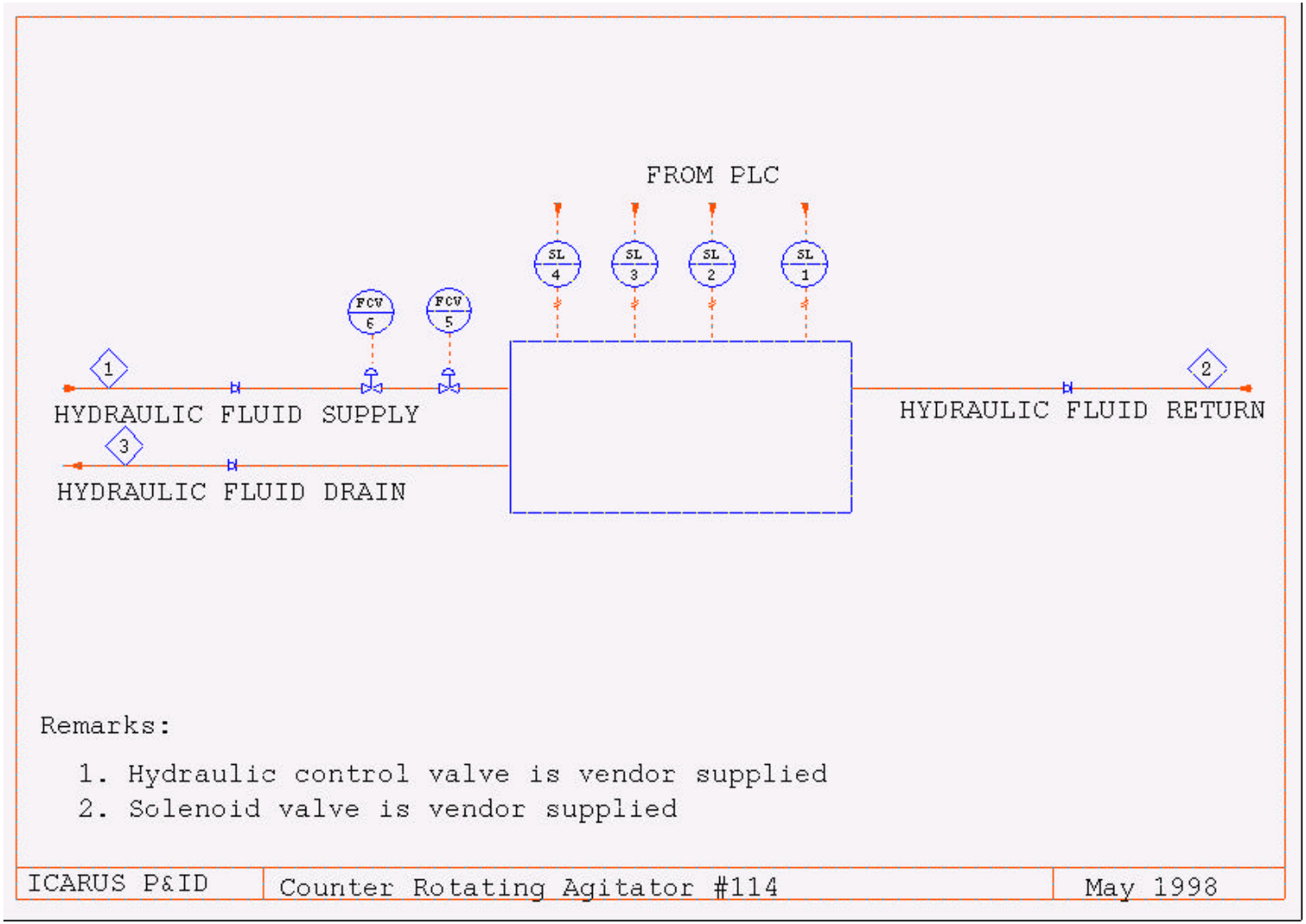
112 Jacket Horizontal Ribbon Blender



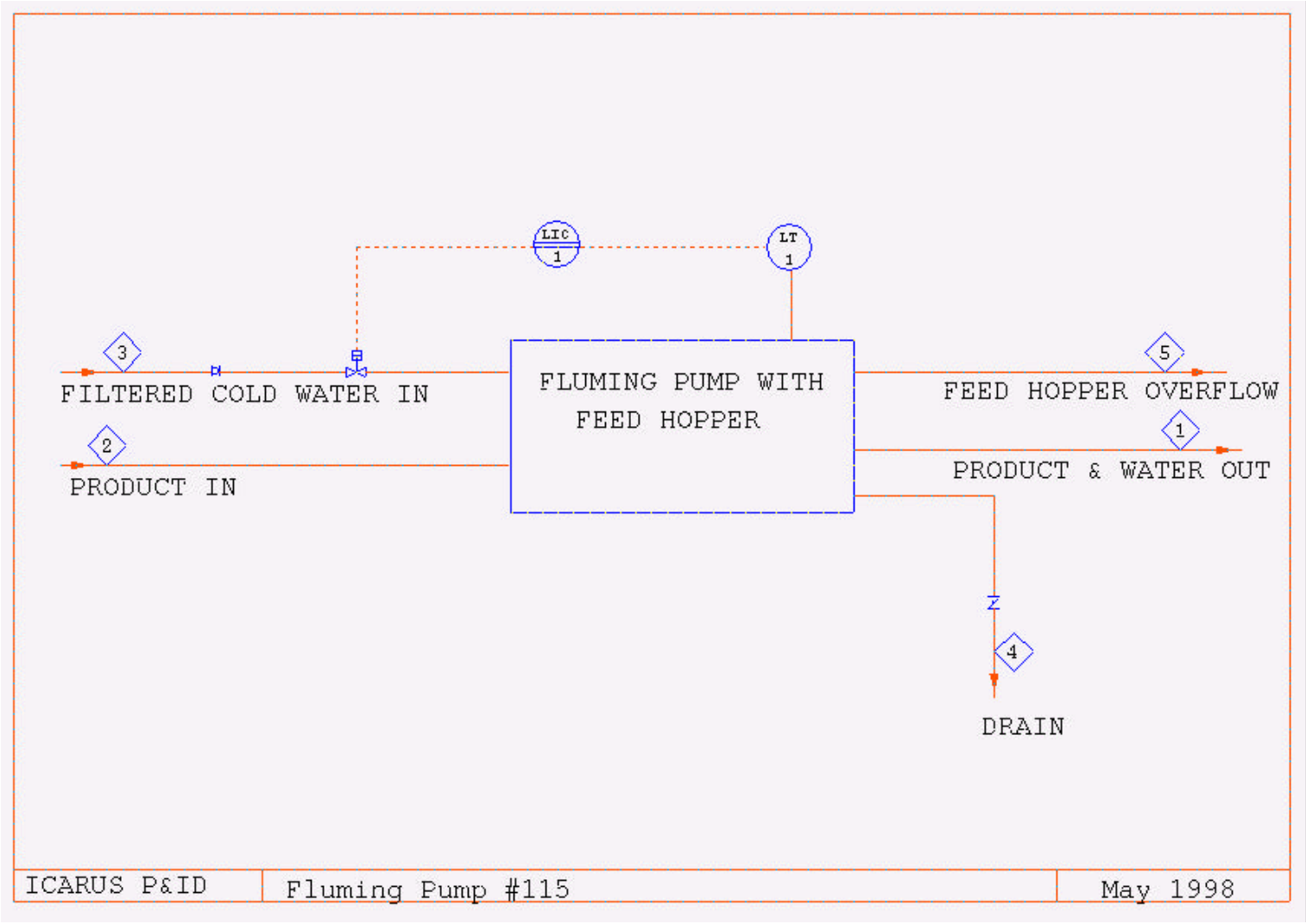
113 Reversing Anchor Agitator



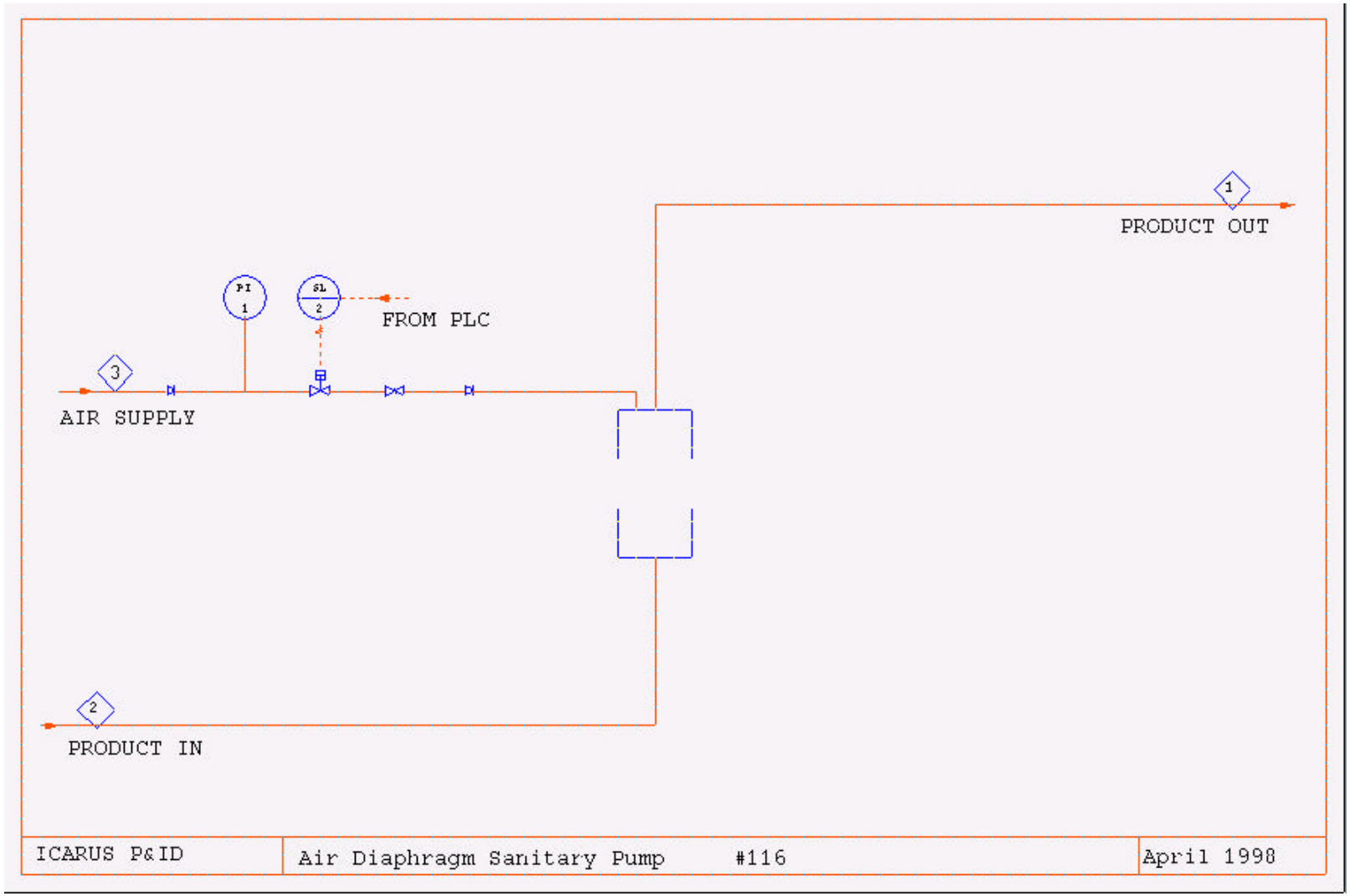
114 Double Motion Agitator



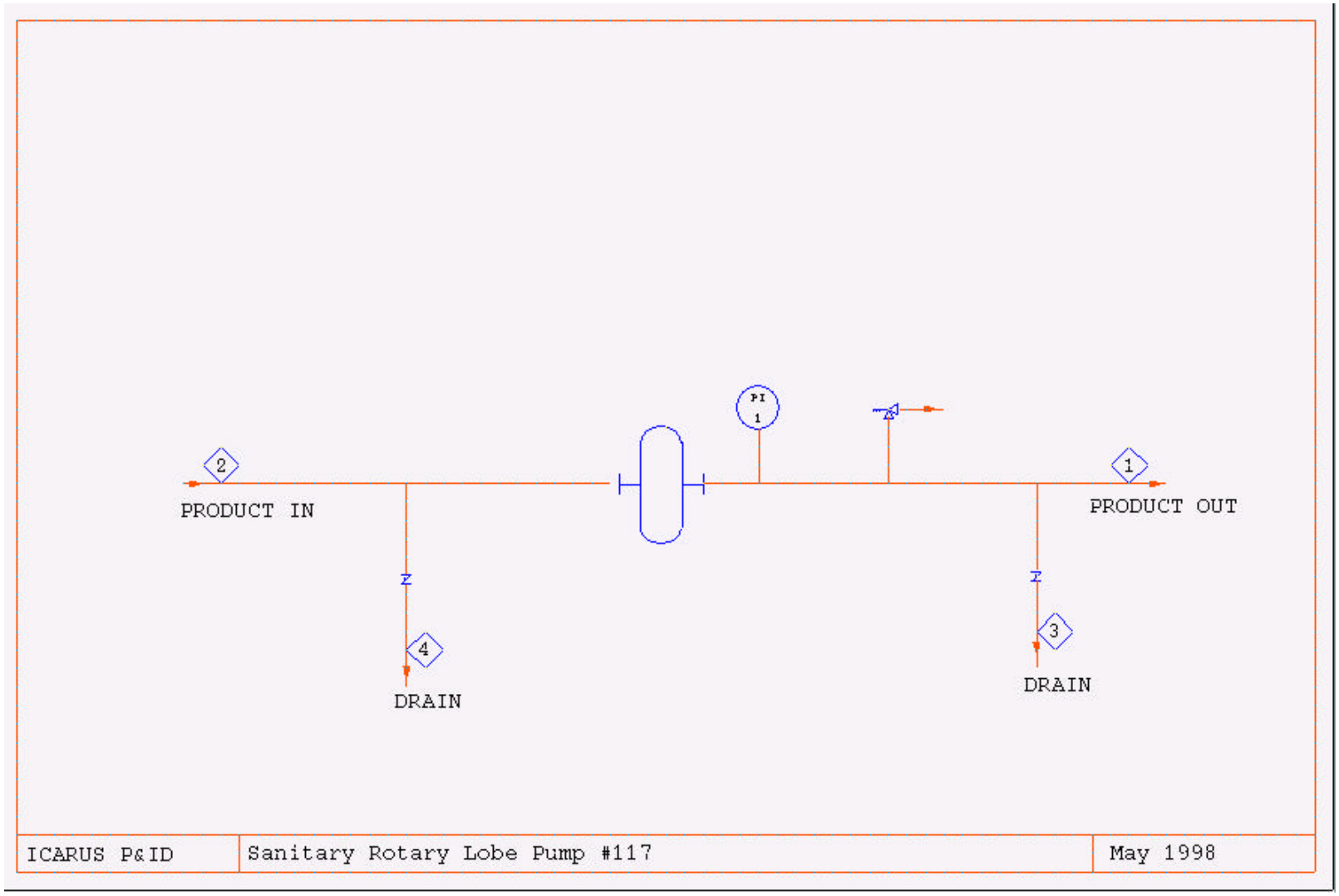
115 Fluming Pump



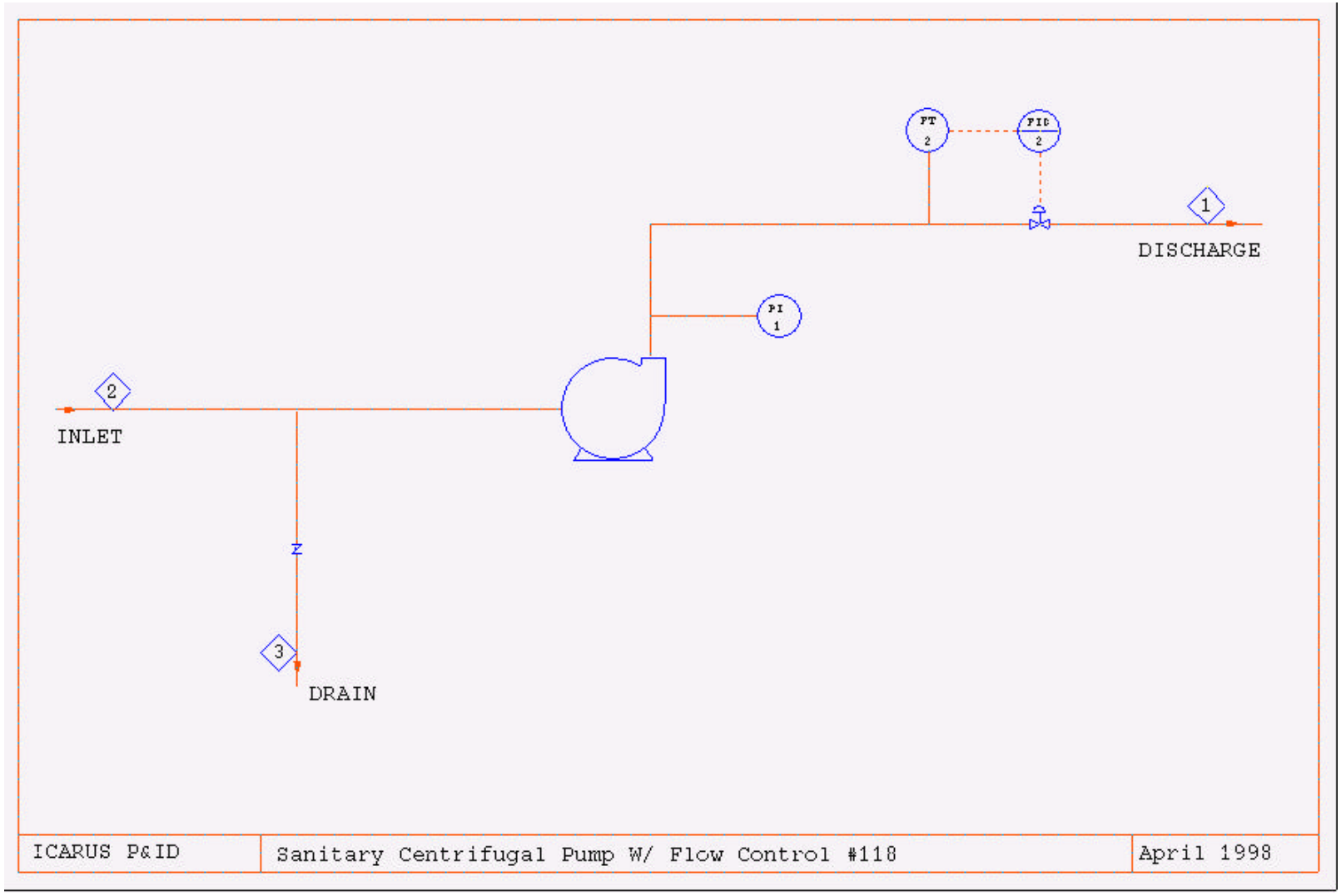
116 Air Diaphragm Sanitary Pump



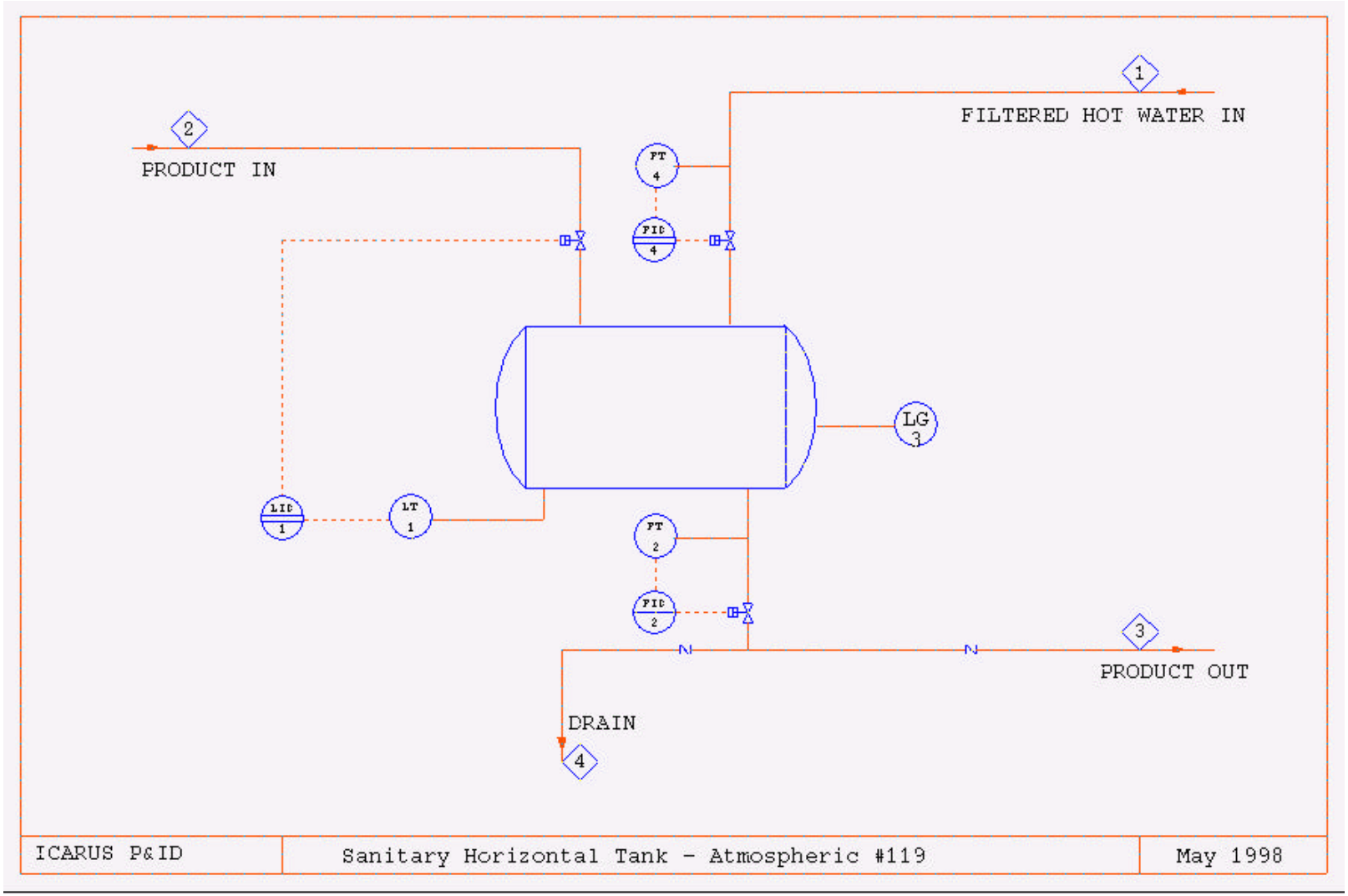
117 Sanitary Rotary Lobe Pump



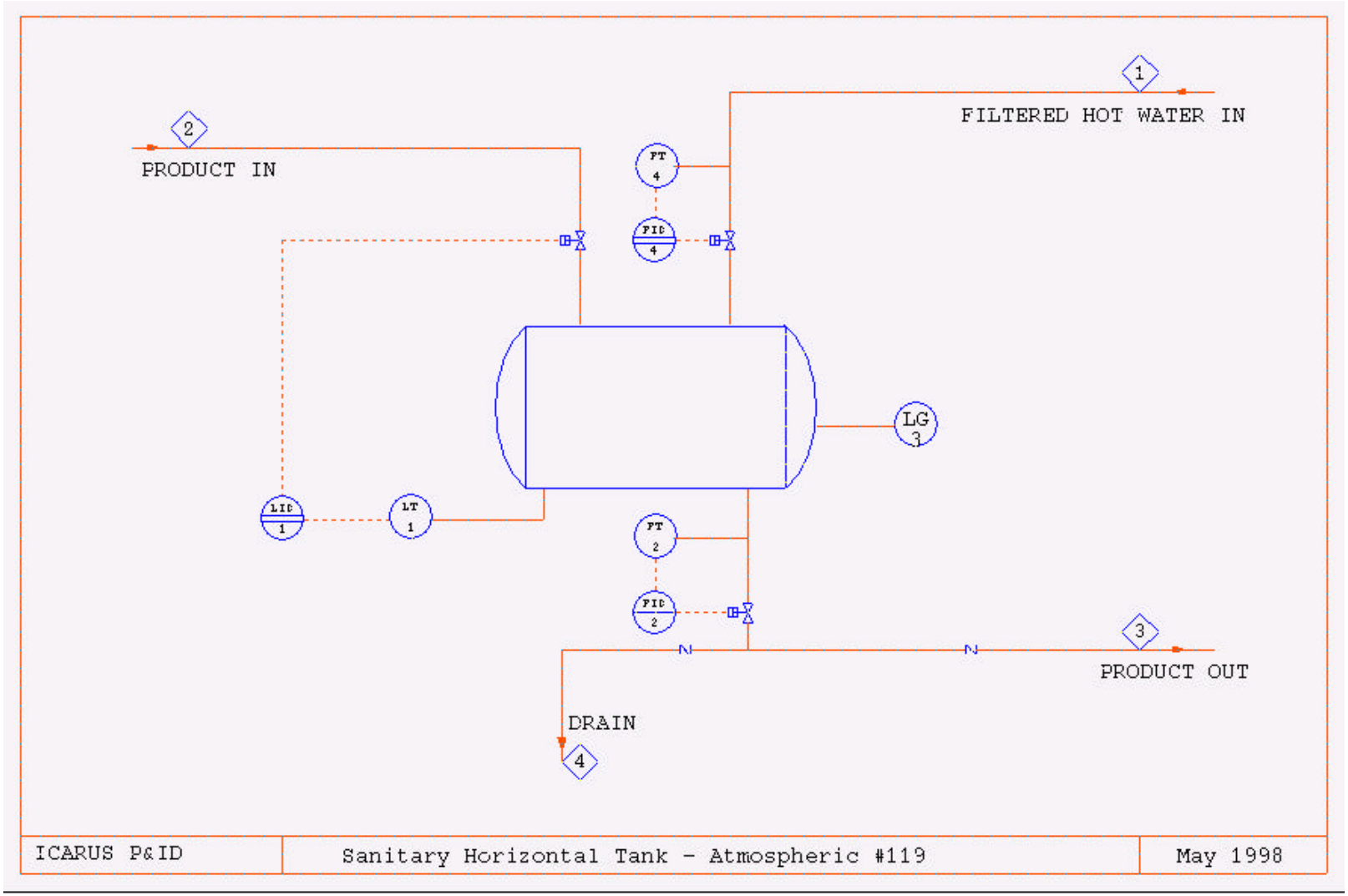
118 Sanitary Centrifugal Pump With Flow Control



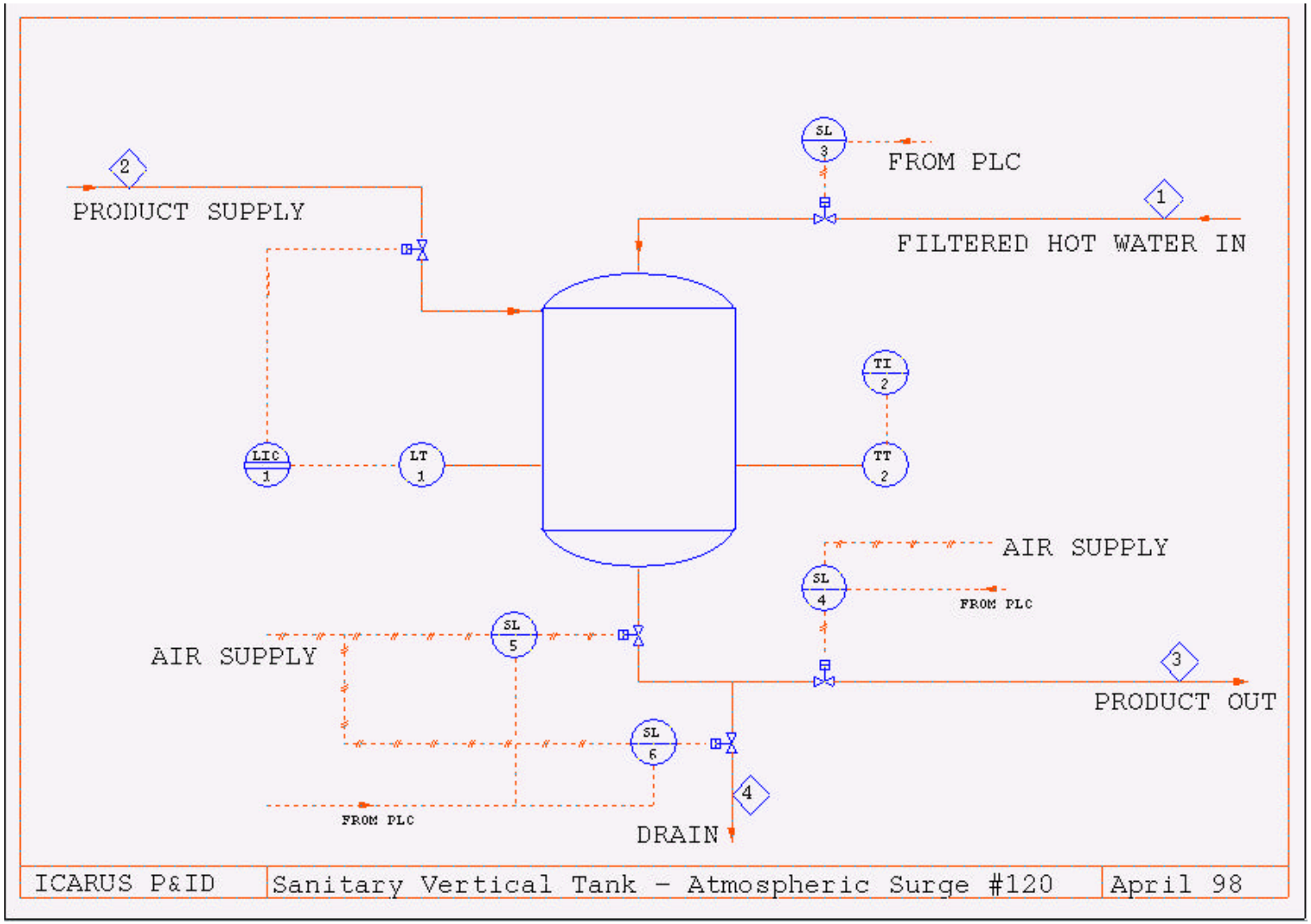
119 Sanitary Horizontal Tank



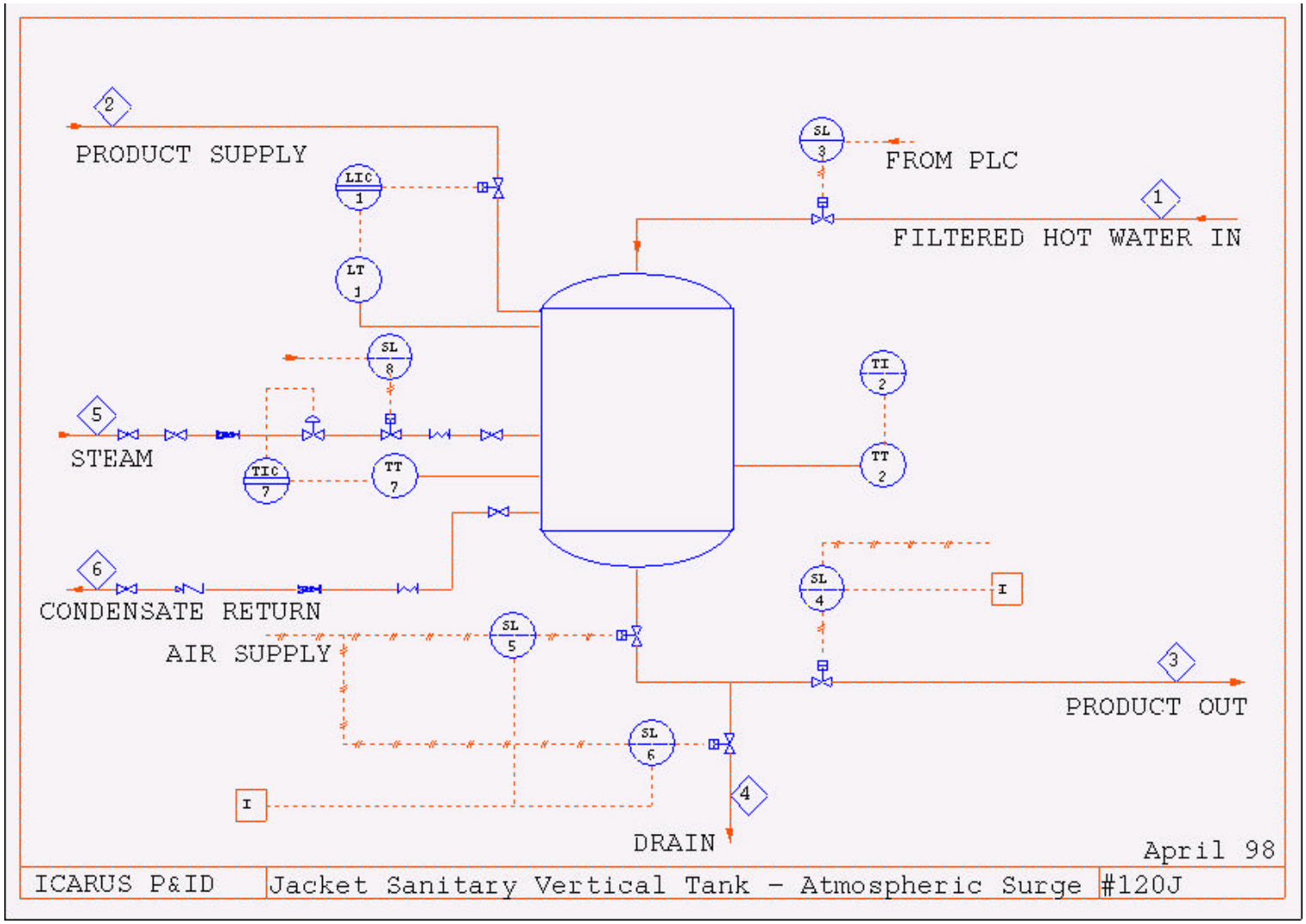
119 Jacket Sanitary Horizontal Tank



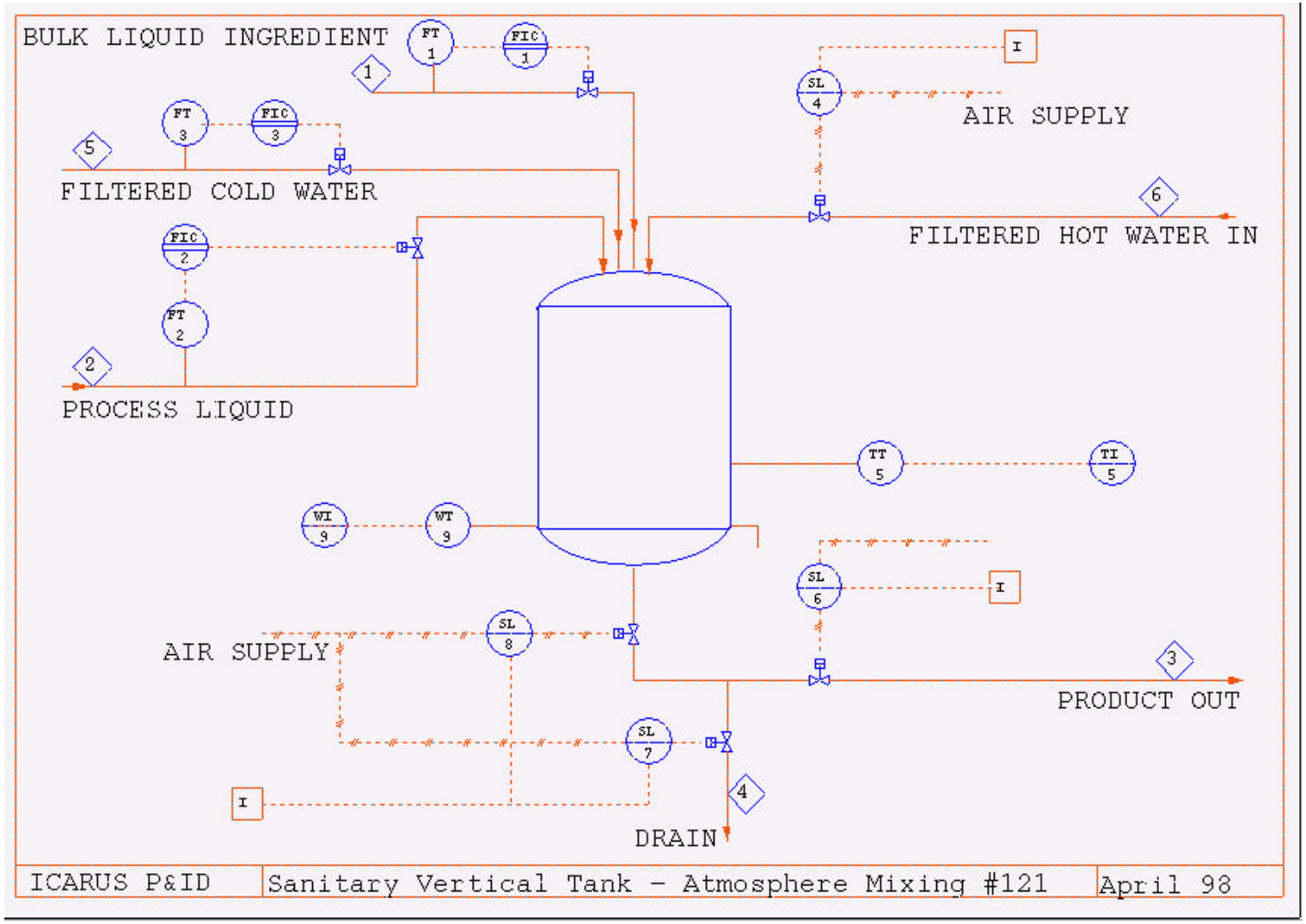
120 Sanitary Vertical Tank – Atmospheric Surge



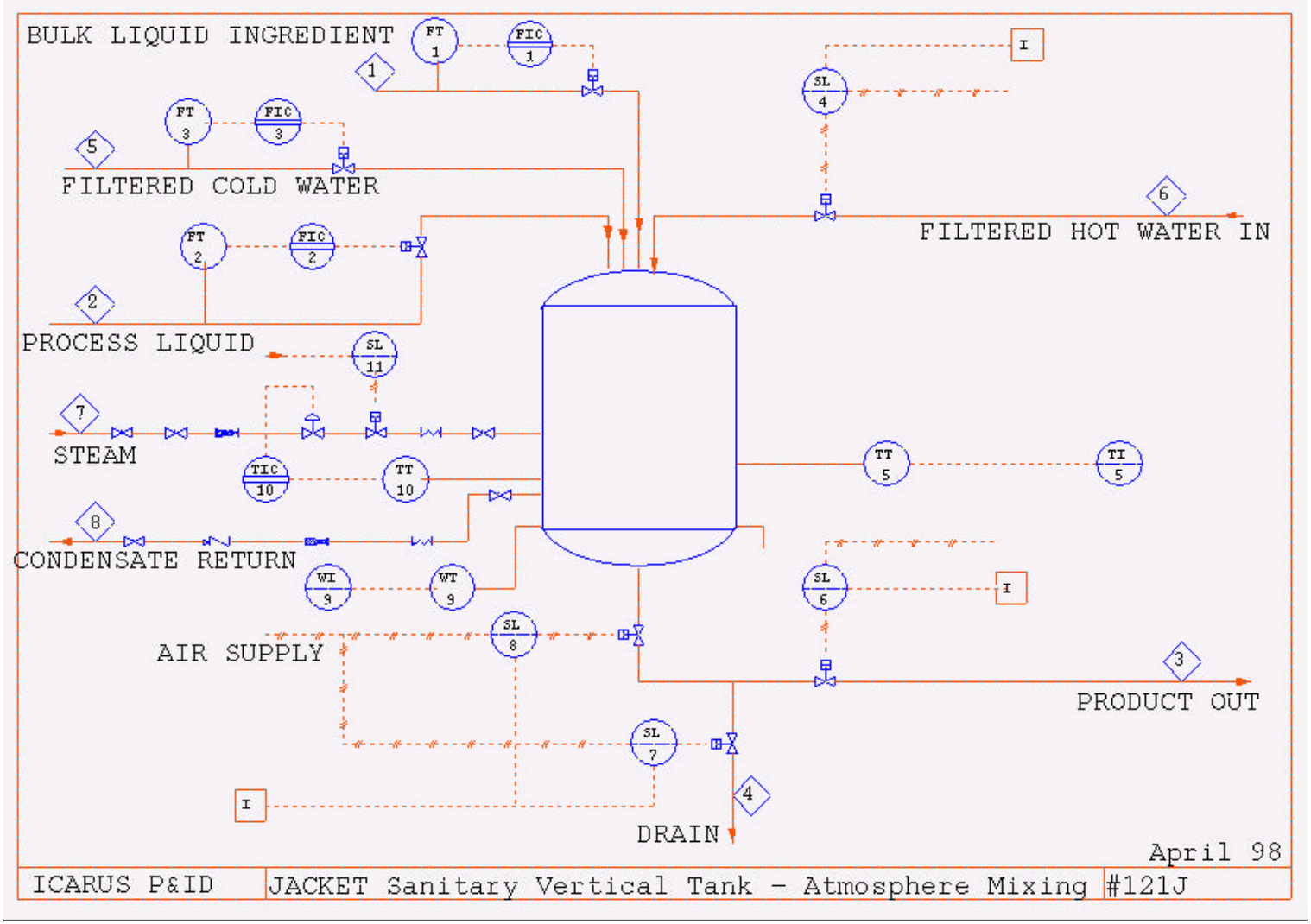
120 Jacket Sanitary Vertical Tank – Atmospheric Surge



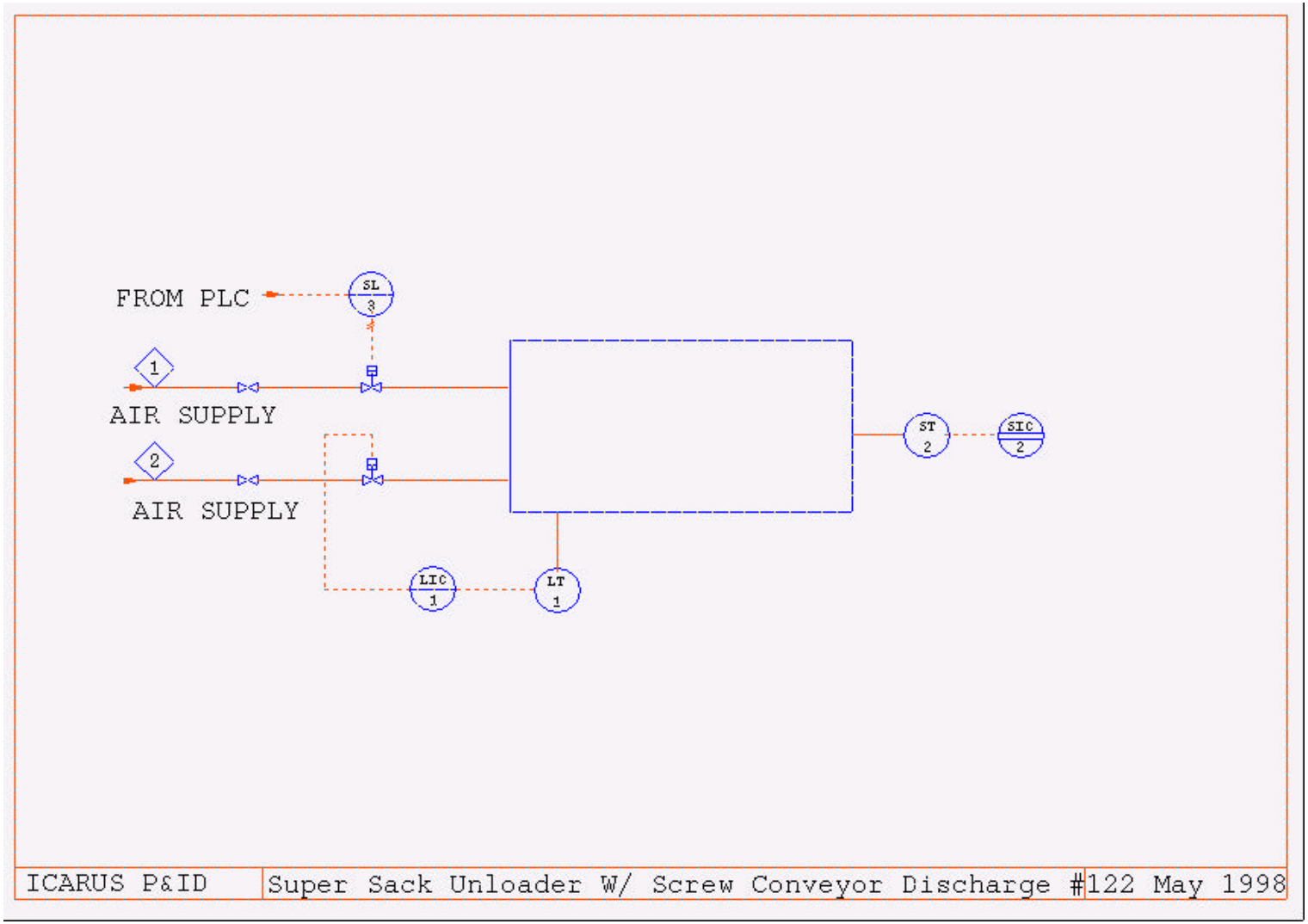
121 Sanitary Vertical Tank – Atmospheric Mixing



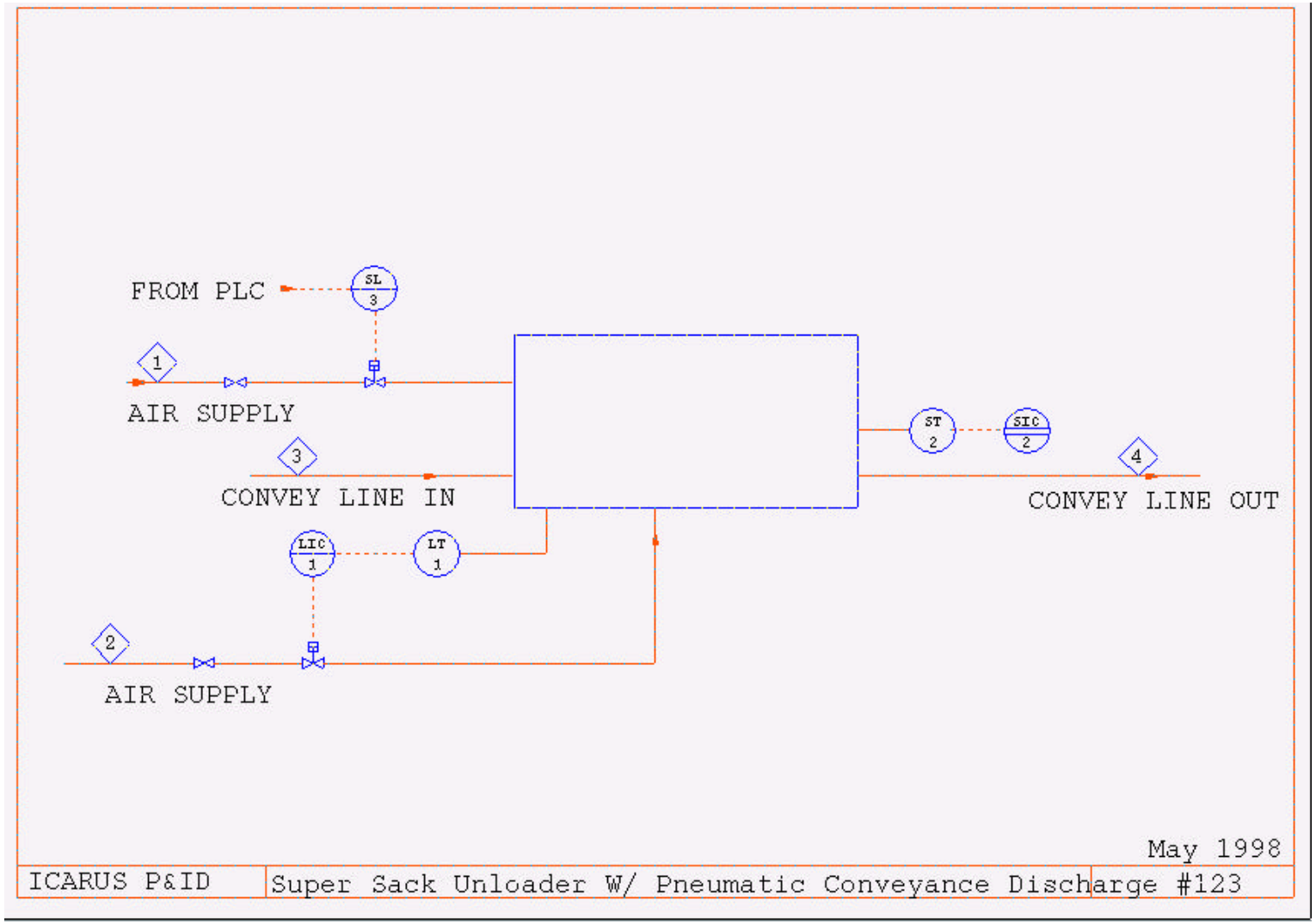
121 Jacket Sanitary Vertical Tank – Atmospheric Mixing



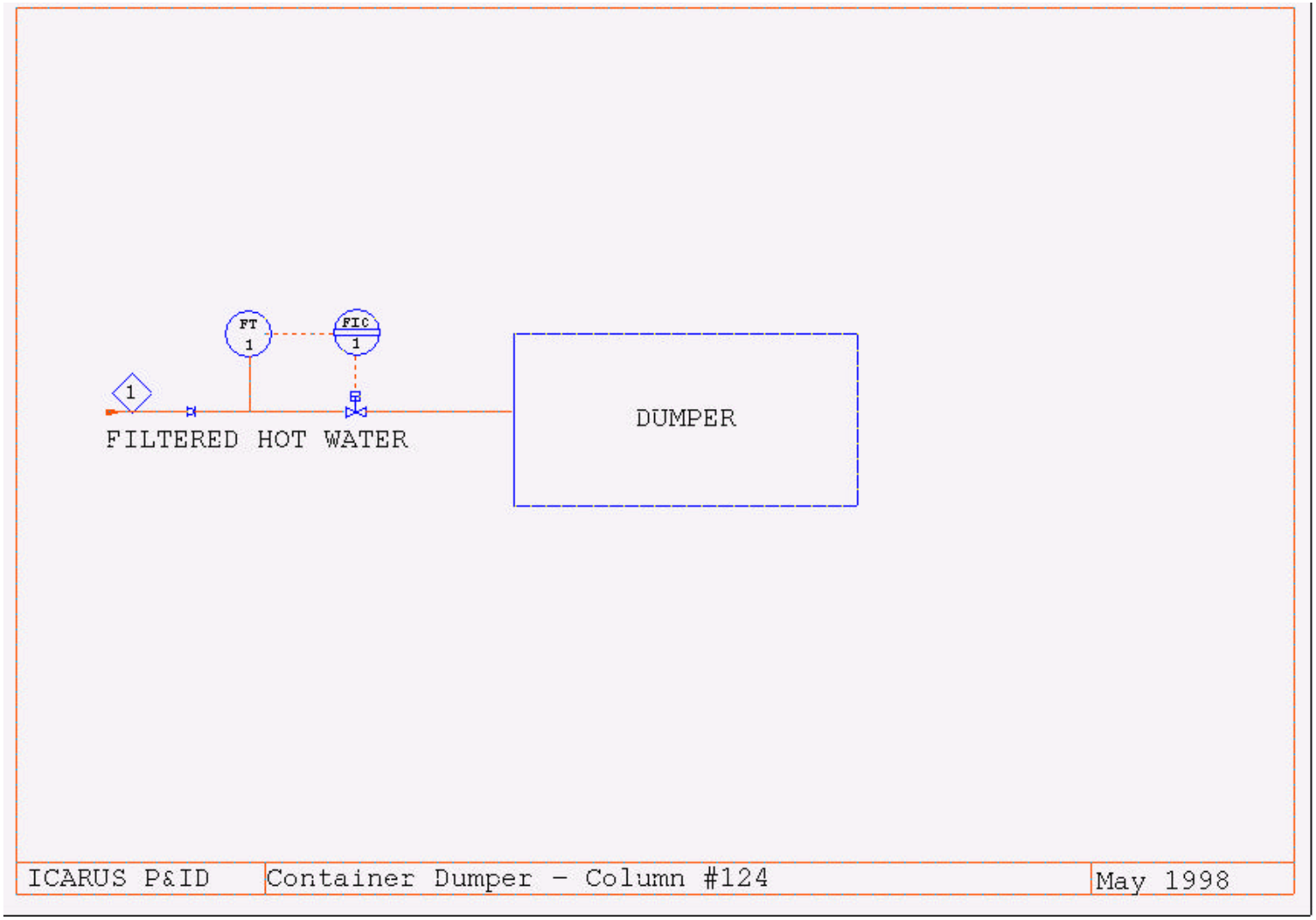
122 Super Sack Unloader With Screw Conveyor Discharge



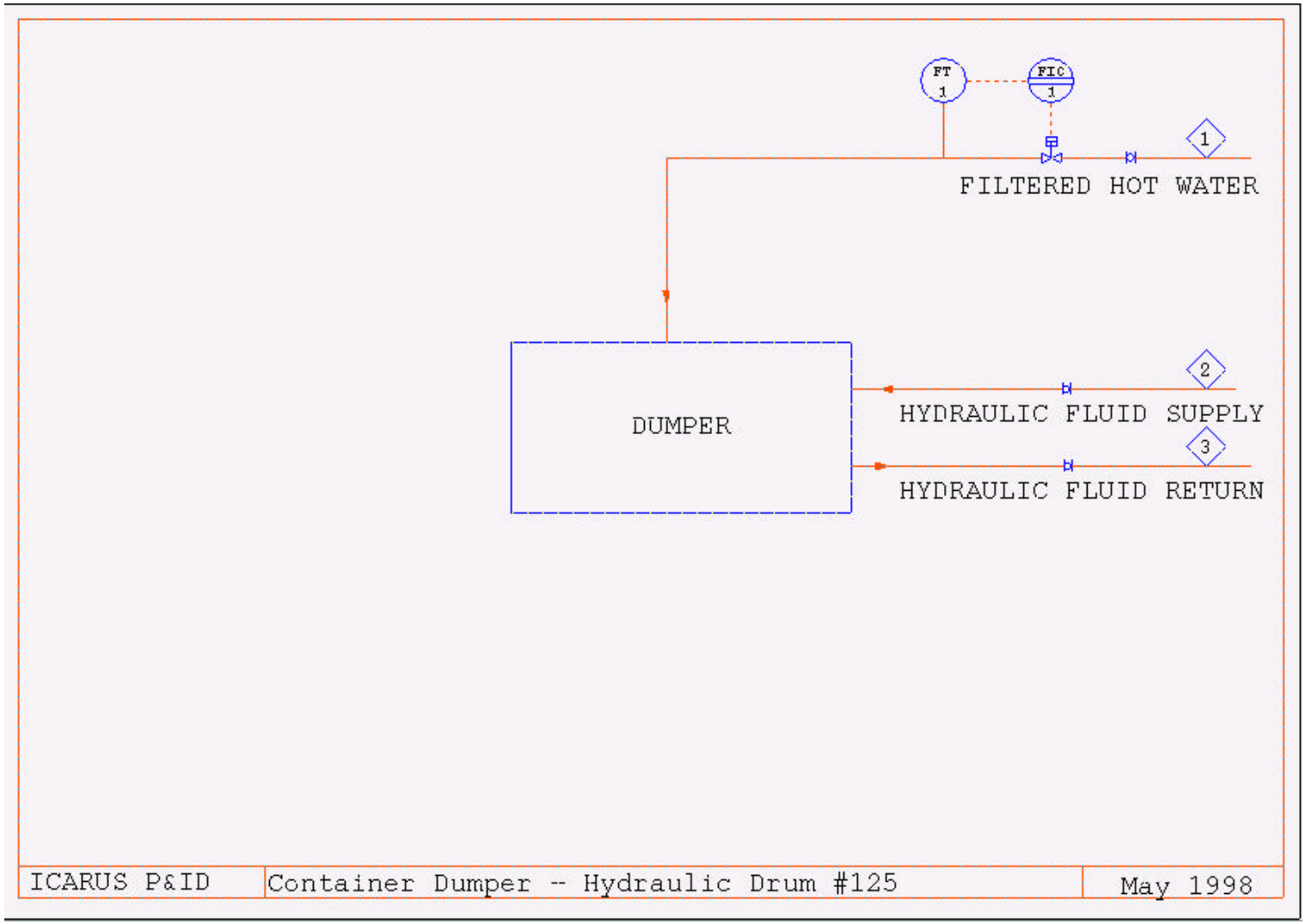
123 Super Sack Unloader With Pneumatic Conveyance Discharge



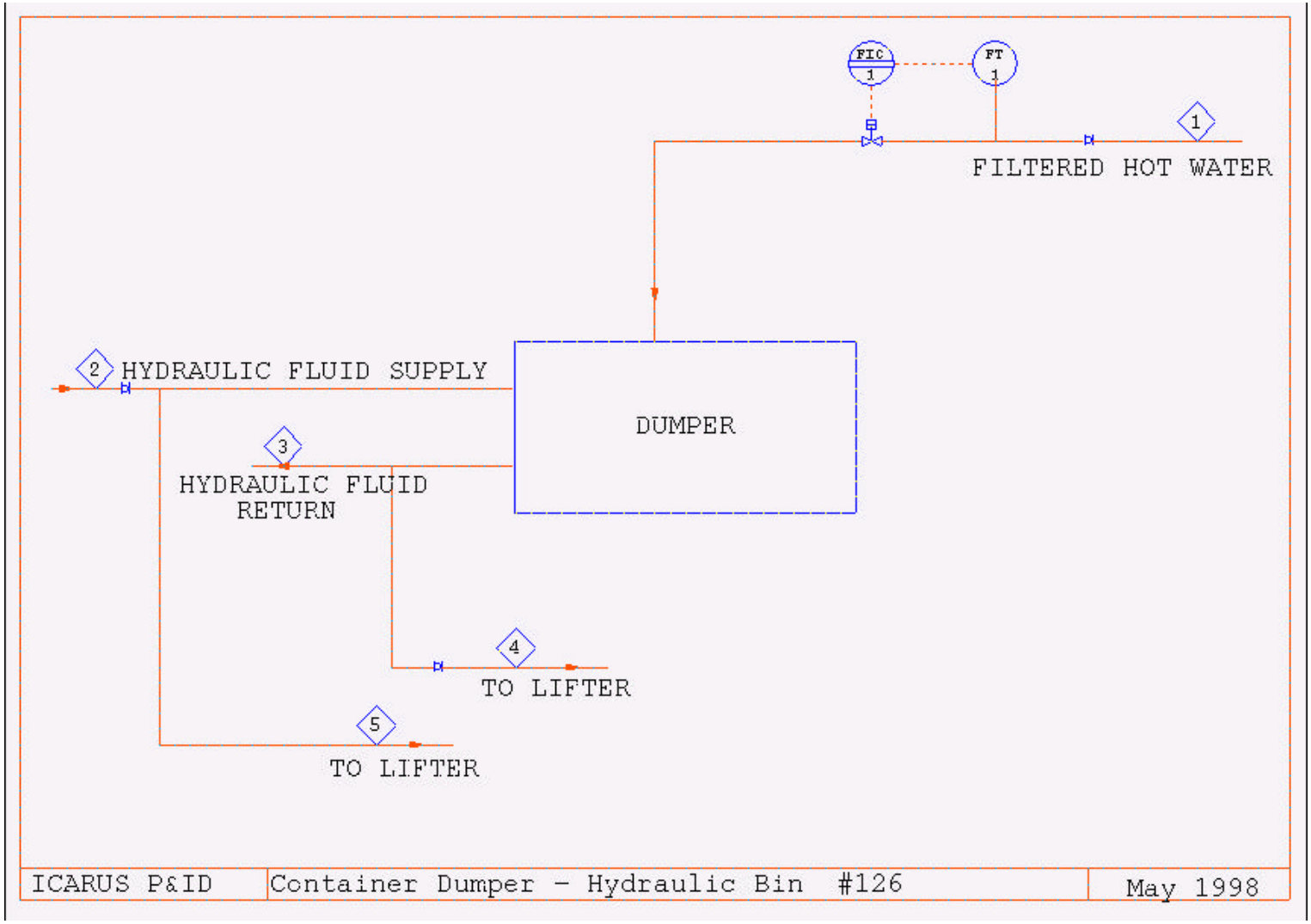
124 Container Dumper – Column



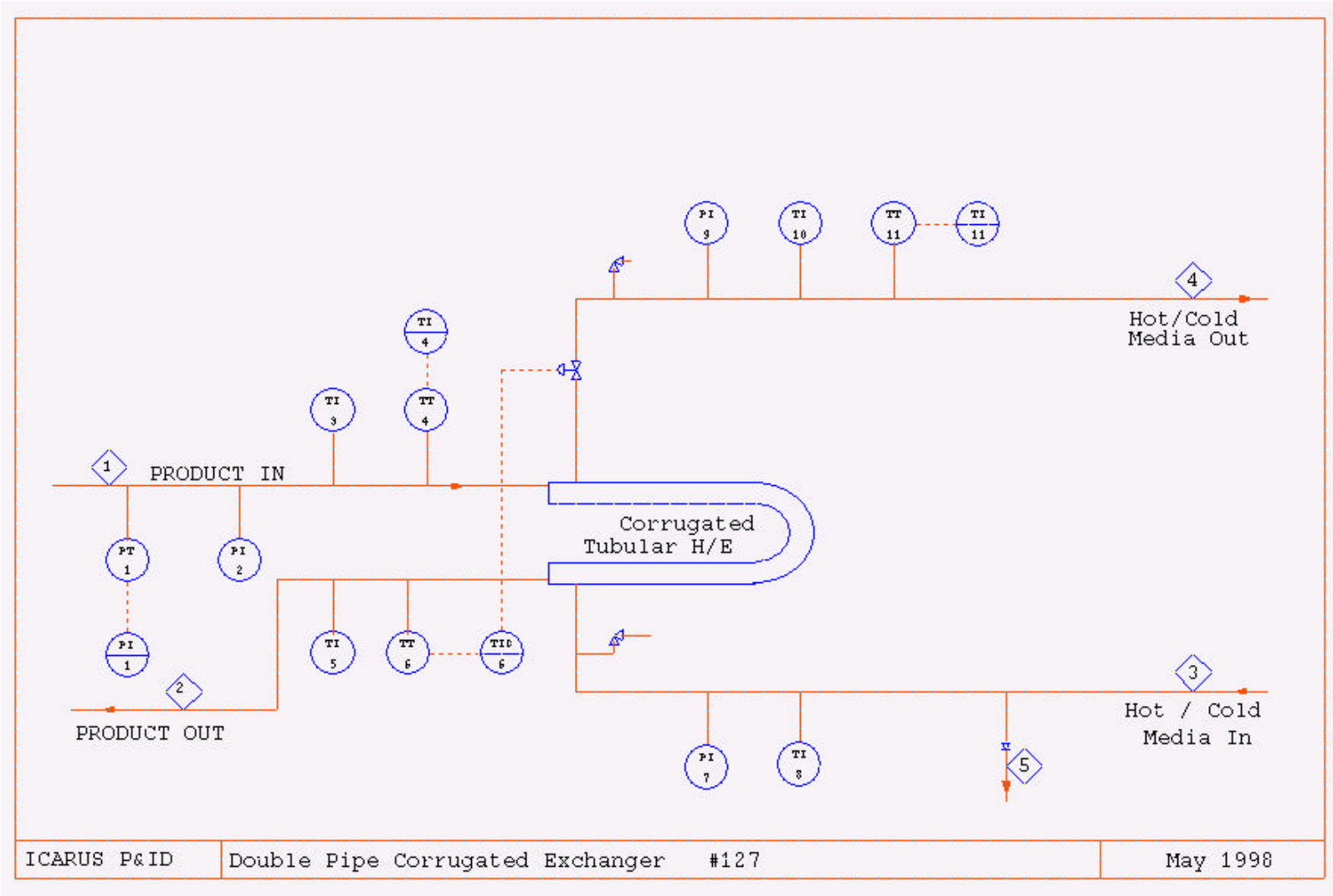
125 Container Dumper – Hydraulic Drum



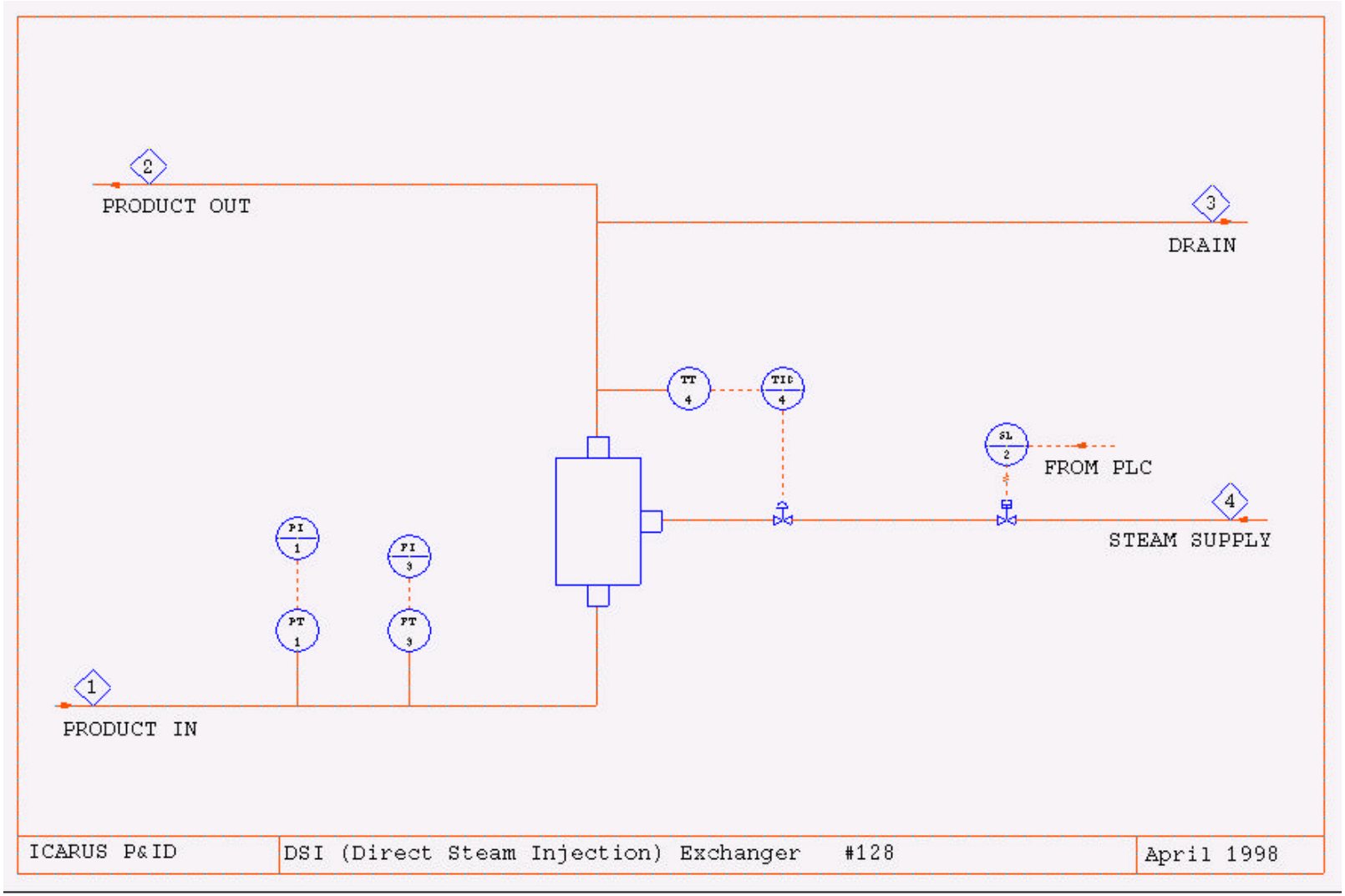
126 Container Dumper – Hydraulic Bin



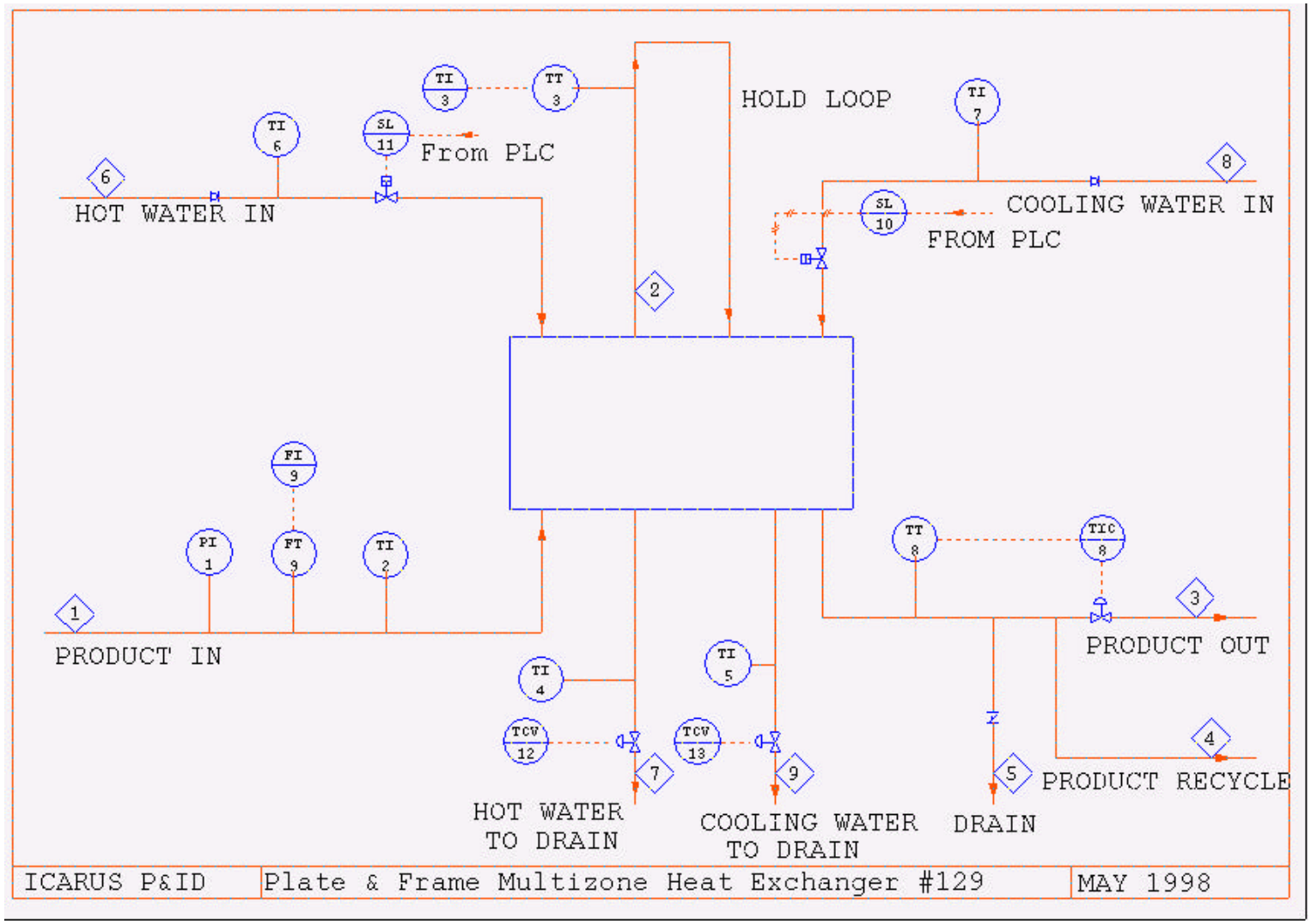
127 Double Pipe Corrugated Exchanger



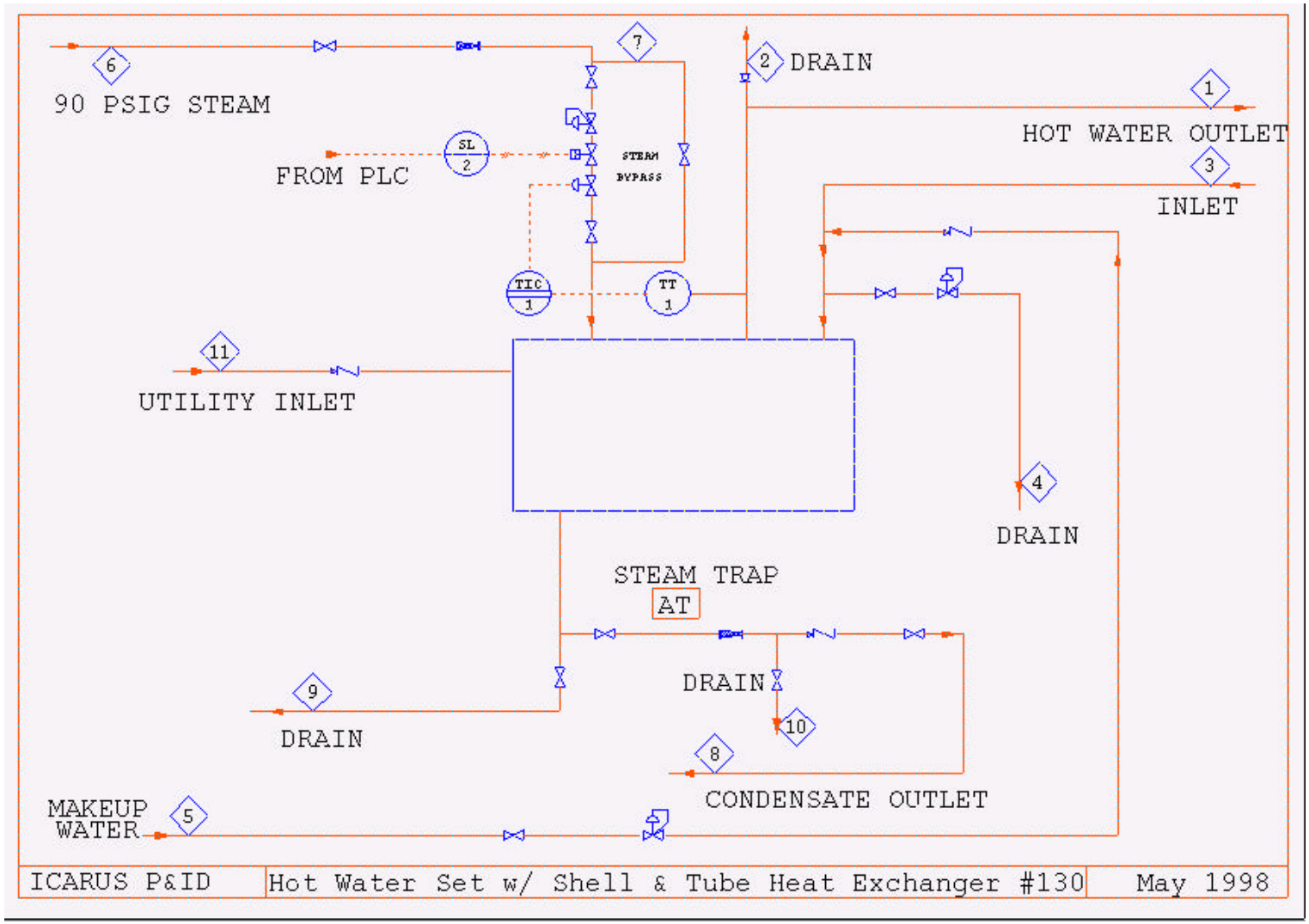
128 Direct Steam Injection (DSI) Exchanger



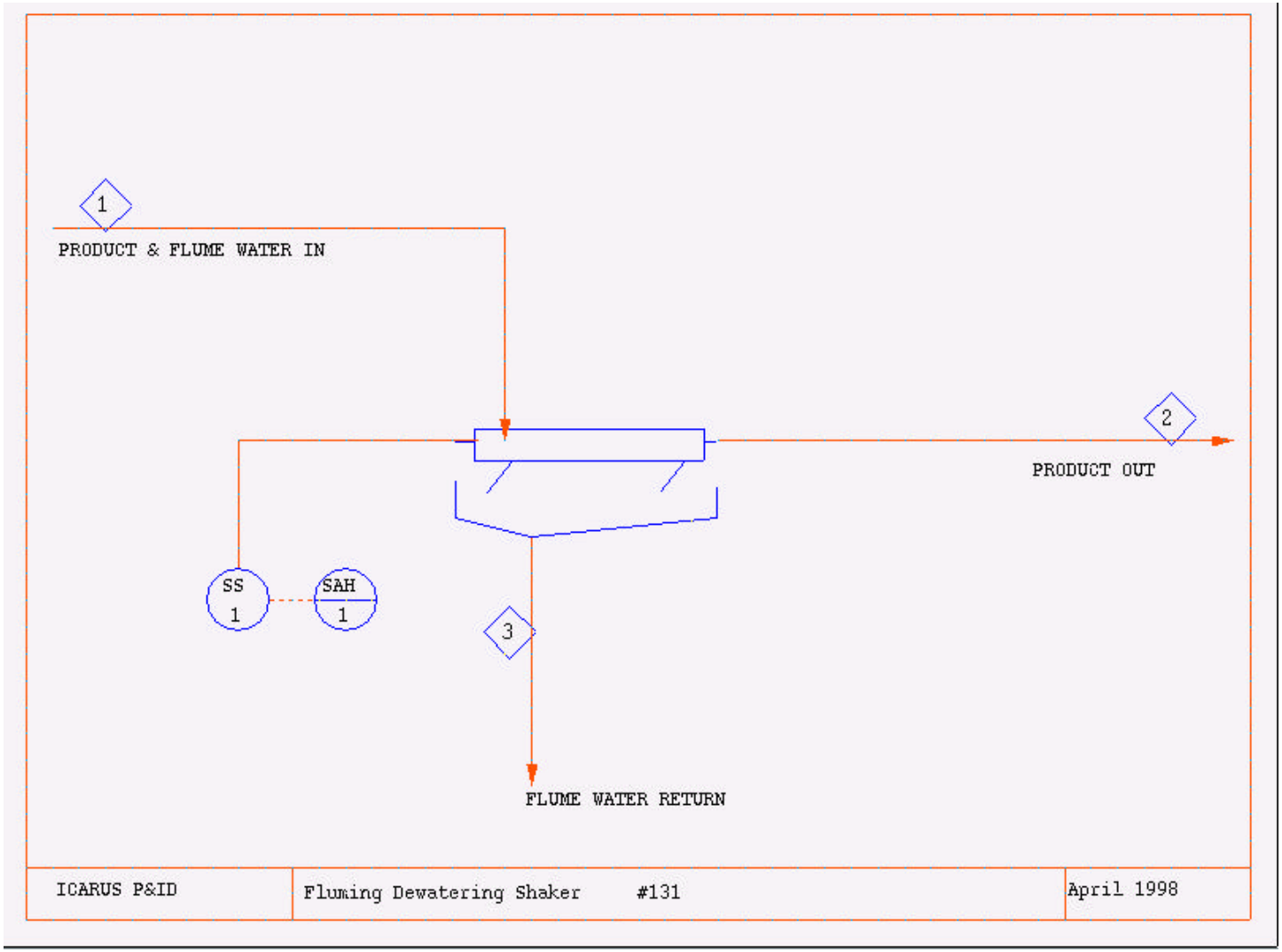
129 Plate & Frame Multizone Heat Exchanger



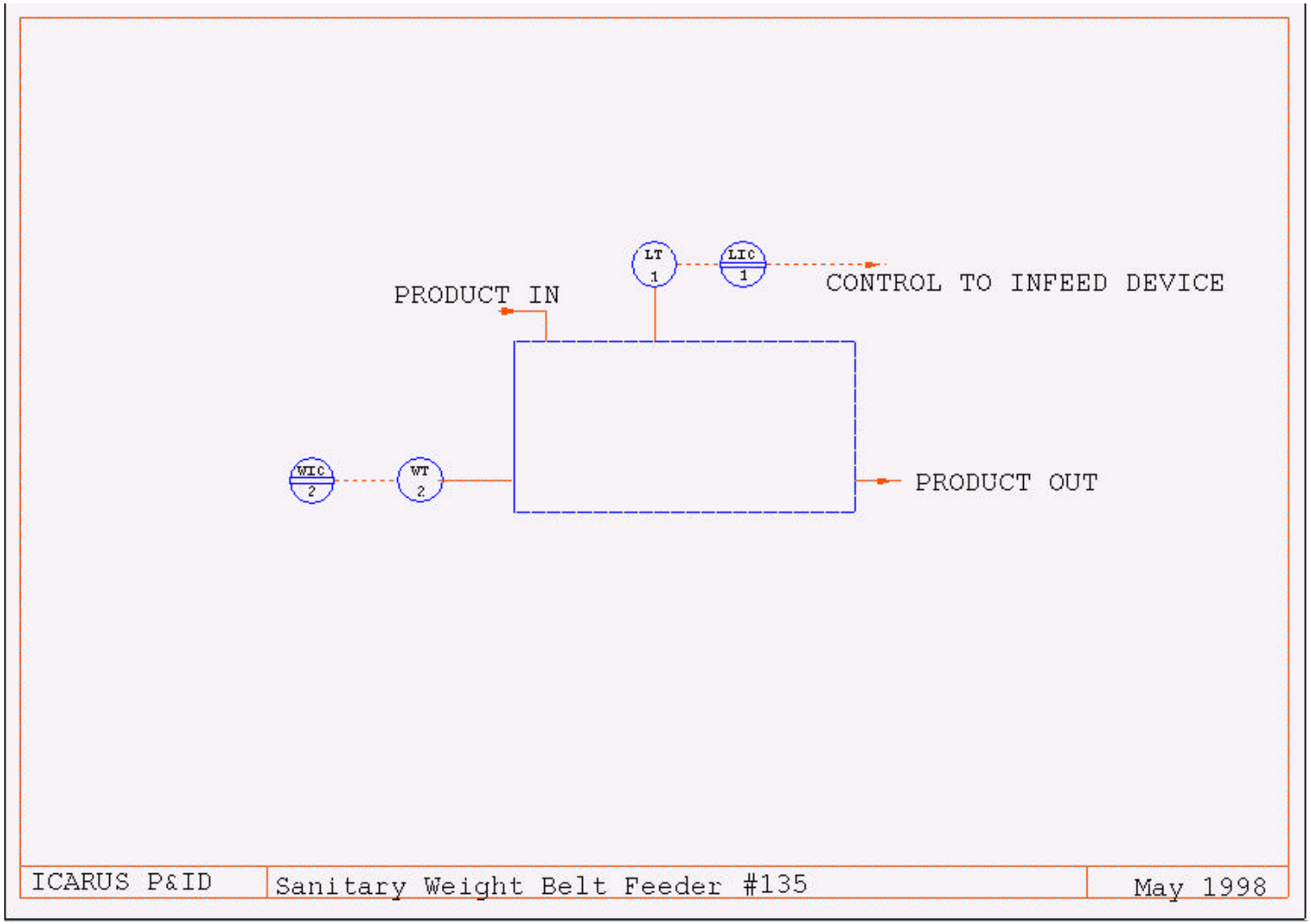
130 Hotwater Set With Shell & Tube Heat Exchanger



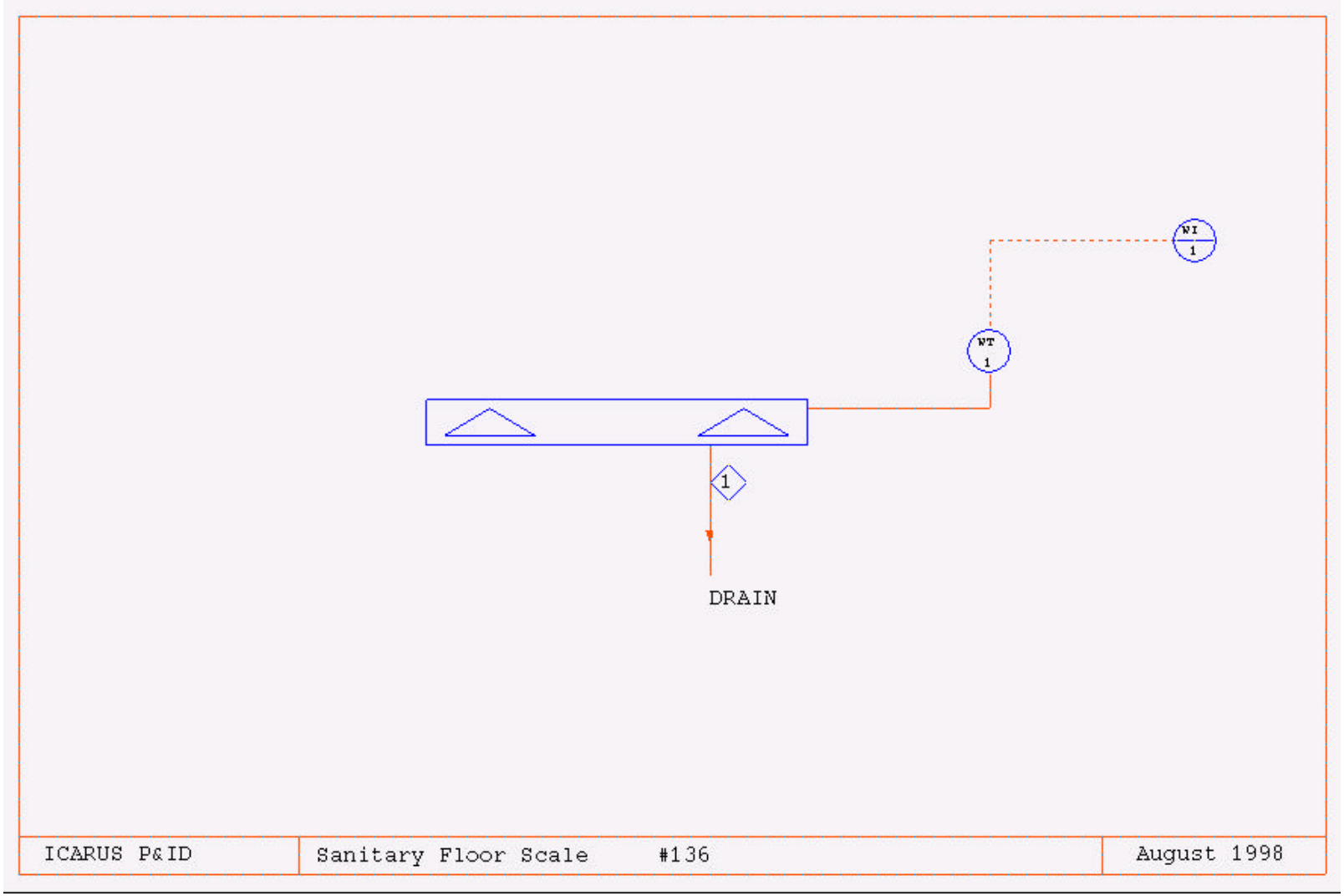
131 Fluming Dewatering Shaker



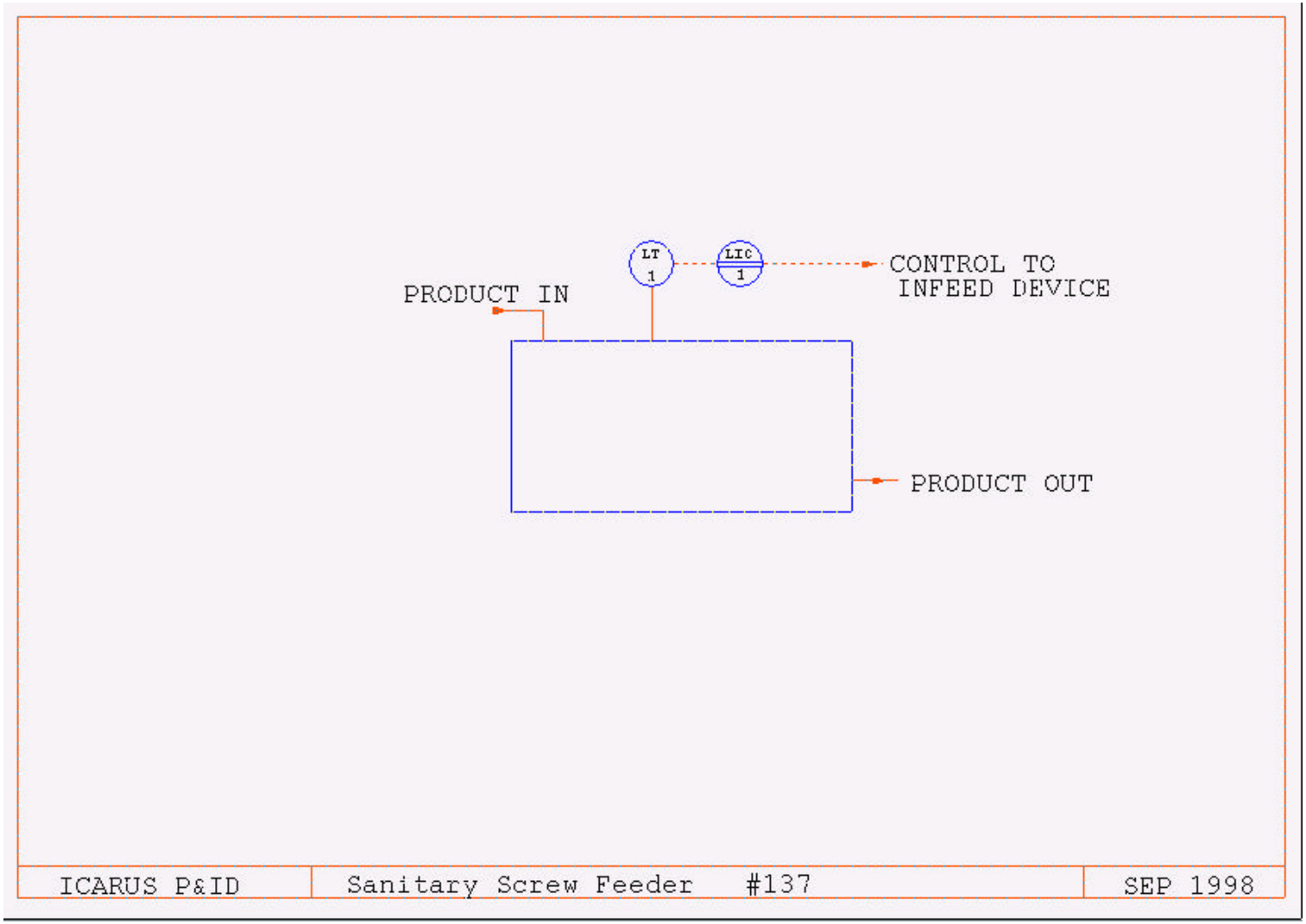
135 Sanitary Weight Belt Feeder



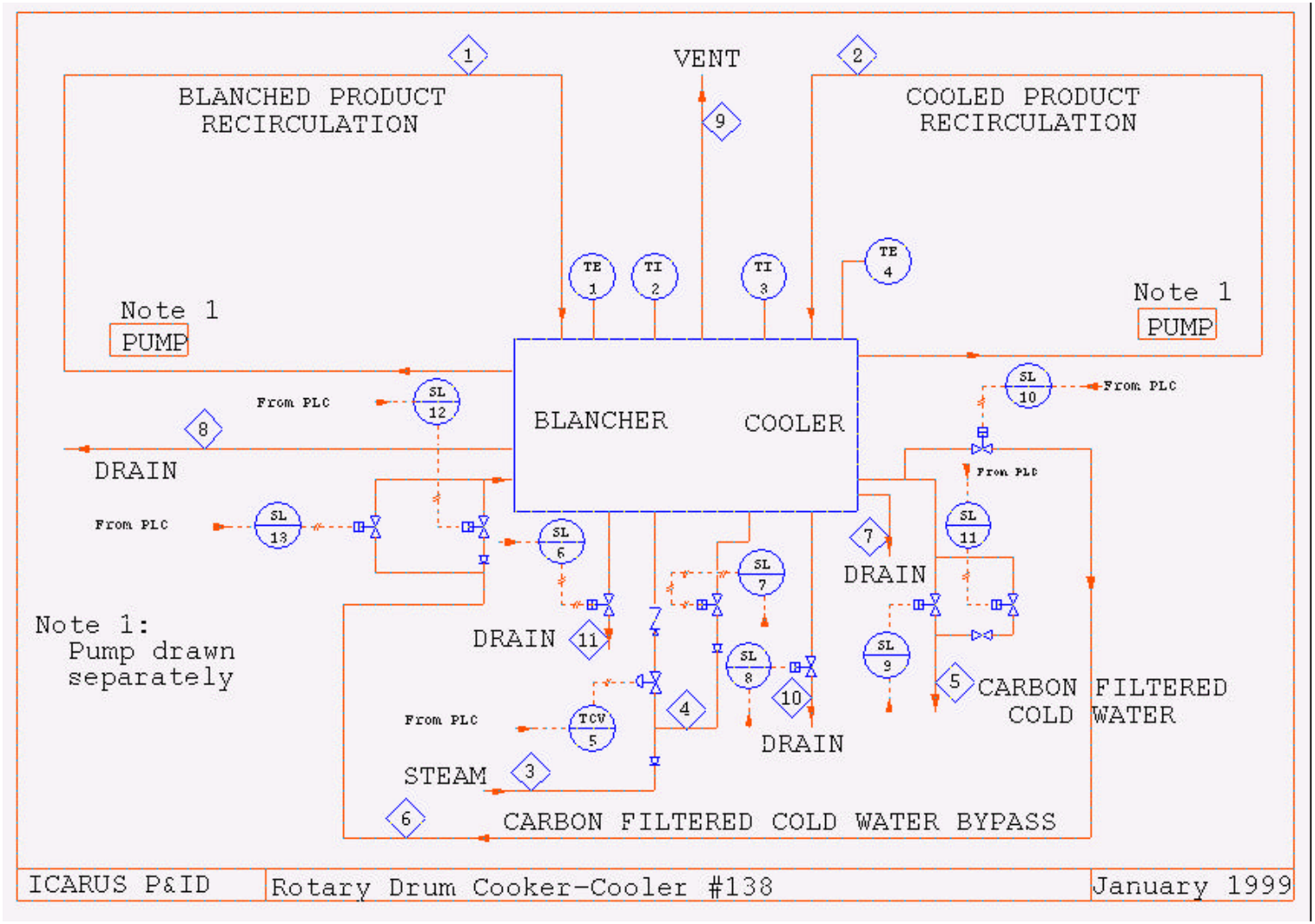
136 Sanitary Floor Scale



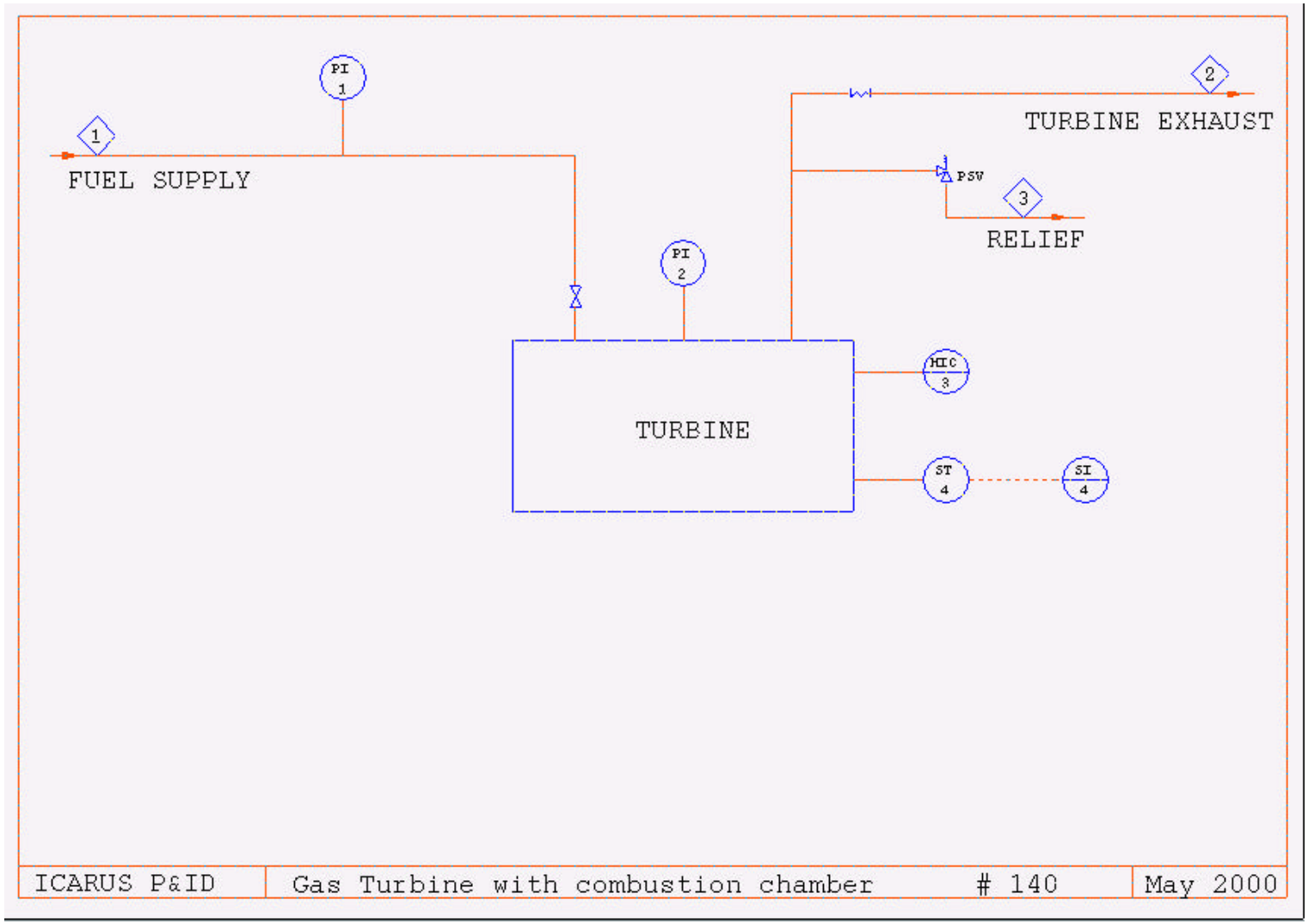
137 Sanitary Screw Feeder



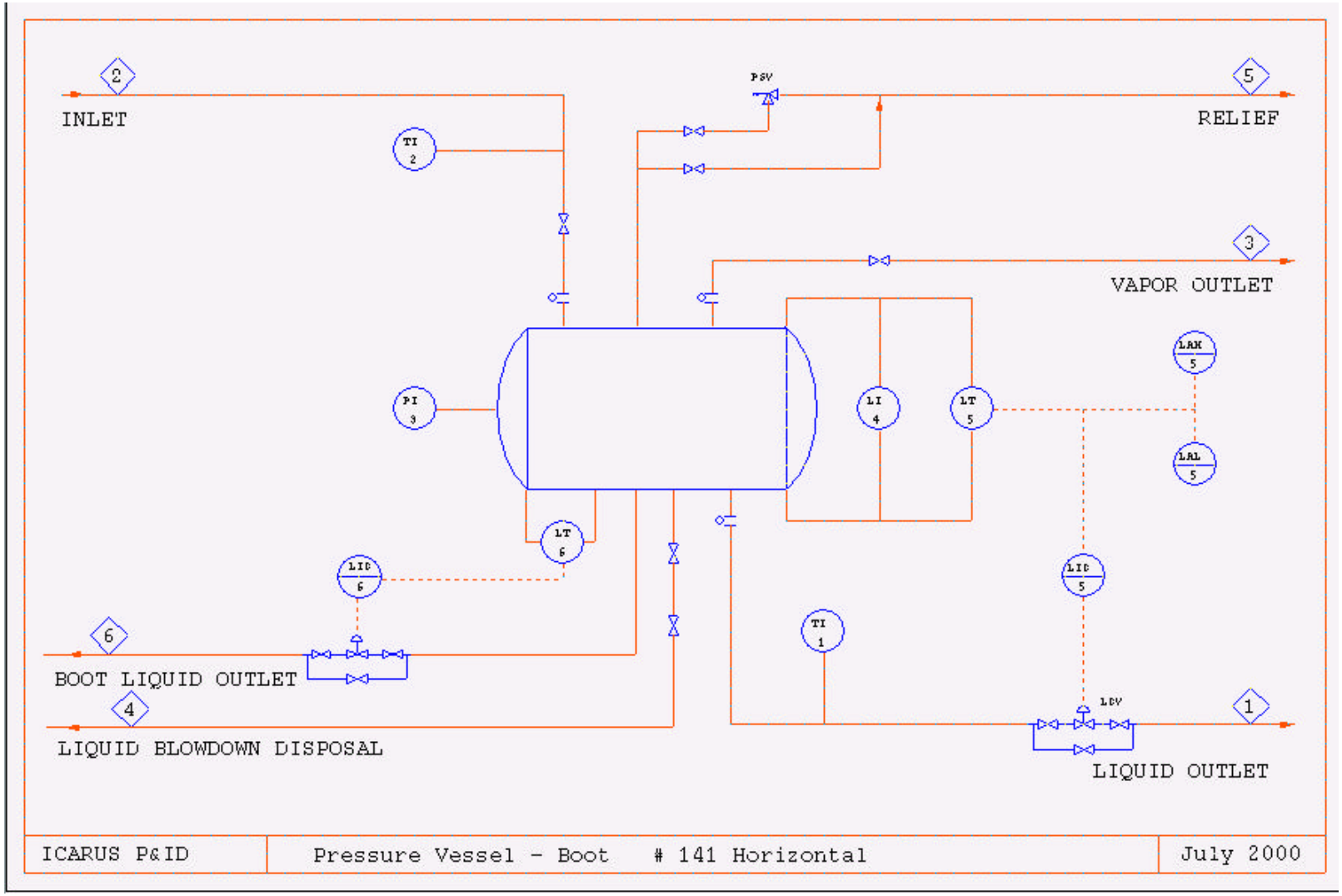
138 Rotary Drum Cooker-Cooler



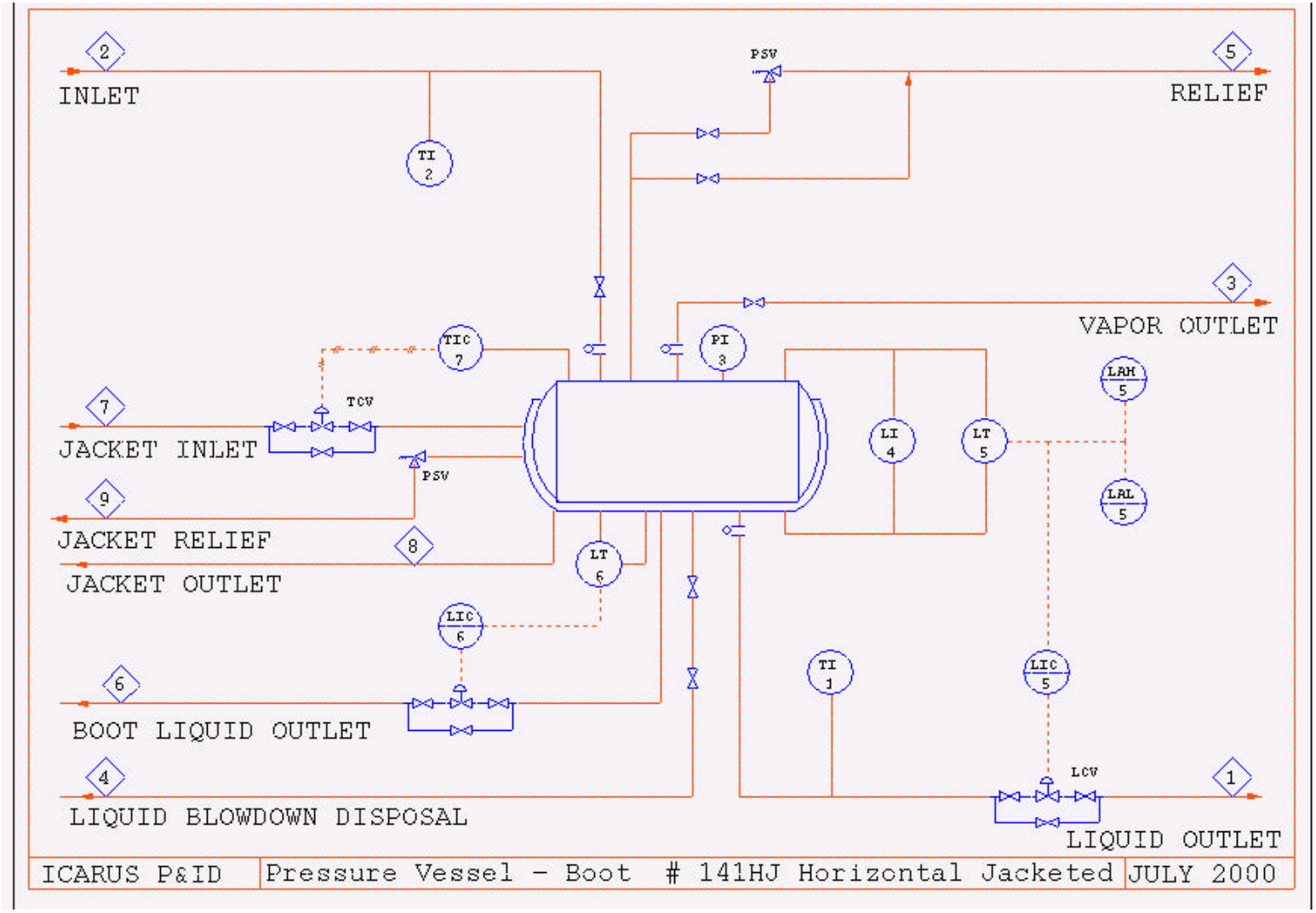
140 Gas Turbine With Combustion Chamber



141 Horizontal Pressure Vessel With Boot

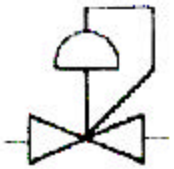


141 Horizontal Jacketed Pressure Vessel With Boot



Appendix A: Symbols

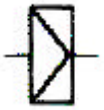
Piping Symbols



Regulating Valve

Pressure Safety Valve

Spectacle Blind



Rupture Disk

or

Check Valve

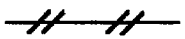
Flanged Connection

Reducer

Drain

Expansion Joint

Instrument Symbols



Pneumatic Signal

Electronic Signal

Direct Connection

Thermocouple Wire

Solenoid

Flow Indicator (Rotometer

Flow Indicator (Gauge)

Orifice Plate

Interlock

Input/Output Card

(s = A for Analog or D for Digital)
(d = I for Input or O for Output)

Relay Function

Mounted Local to Equipment

(v = Sensor Type)
(n = Loop Number)

Mounted on Control Center Panel

Front of Panel Back of Panel

Mounted on Equipment Panel

Front of Panel Back of Panel

Note: Displayed on Operator Center CRT with Digital Controls

Appendix B: Abbreviations

Instrument Identification

Process Variable (first position of name)

Symbol	Description
C	Consistency
F	Flow
T	Temperature
P	Pressure
dP	Differenctial Pressure
L	Level
S	Speed
PN	Position
PH	pH Analysis
XM	Axial Motion
XR	Radial Motion
H	Hand (no measurement)
X	Miscellaneous (e.g., Vibration)

Device (second position of name; MODE: F=field, P=panel)

Symbol	Mode	Description
R	R,P	Recorder
I	F,P	Indicator
C	F,P	Controller
RC	F,P	Recording Controller
IT	F	Indicating Transmitter
S	F	Switch
E	F	Element
A	O	Alarm (F-O-P)
Y	P	Relay (B-O-P)
EY	F	Solenoid
EL	P	Electric Light, Indicator
PB	P	Push Buttons, Start/Stop
CV	F	Control Valve
SV	F	Safety Valve

Qualifiers (last position)

Symbol	Description
H	High
L	Low
HH	High High
LL	Low Low

Special

TW	Thermowell
S.P.	Set Point
ESD	Emergency Shut-Down

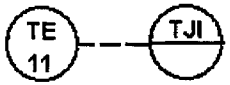
Thermocouple Devices

JI	P	Multipoint Indicator
JR	P	Multipoint Recorder

Examples:

Local flow indicating transmitter, pneumatic; Loop No. 3.

Pressure recording controller, electronic, mounted on panel; displayed, if digital at Loop No. 2.



Thermocouple element, local to equipment, connected via thermocouple wire to multipoint temperature indicator mounted on panel; displayed, if digital at Loop No. 11.

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