
Piping and Instrumentation Drawings



September 2001

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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 data. 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.

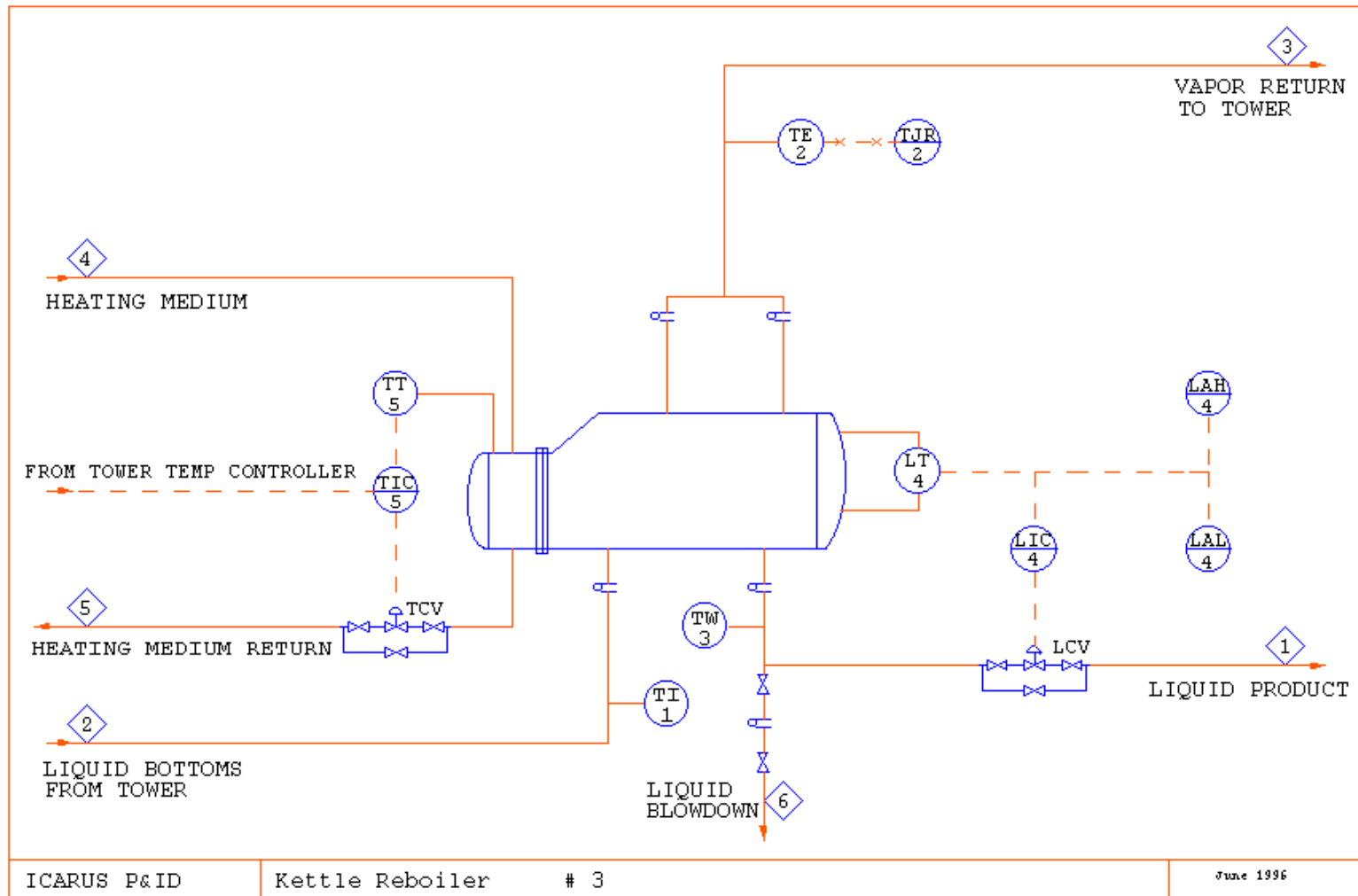
Thermocouple Wiring

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

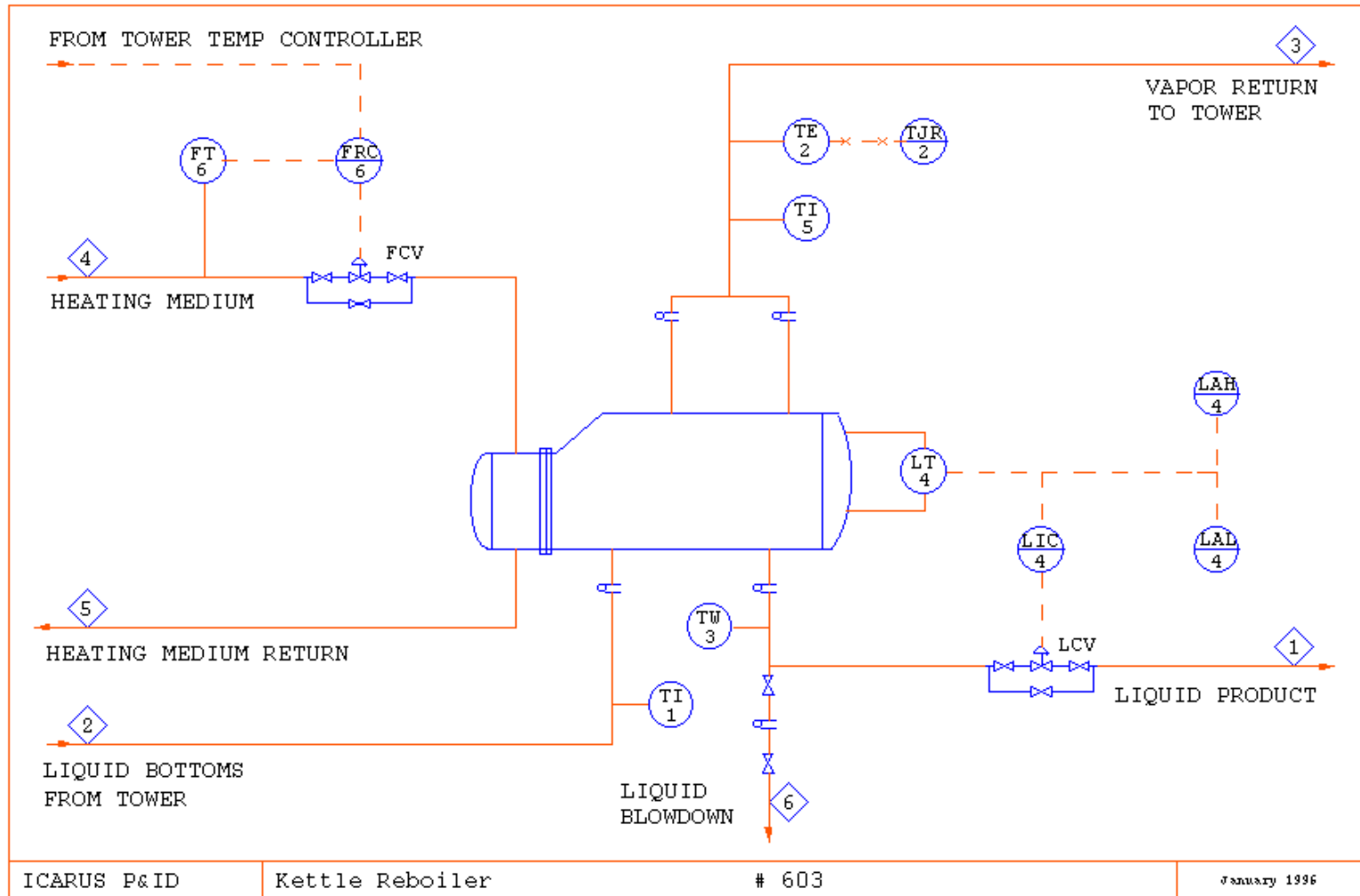
Drawings

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.

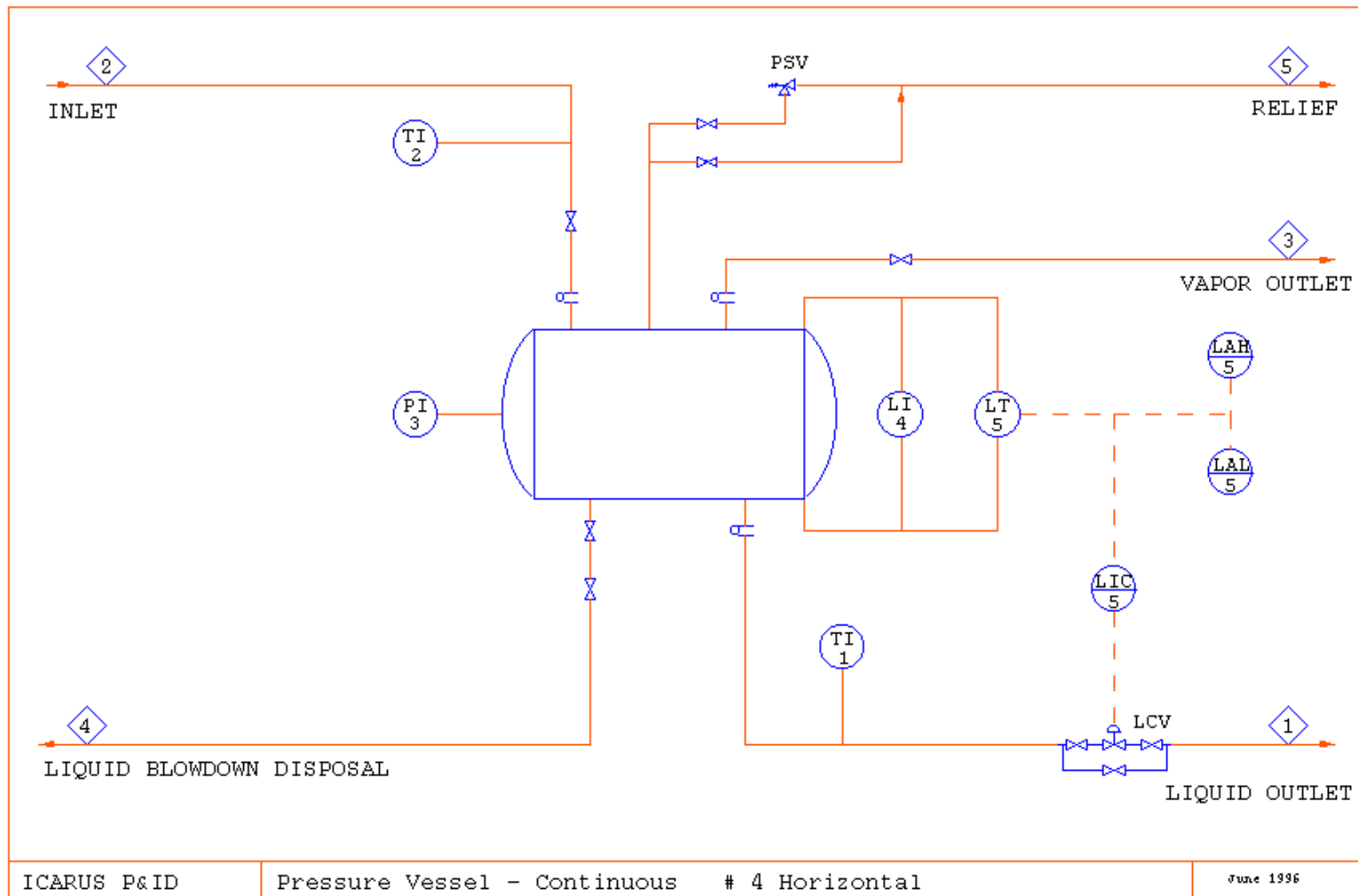
3 Kettle Reboiler



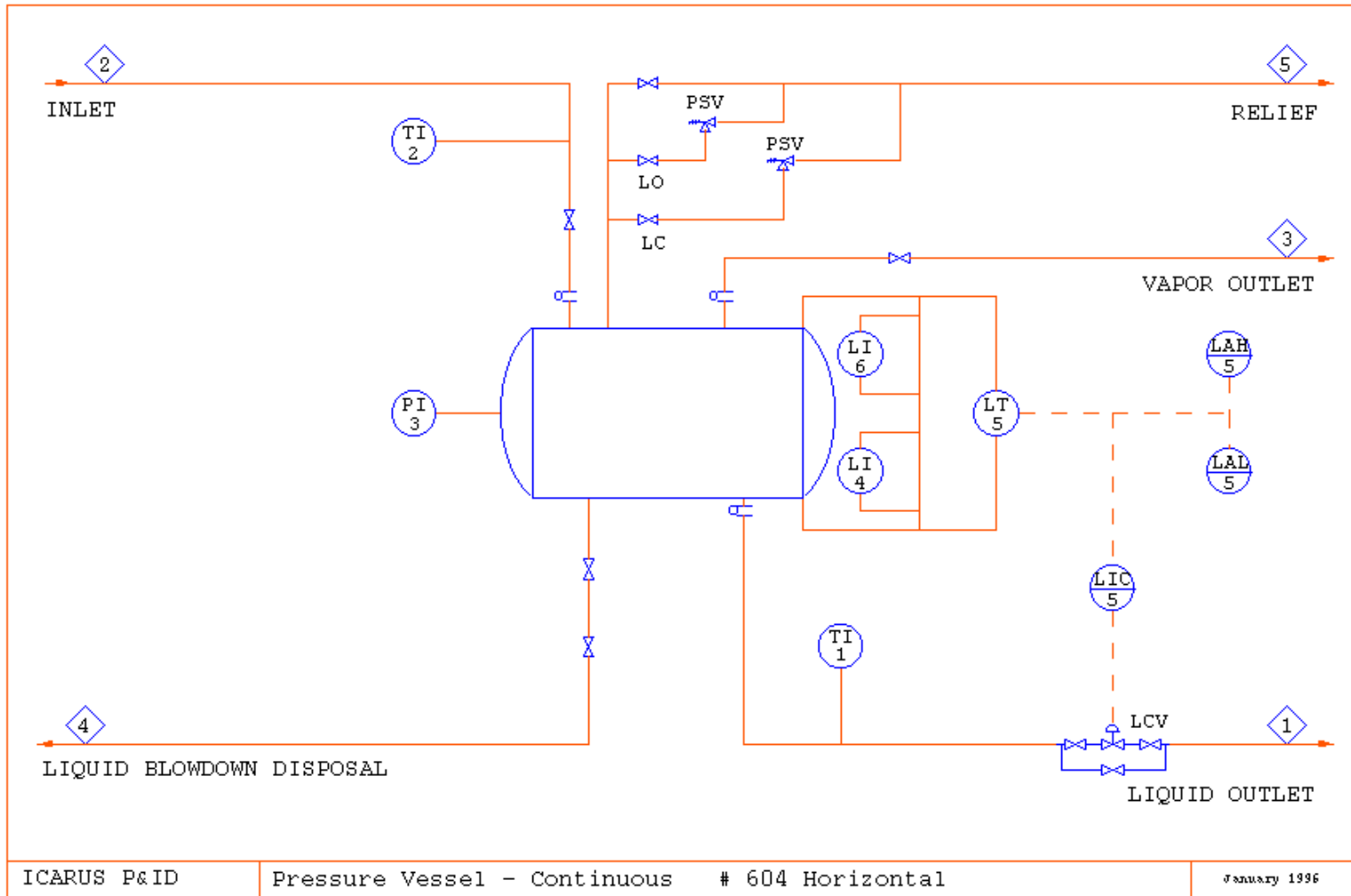
603 Kettle Reboiler



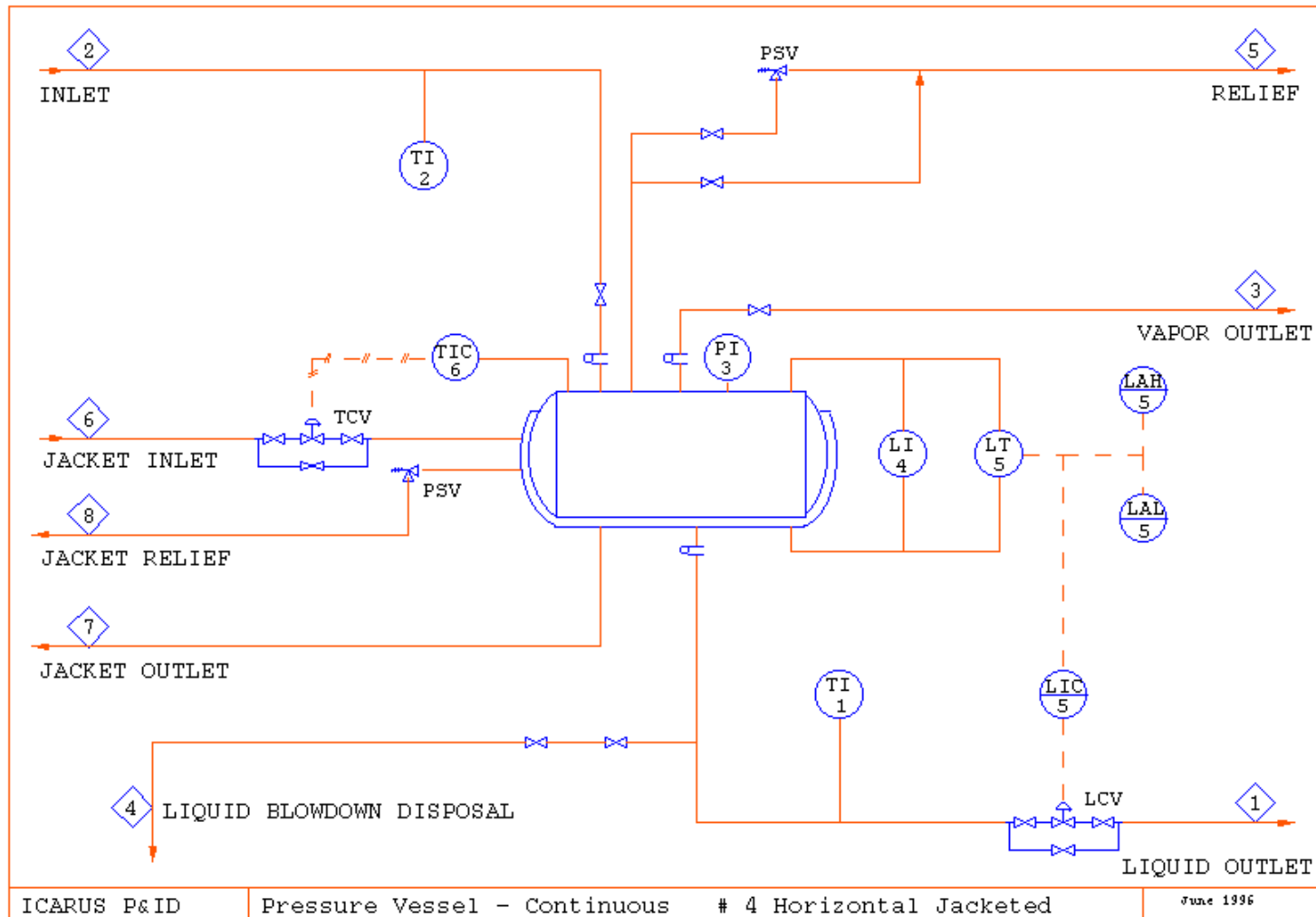
4 Horizontal Pressure Vessel – Continuous



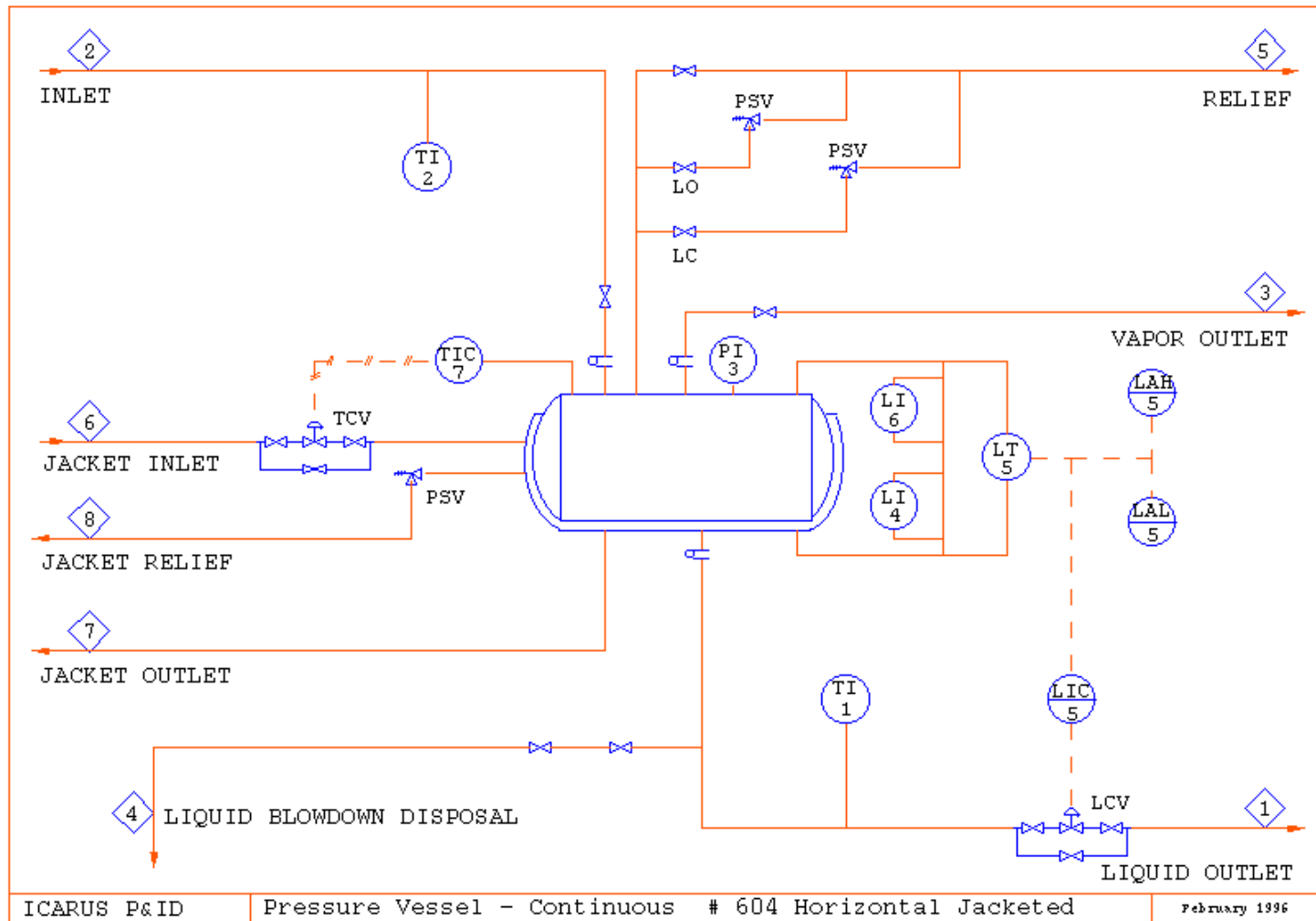
604 Horizontal Pressure Vessel – Continuous



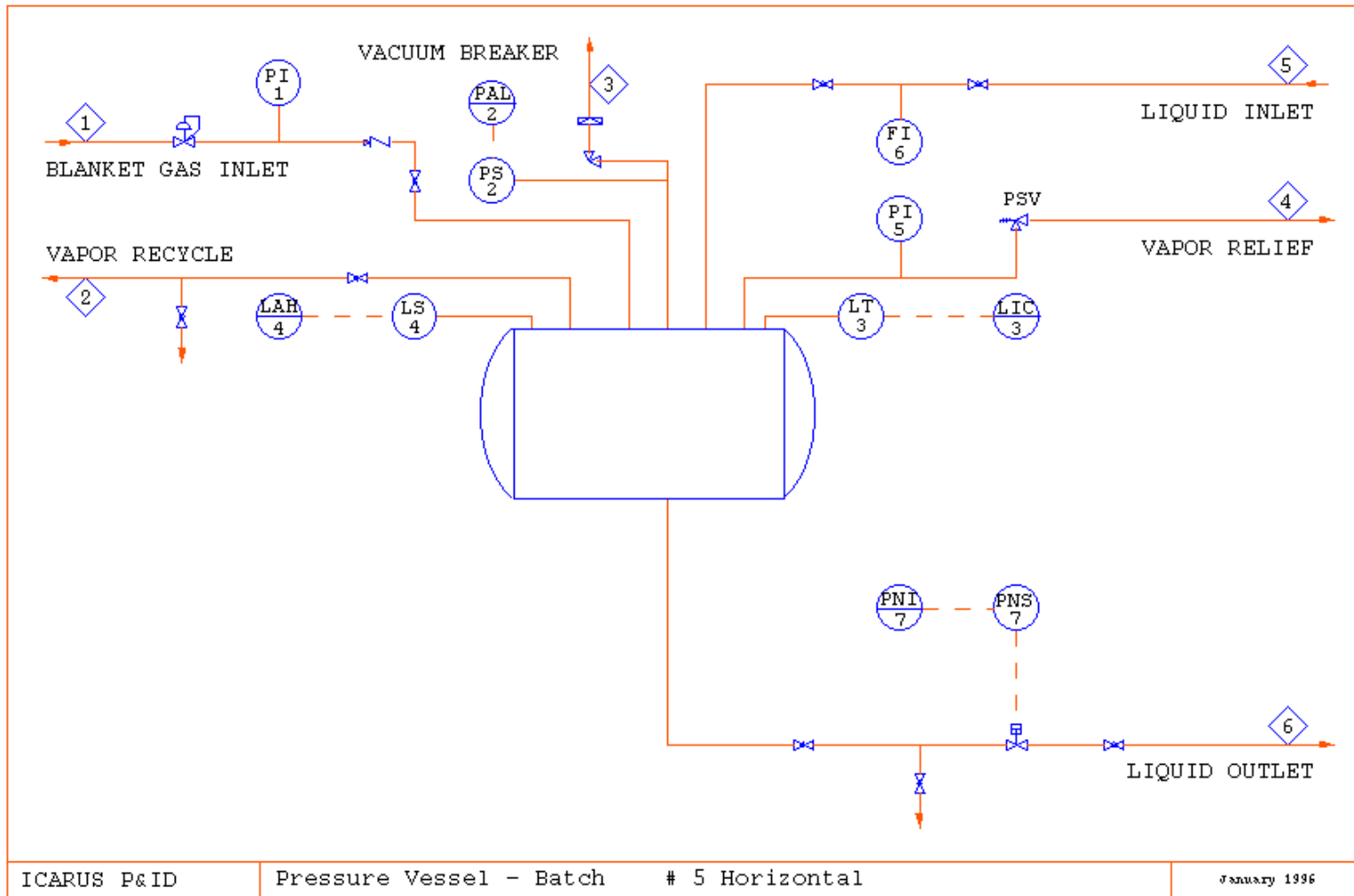
4 Horizontal Jacketed Pressure Vessel - Continuous



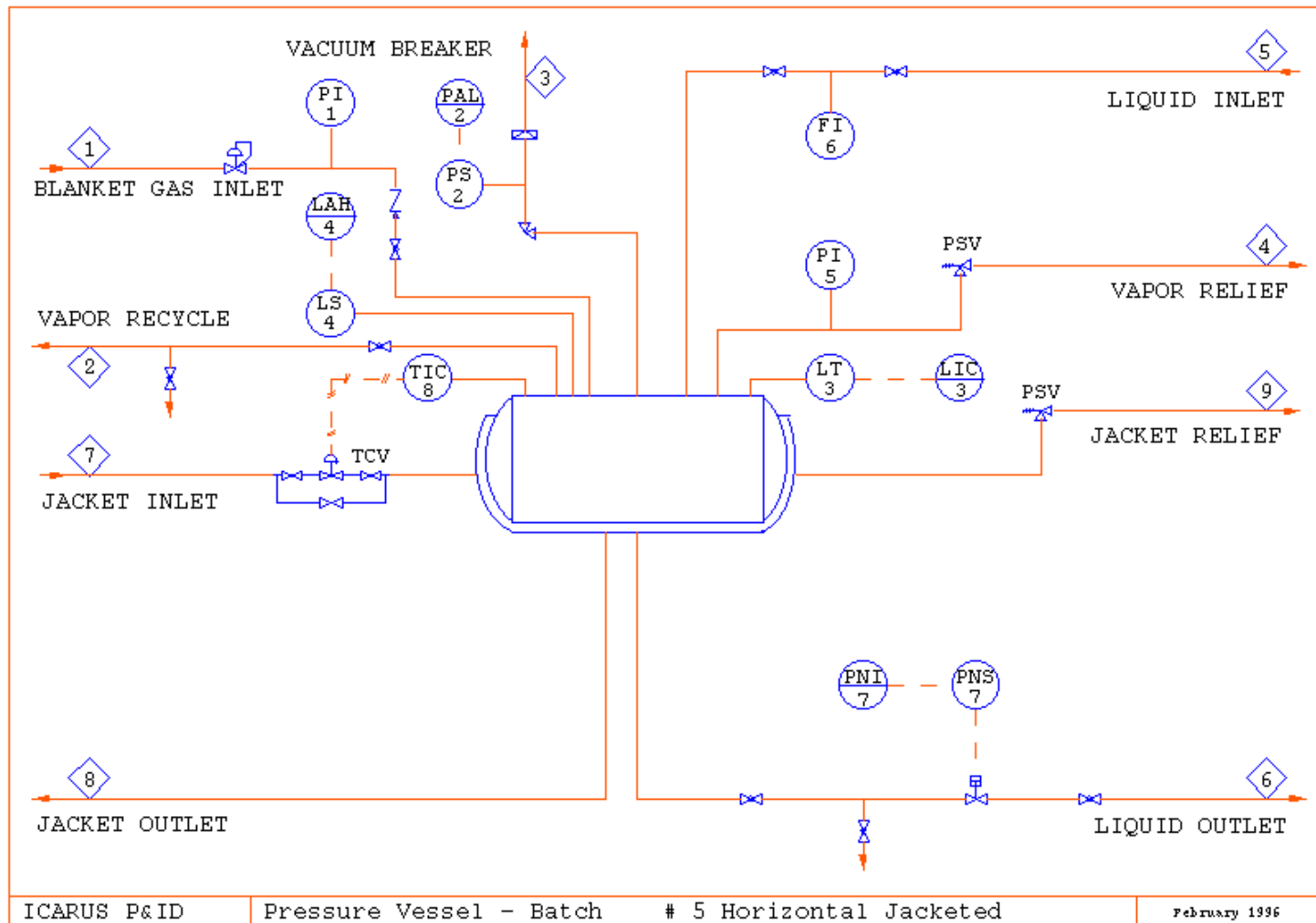
604 Horizontal Jacketed Pressure Vessel – Continuous



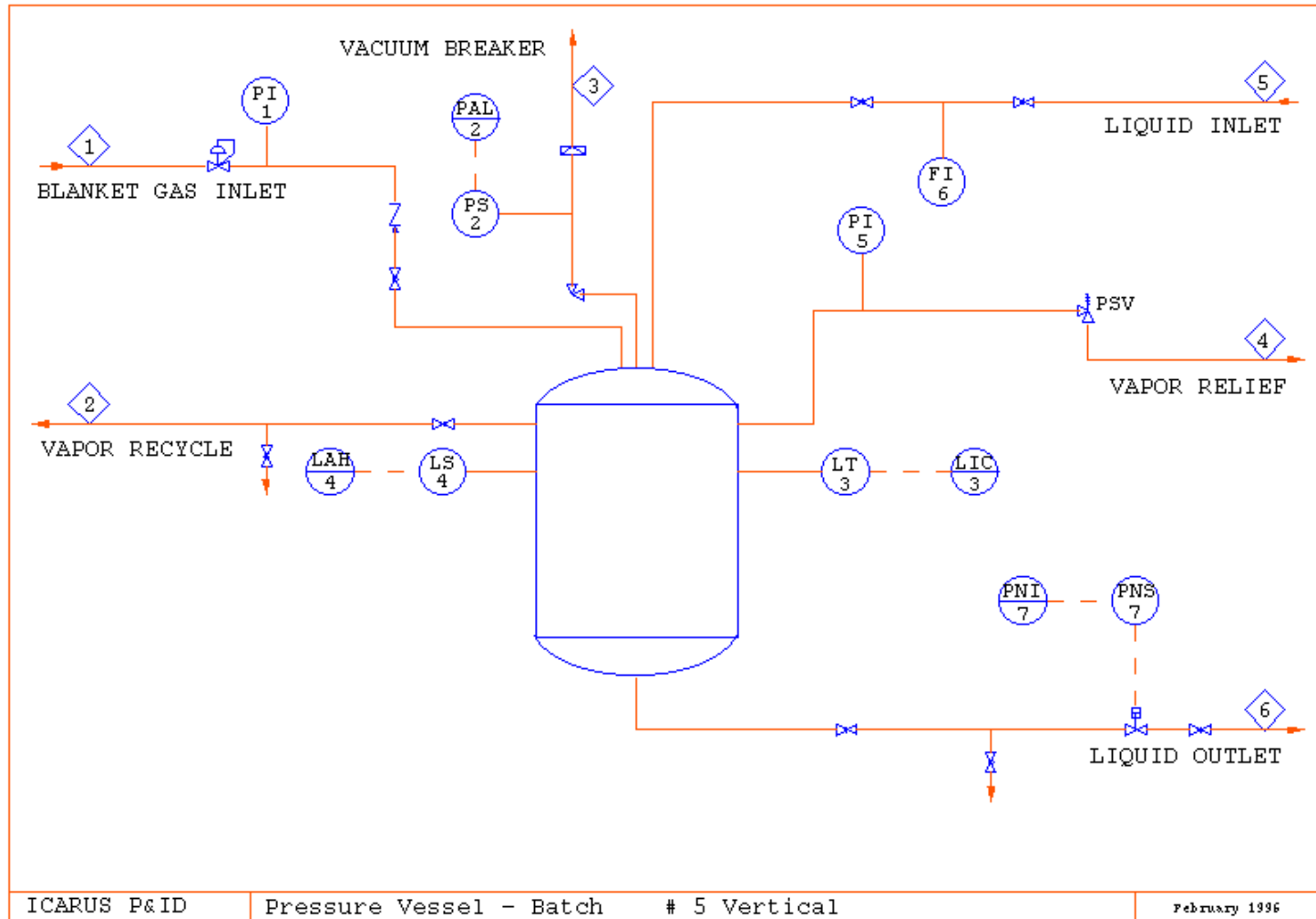
5 Horizontal Pressure Vessel – Batch



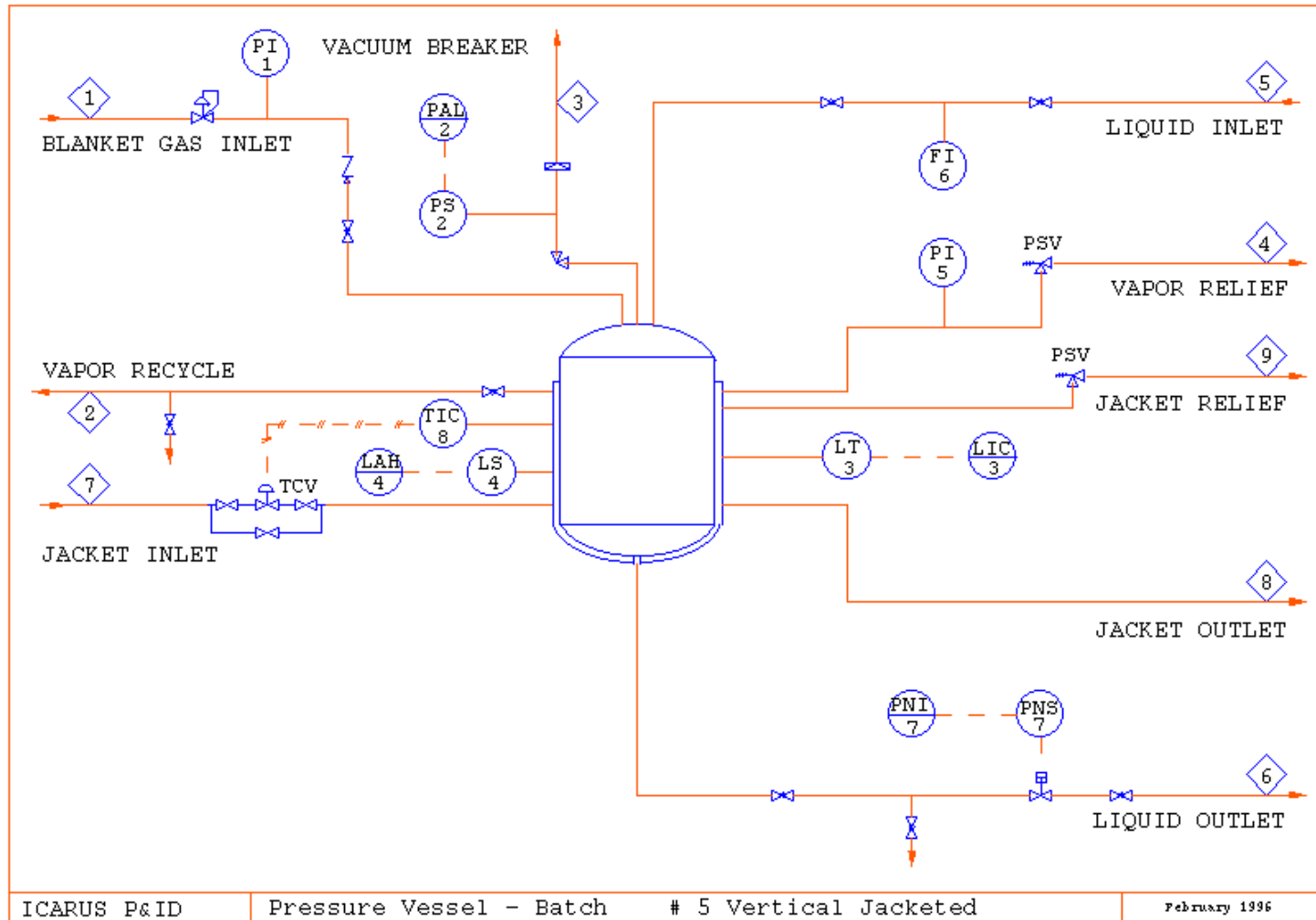
5 Horizontal Jacketed Pressure Vessel – Batch



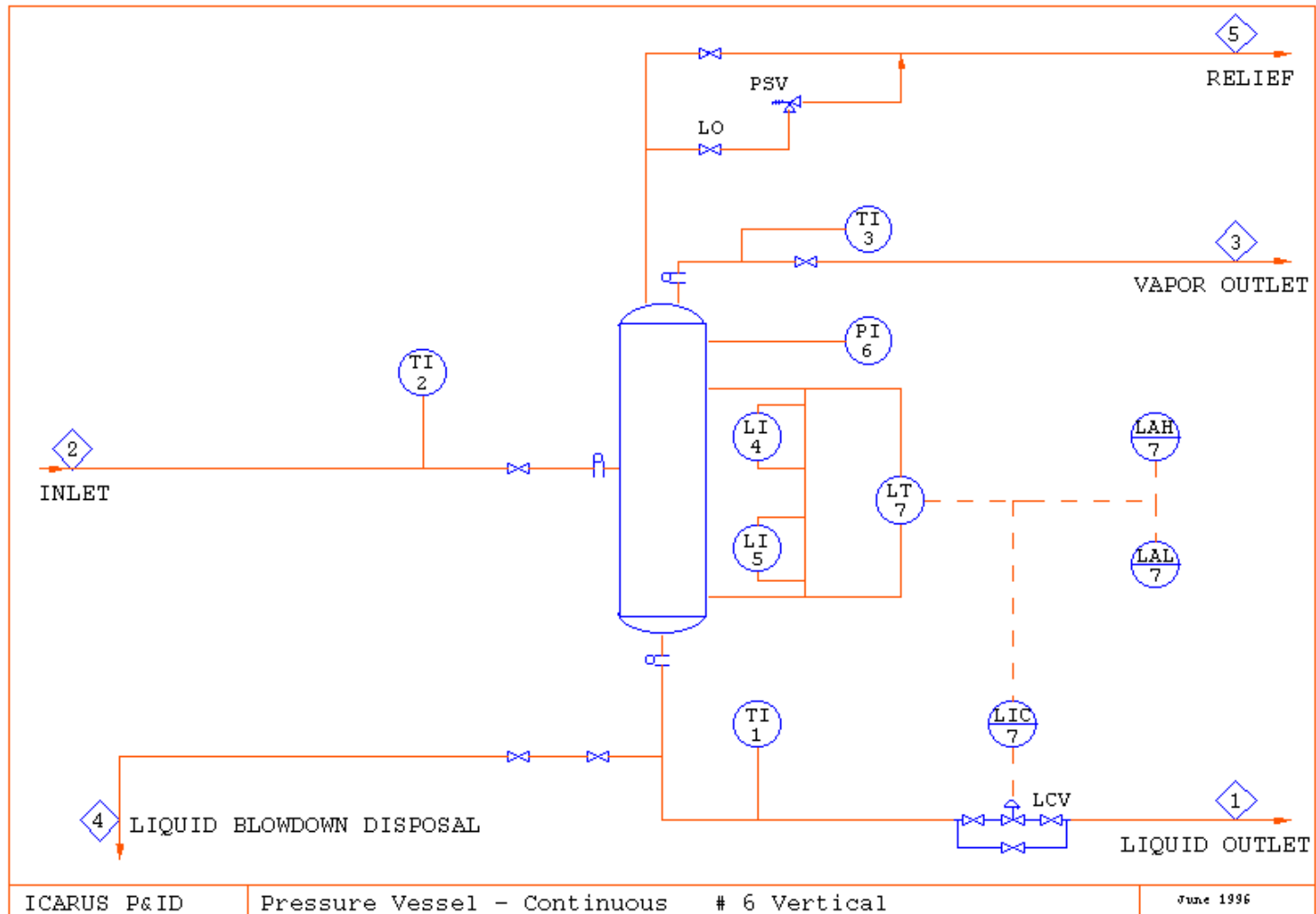
5 Vertical Pressure Vessel – Batch



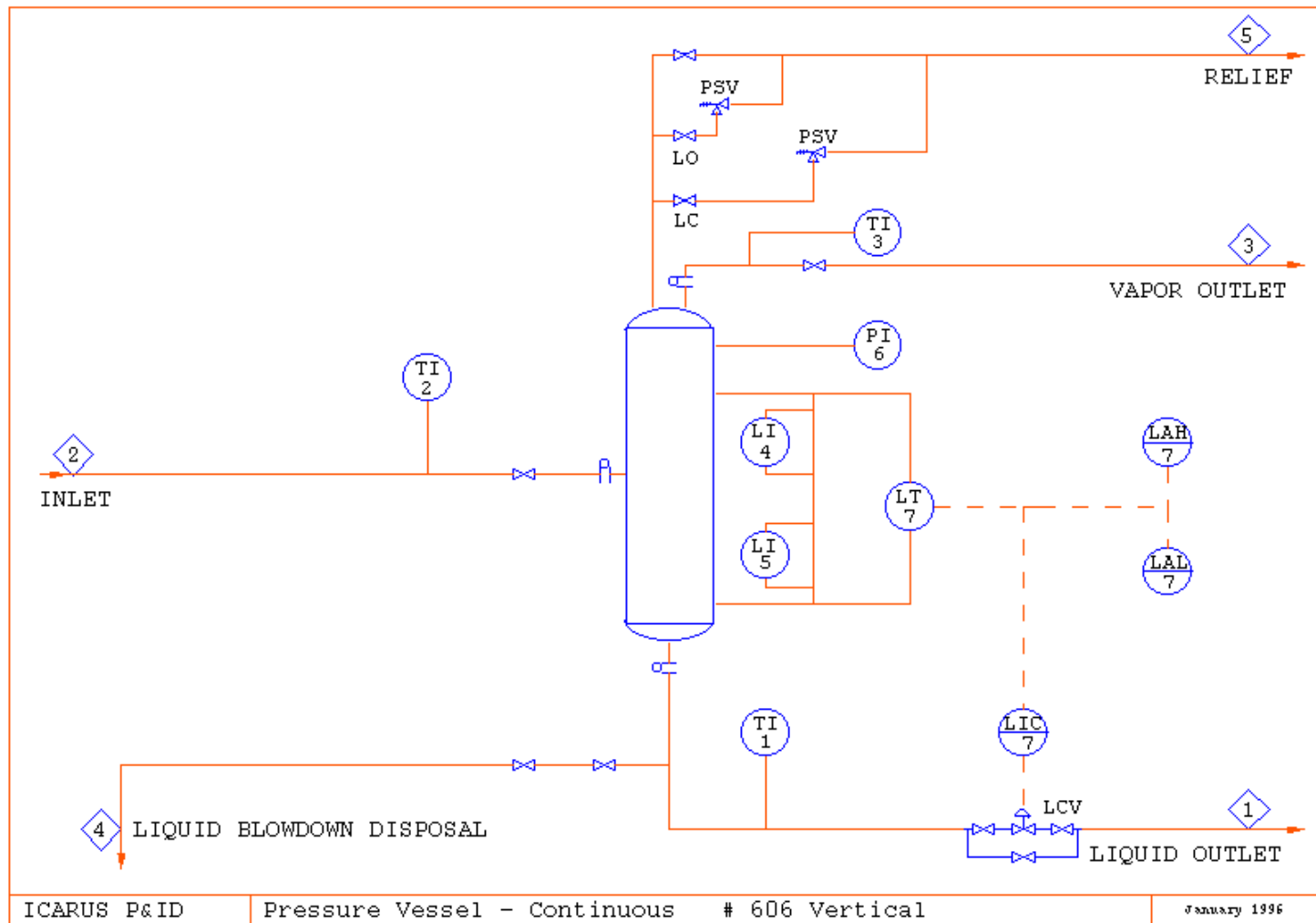
5 Vertical Jacketed Pressure Vessel – Batch



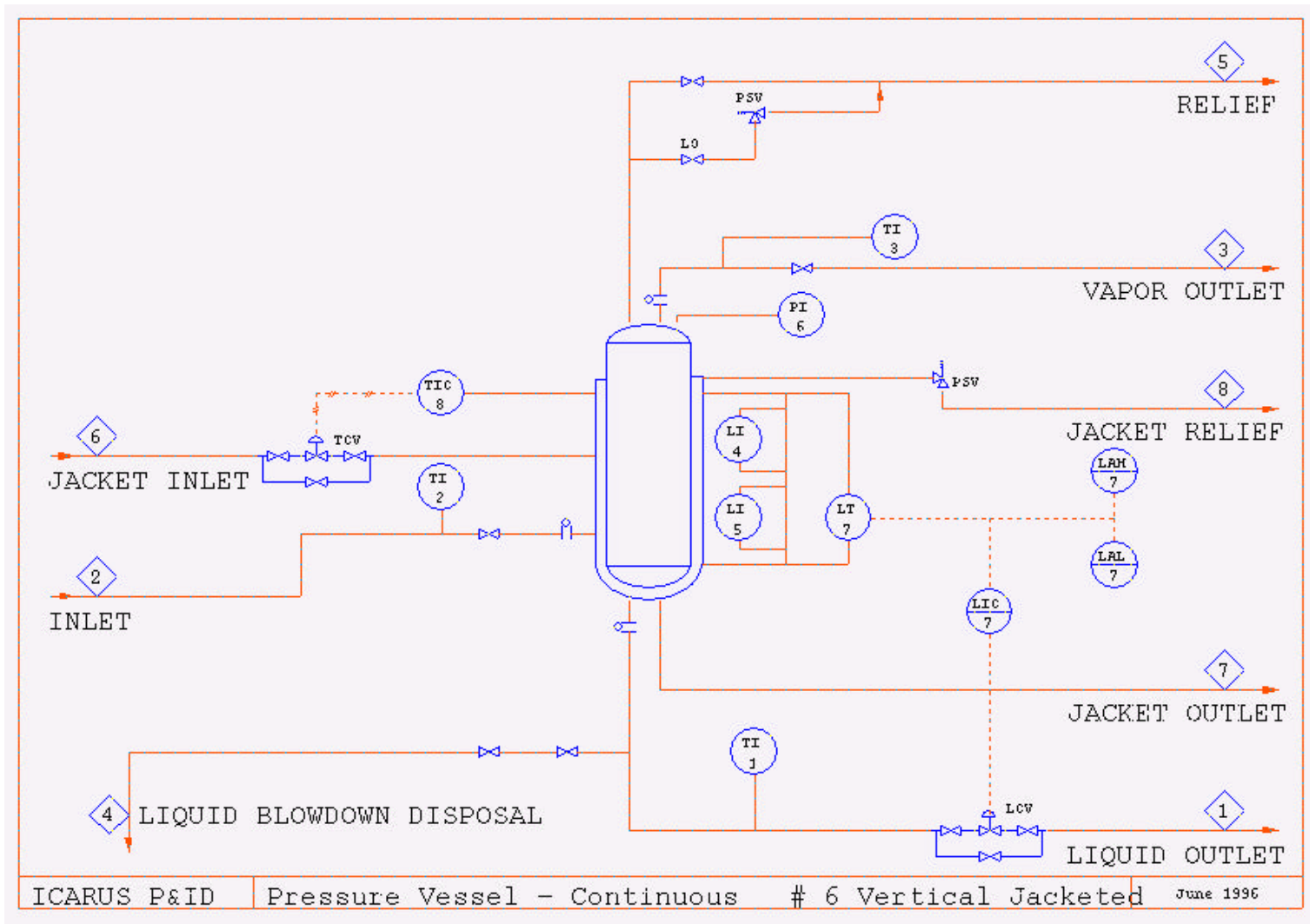
6 Vertical Pressure Vessel – Continuous



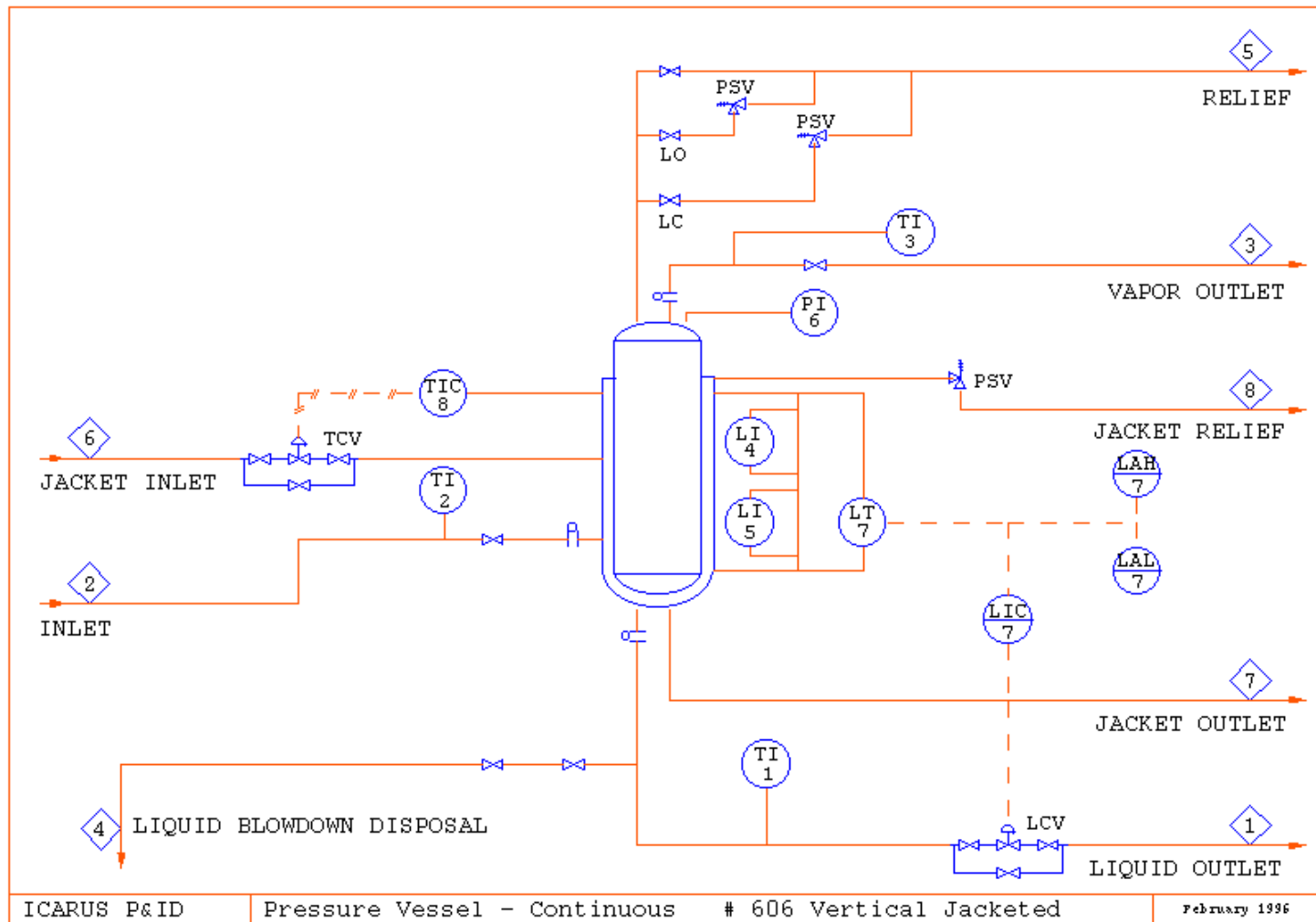
606 Vertical Pressure Vessel – Continuous



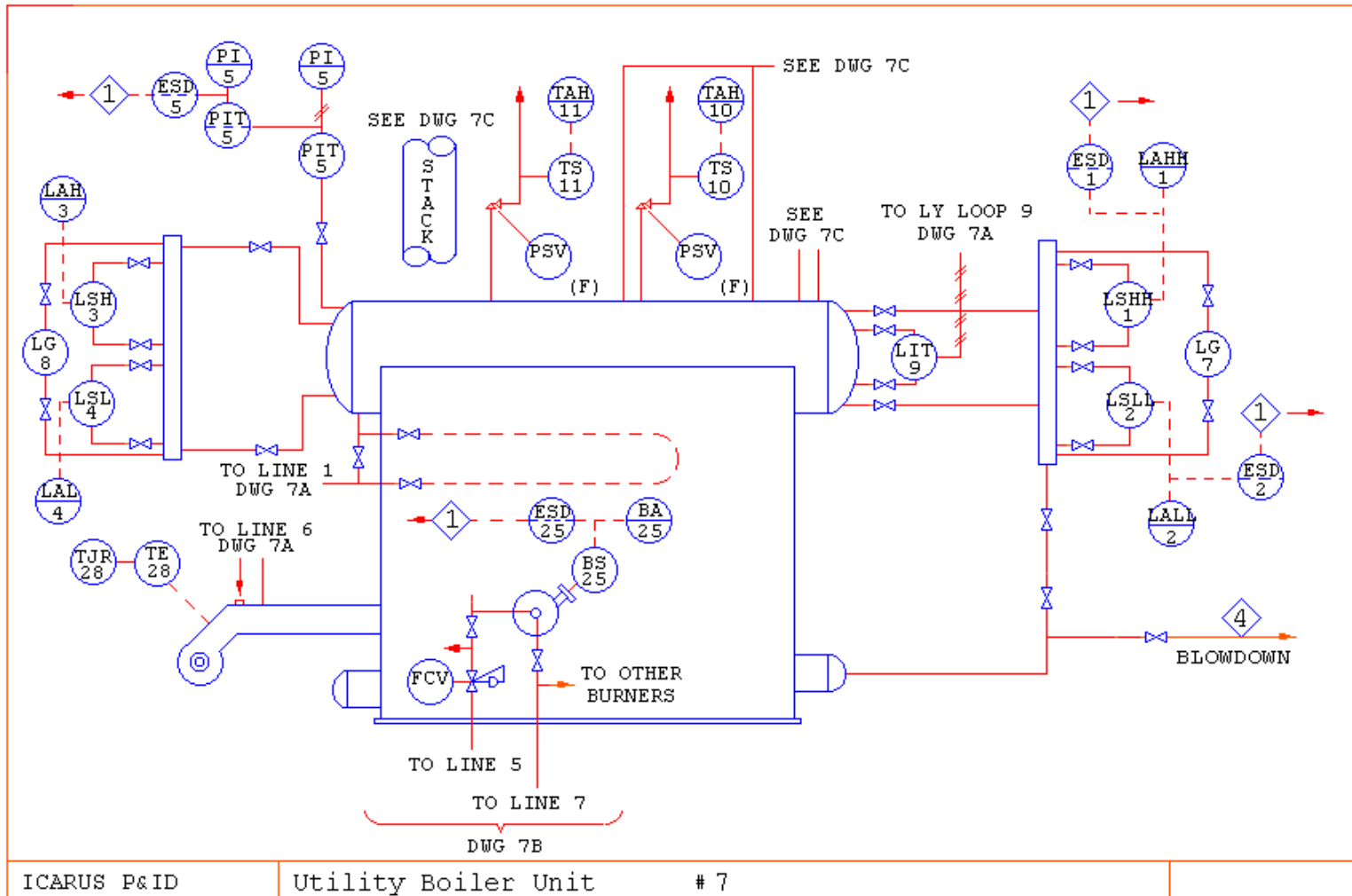
6 Vertical Jacketed Pressure Vessel – Continuous



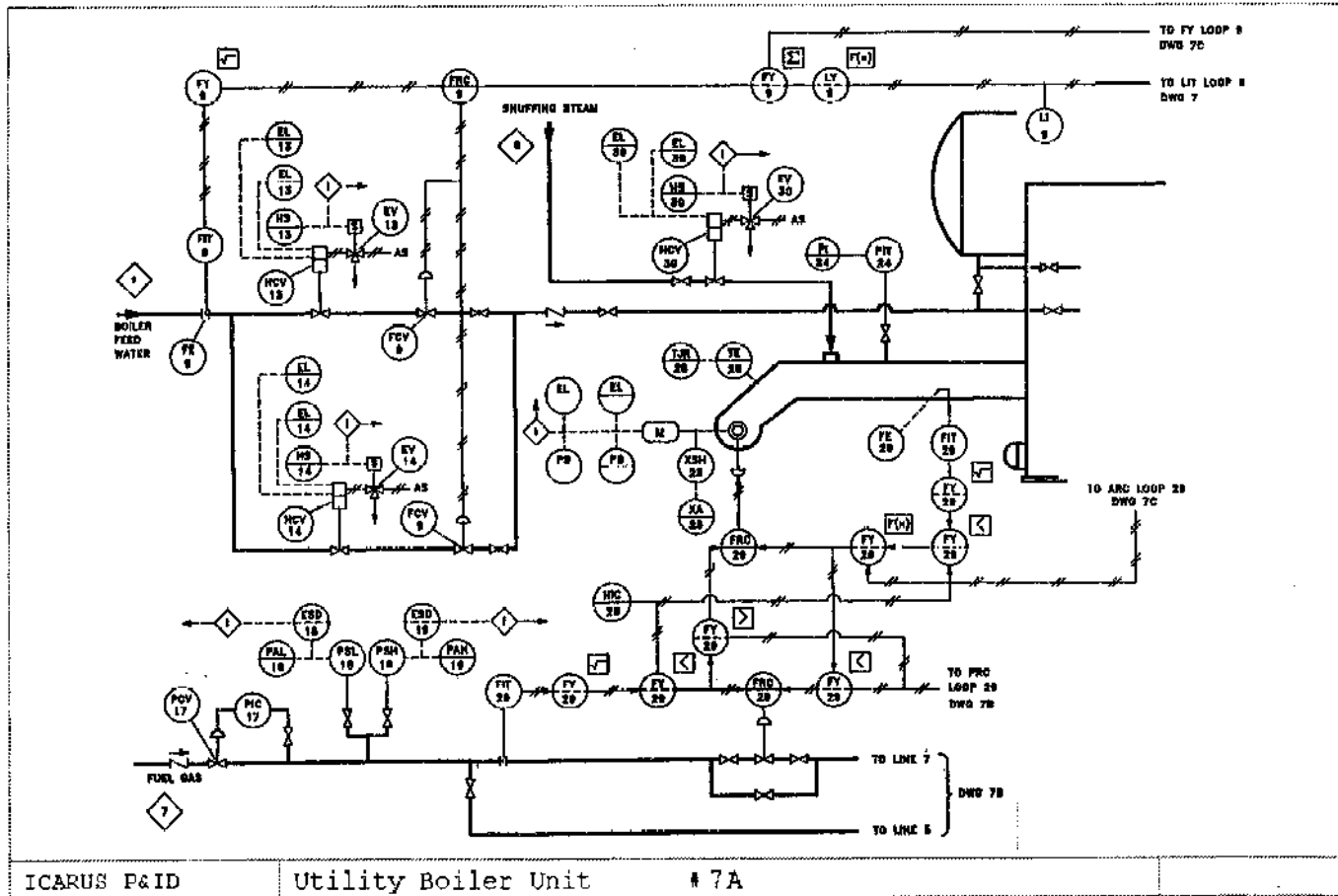
606 Vertical Jacketed Pressure Vessel – Continuous



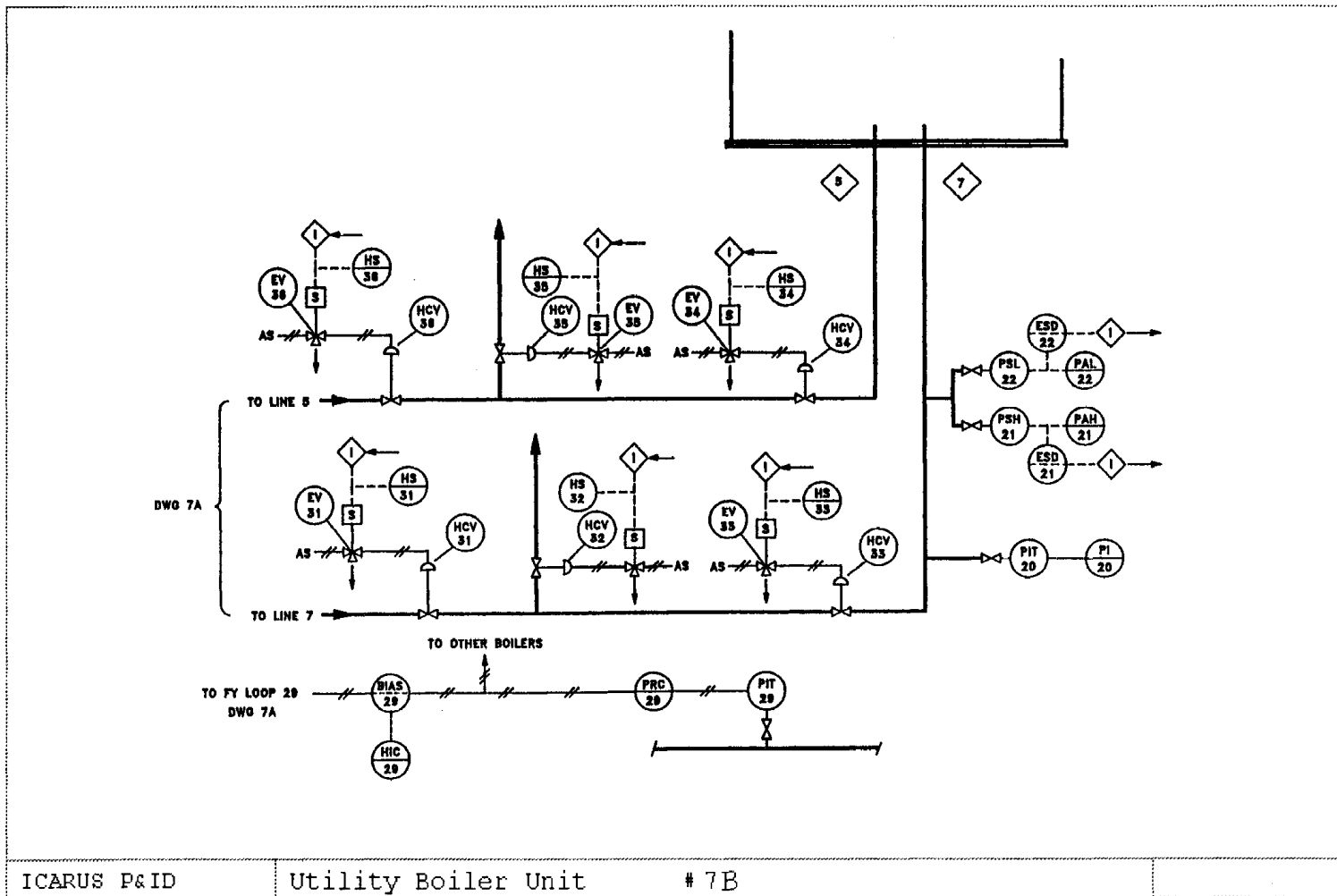
7 Utility Boiler Unit



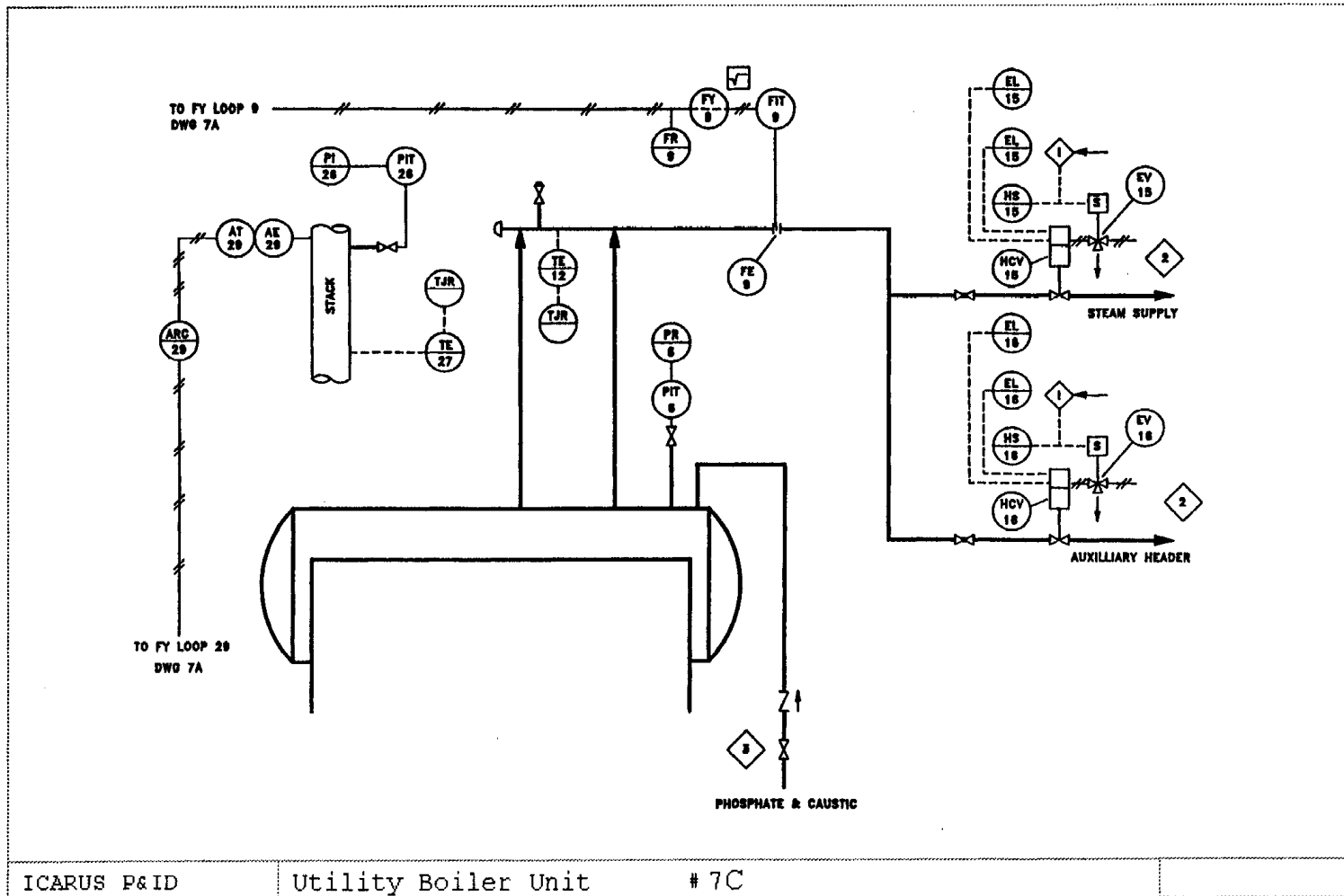
7A Utility Boiler Unit



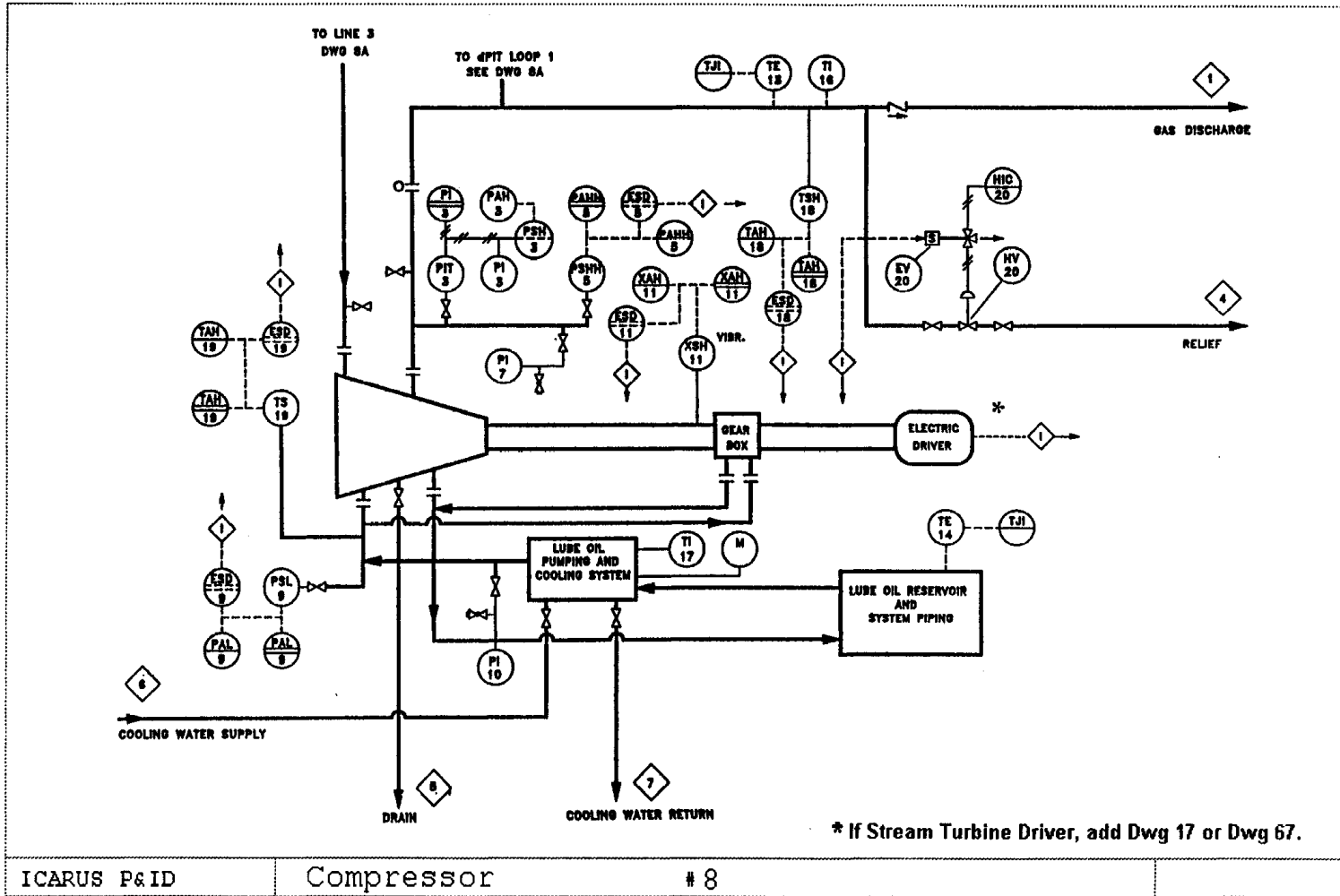
7B Utility Boiler Unit



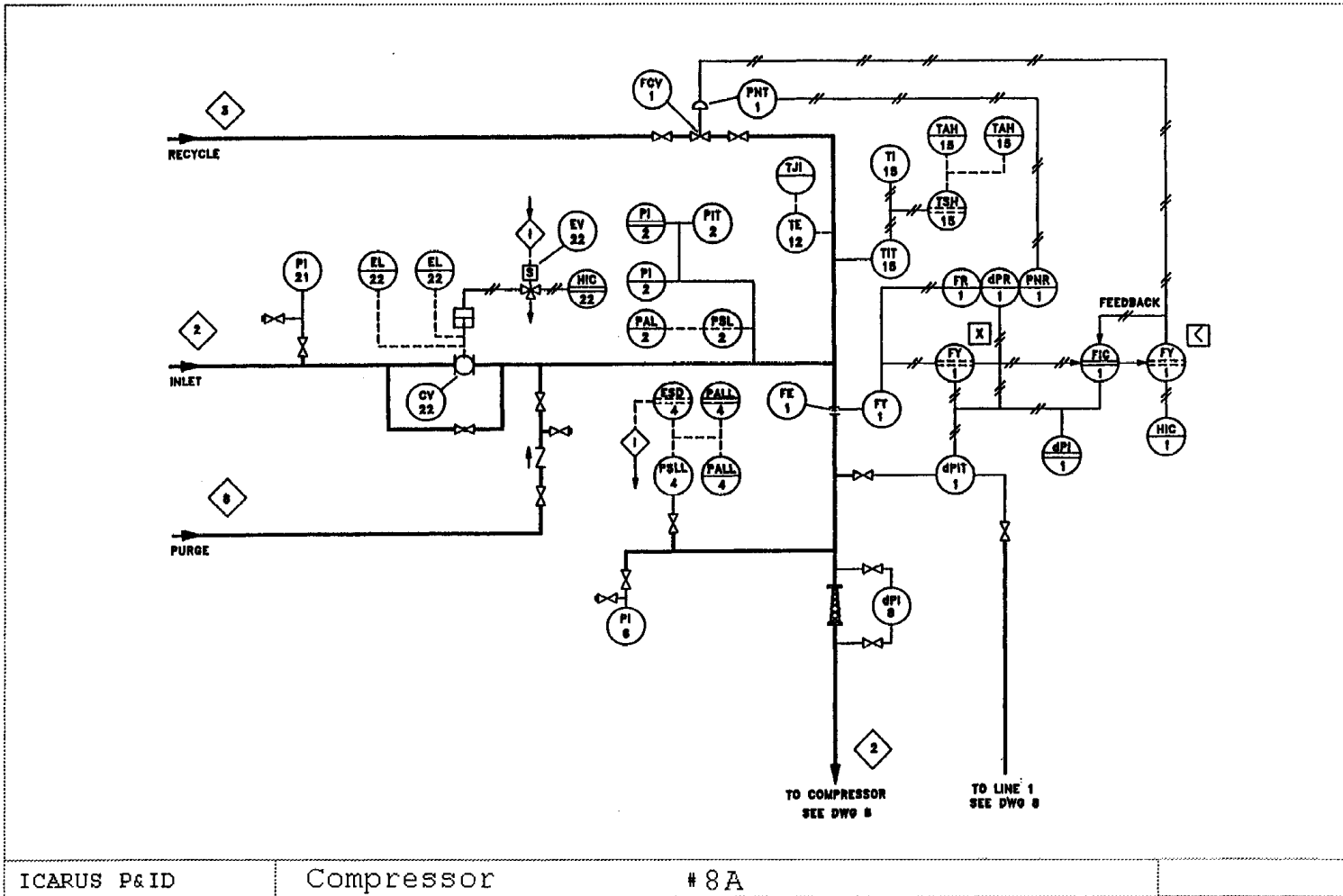
7C Utility Boiler Unit



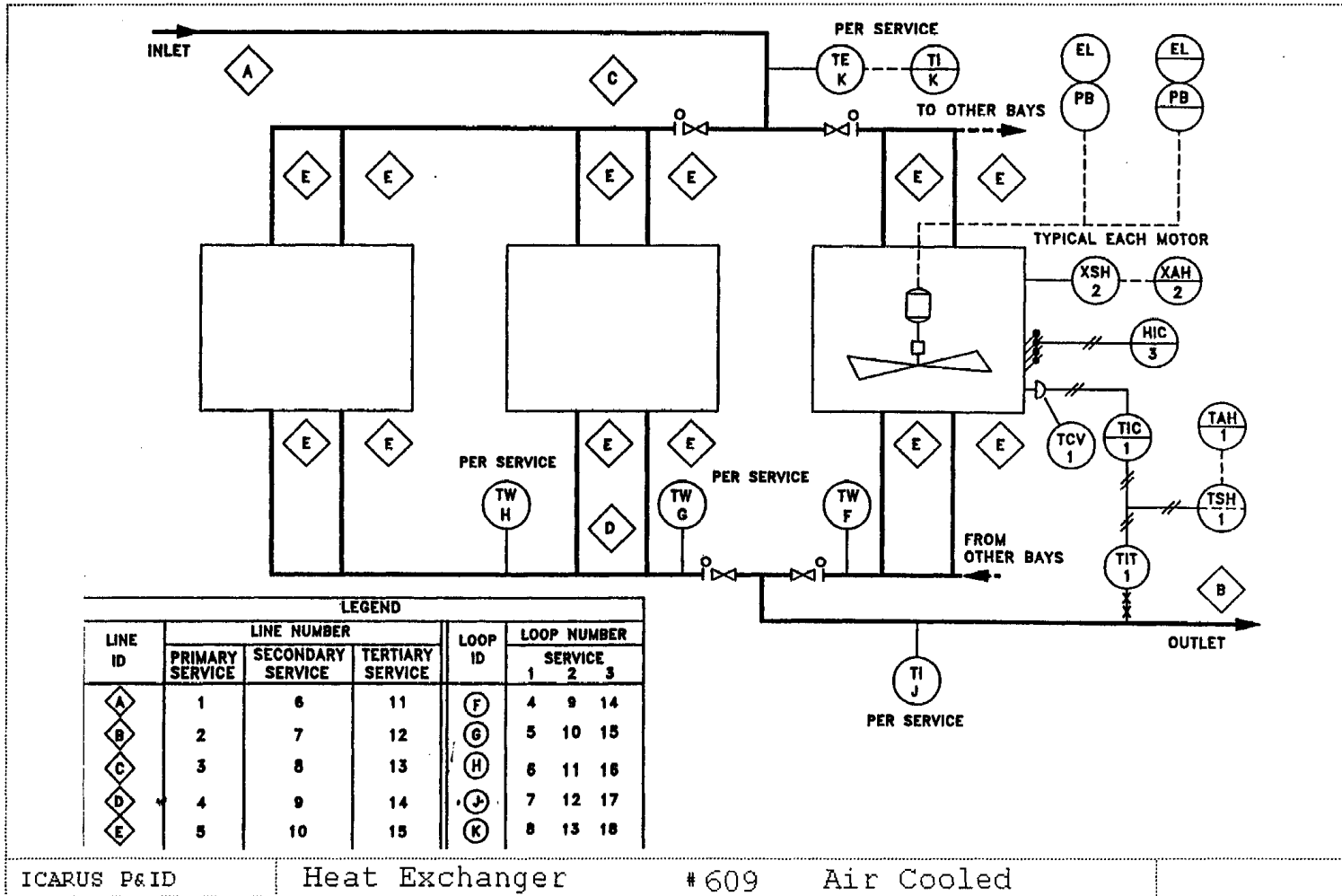
8 Compressor



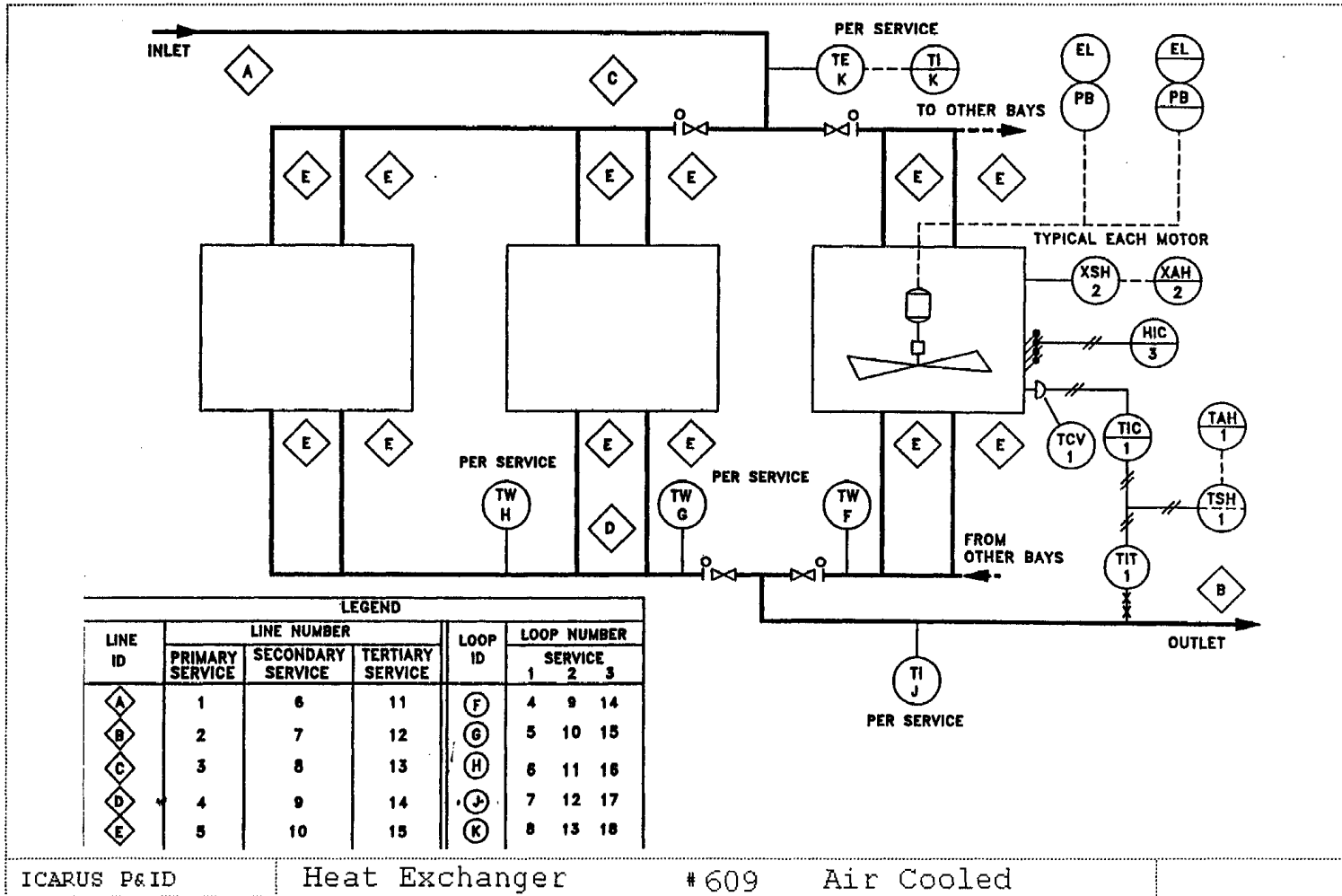
8A Compressor



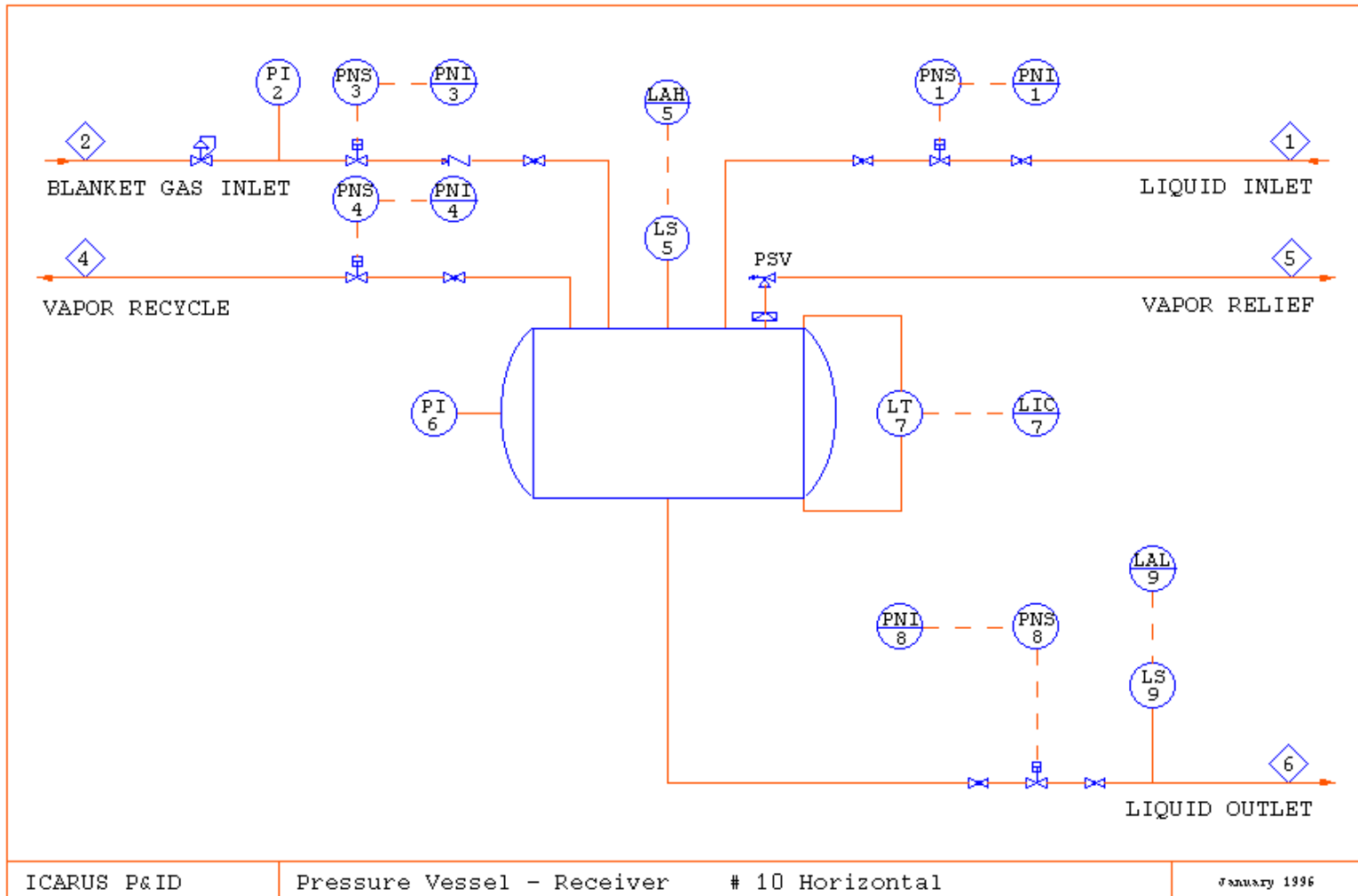
9 Air Cooled Heat Exchanger



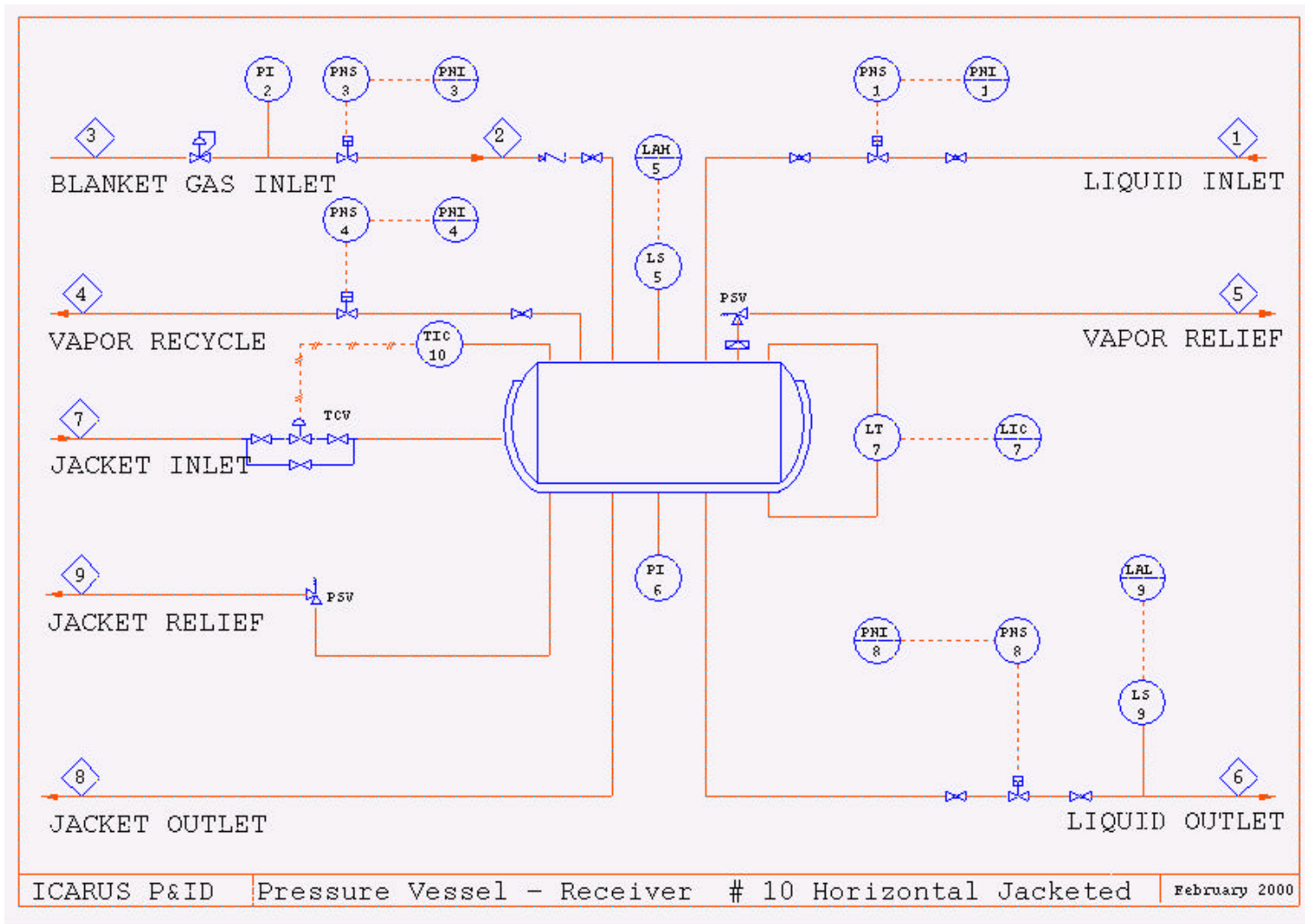
609 Air Cooled Heat Exchanger



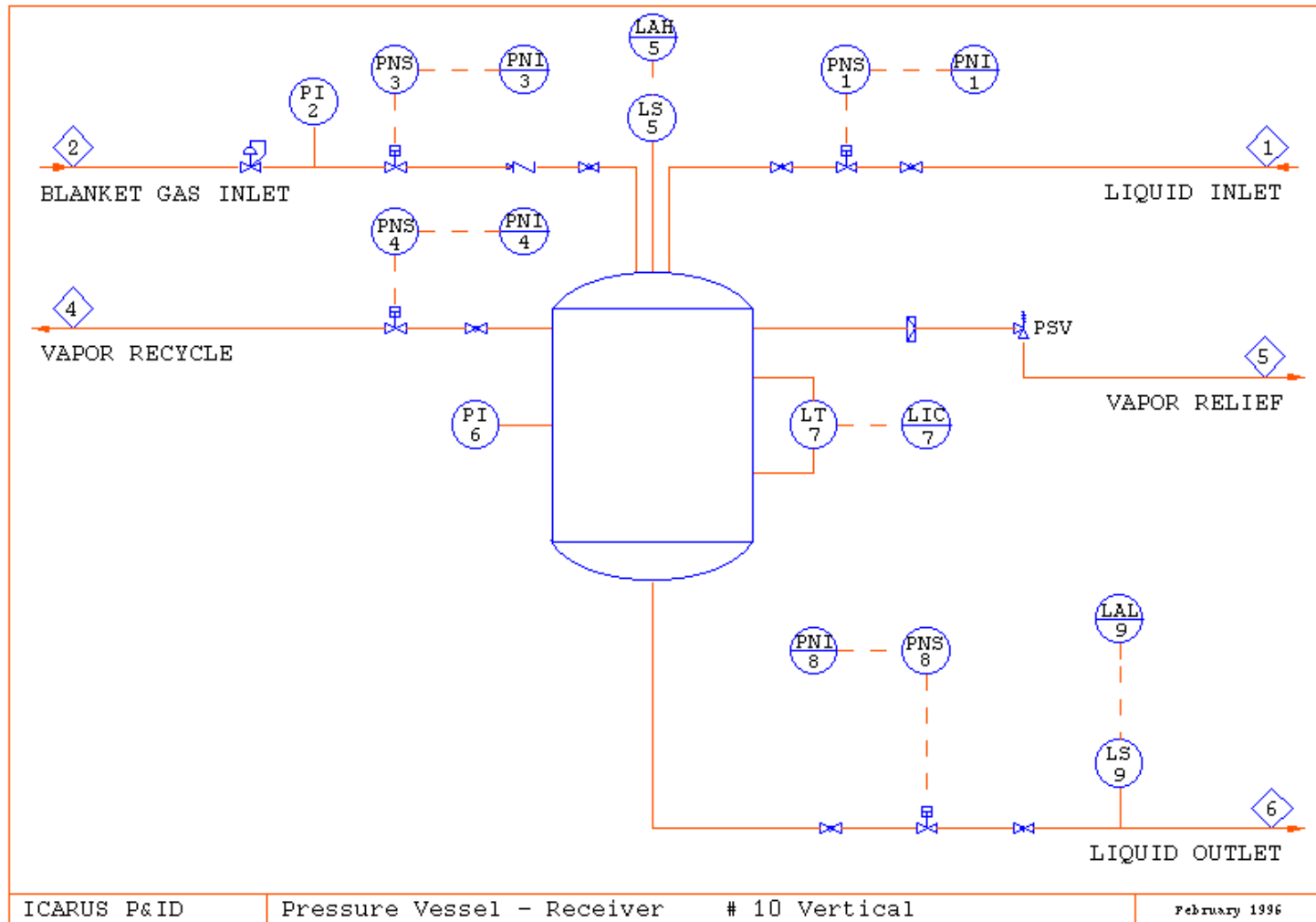
10 Horizontal Pressure Vessel – Receiver



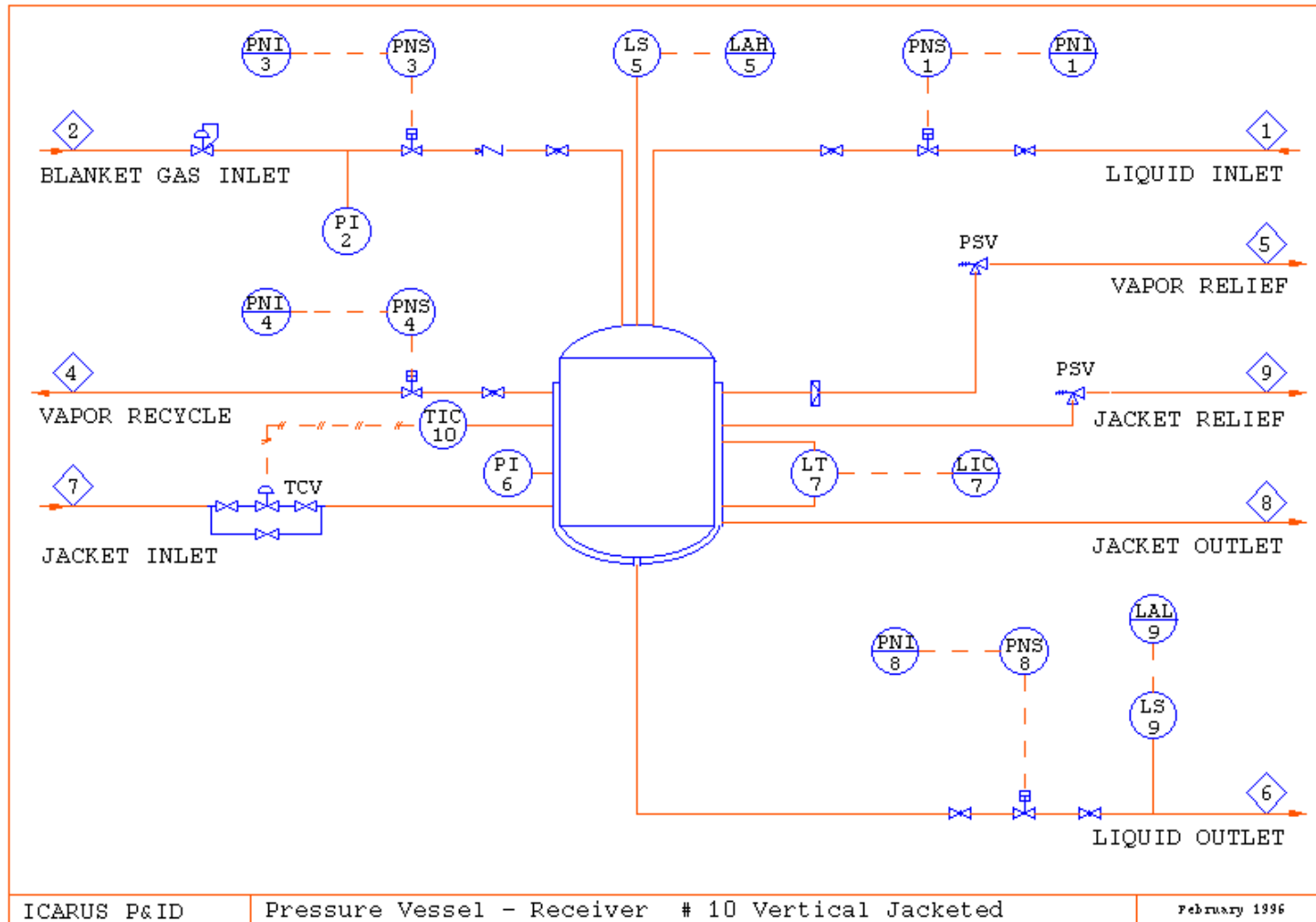
10 Horizontal Jacketed Pressure Vessel – Receiver



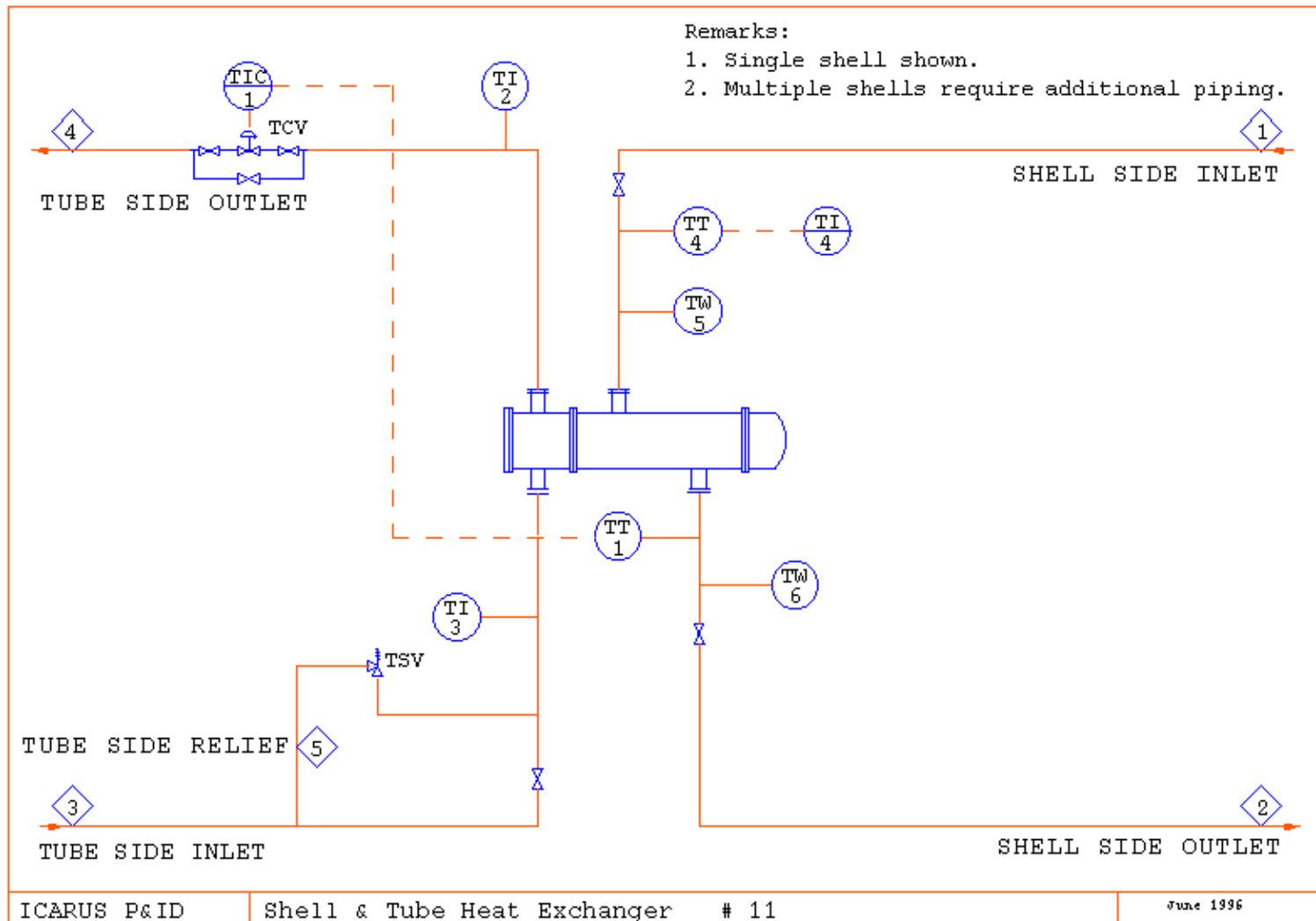
10 Vertical Pressure Vessel – Receiver



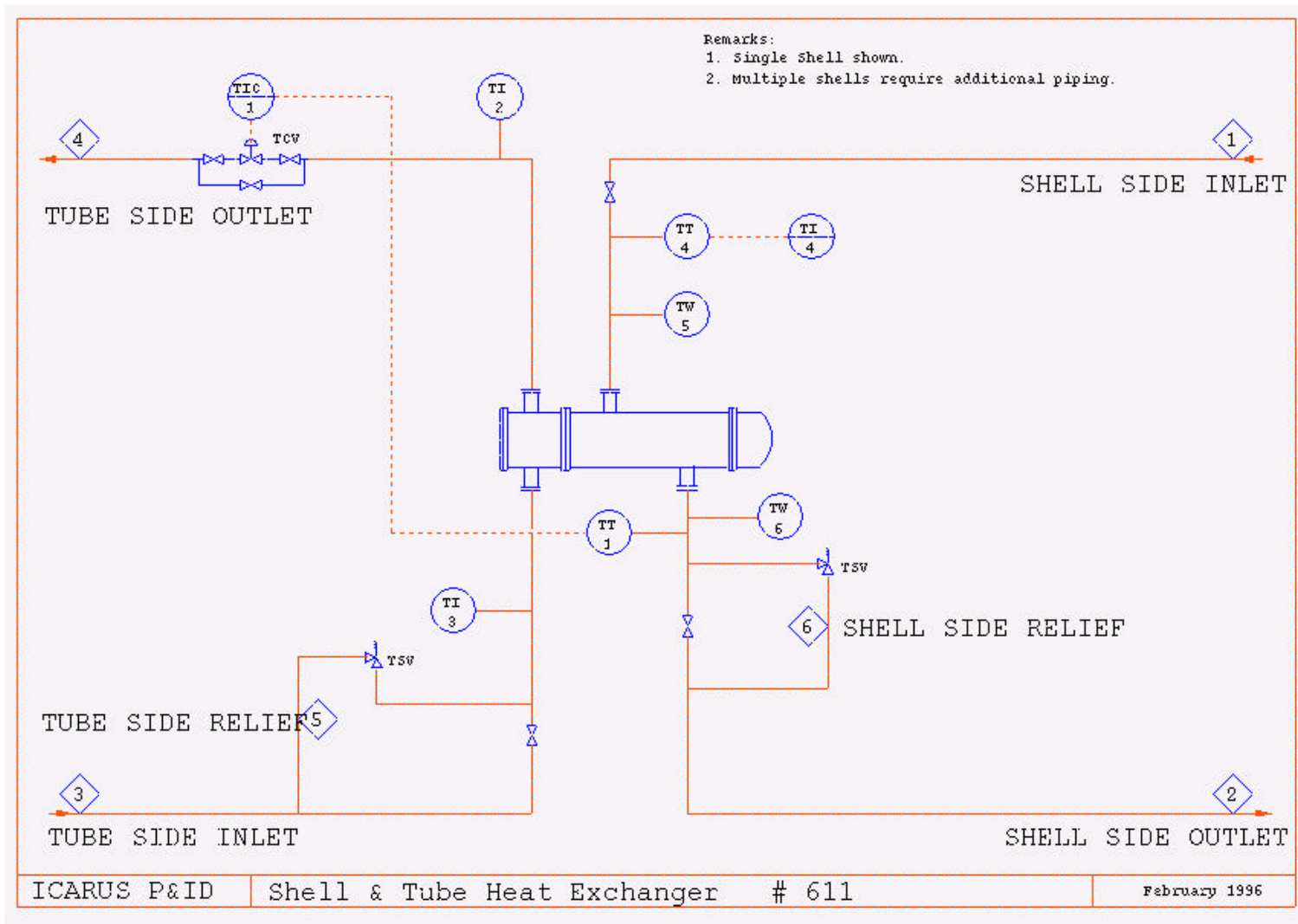
10 Vertical Jacketed Pressure Vessel – Receiver



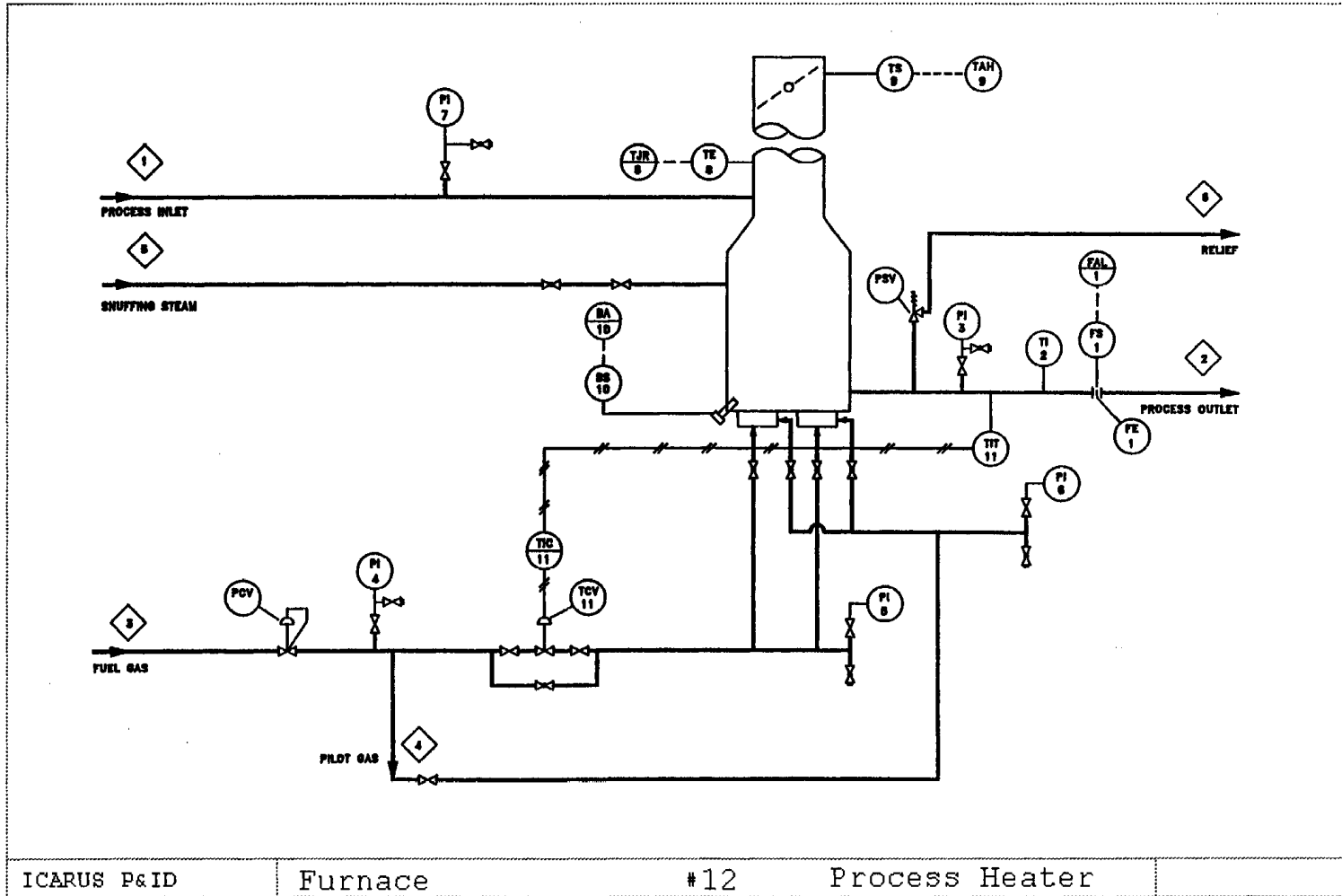
11 Shell & Tube Heat Exchanger



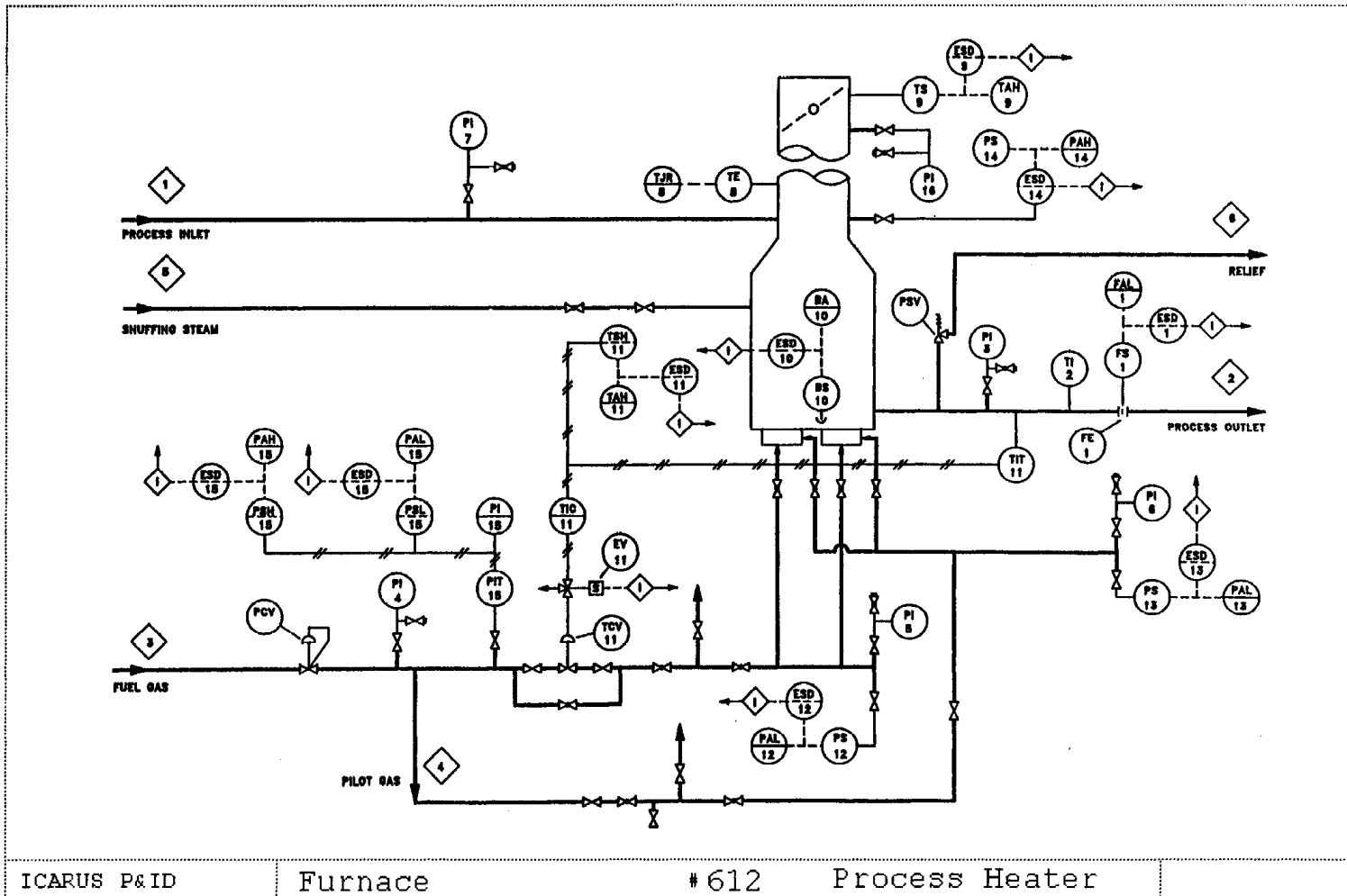
611 Shell & Tube Heat Exchanger



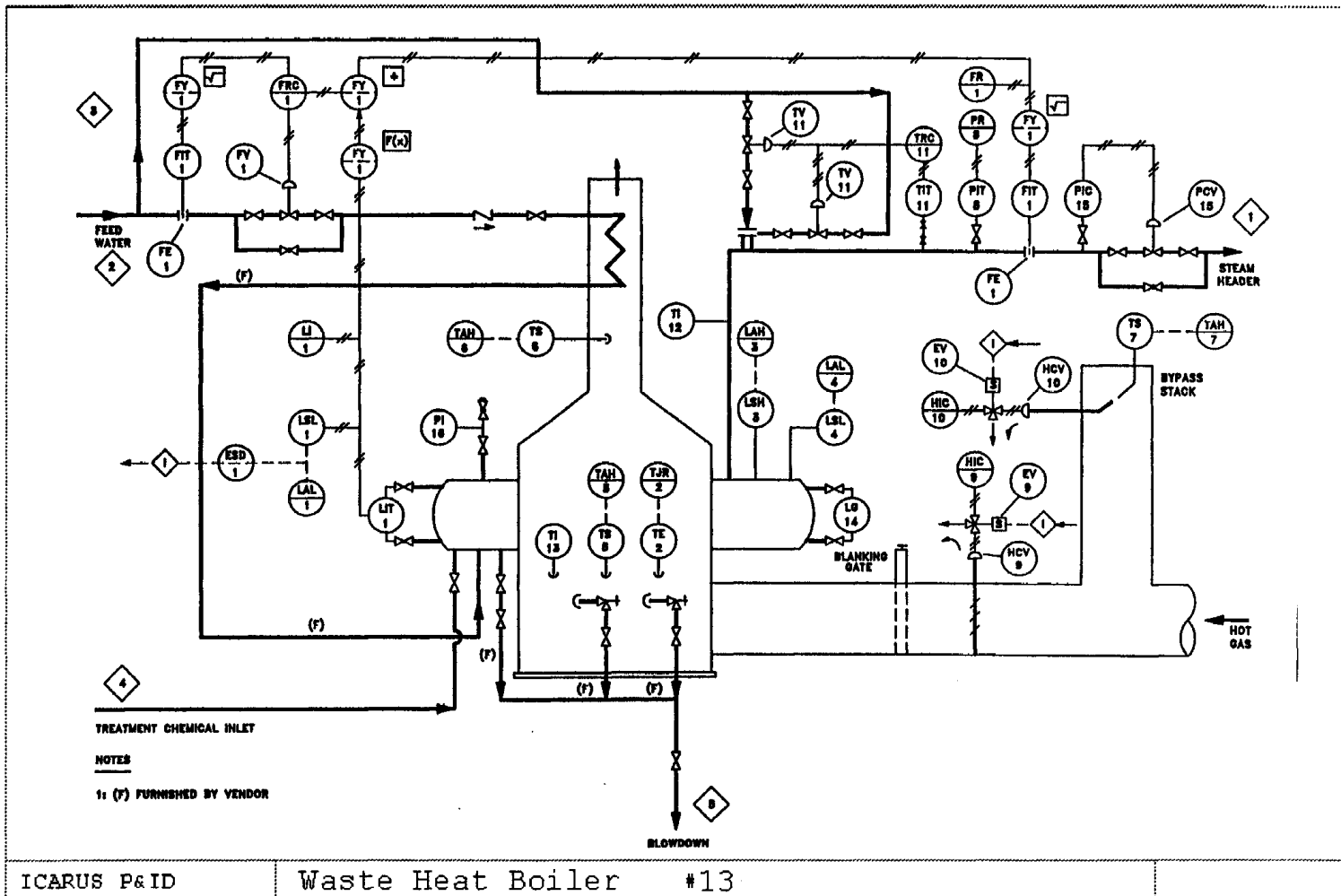
12 Process Heater Furnace



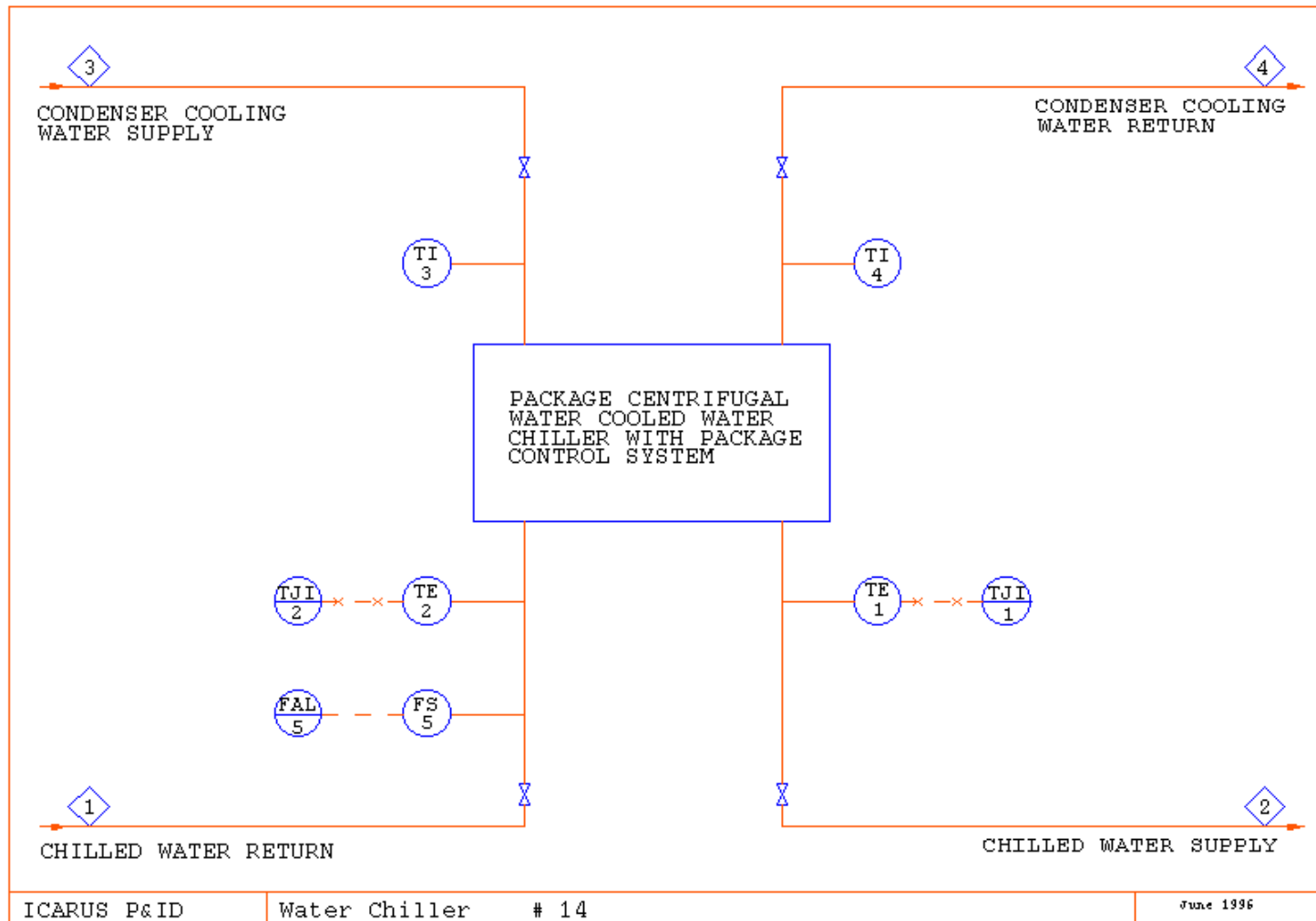
612 Process Heater Furnace



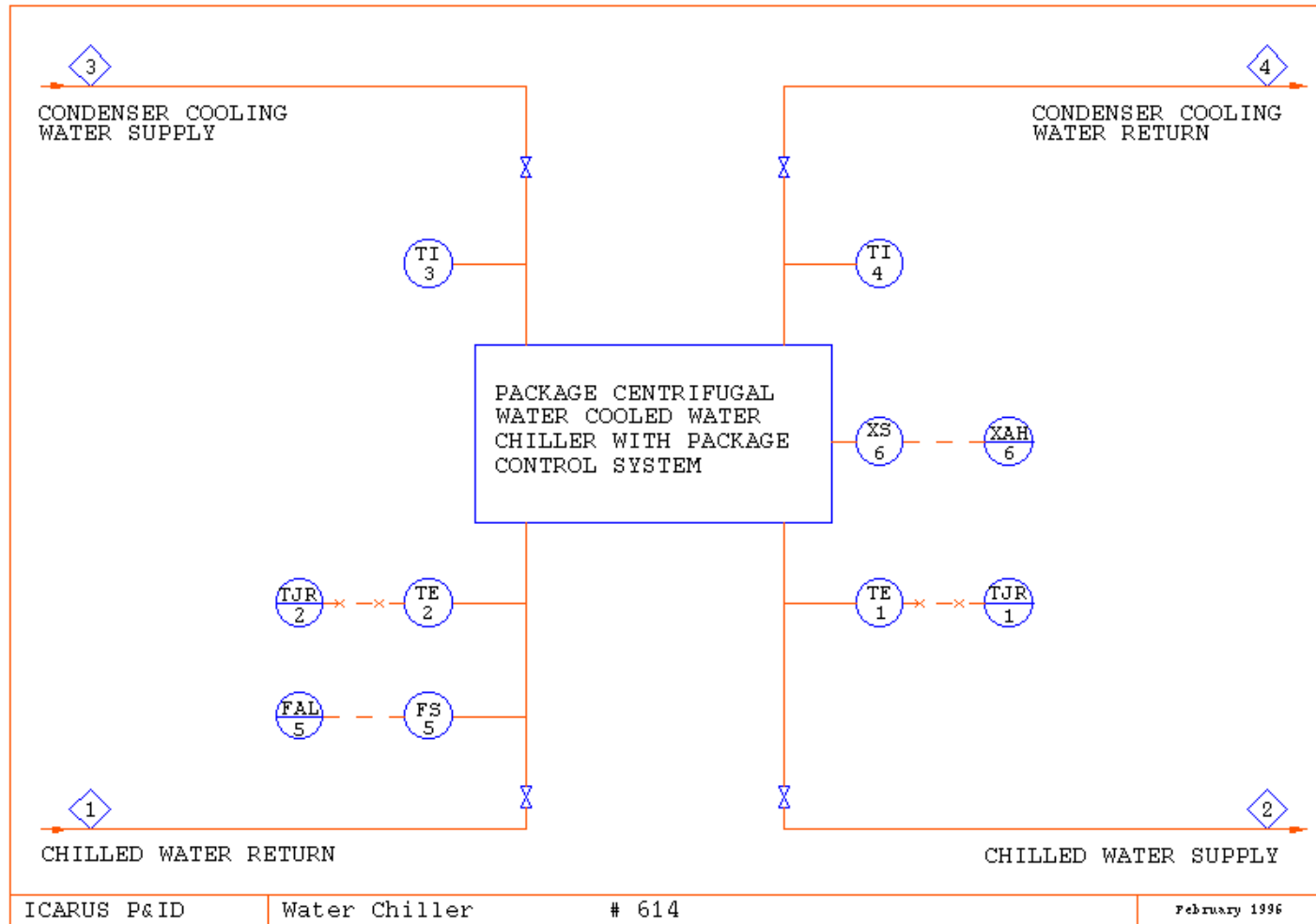
13 Waste Heat Boiler



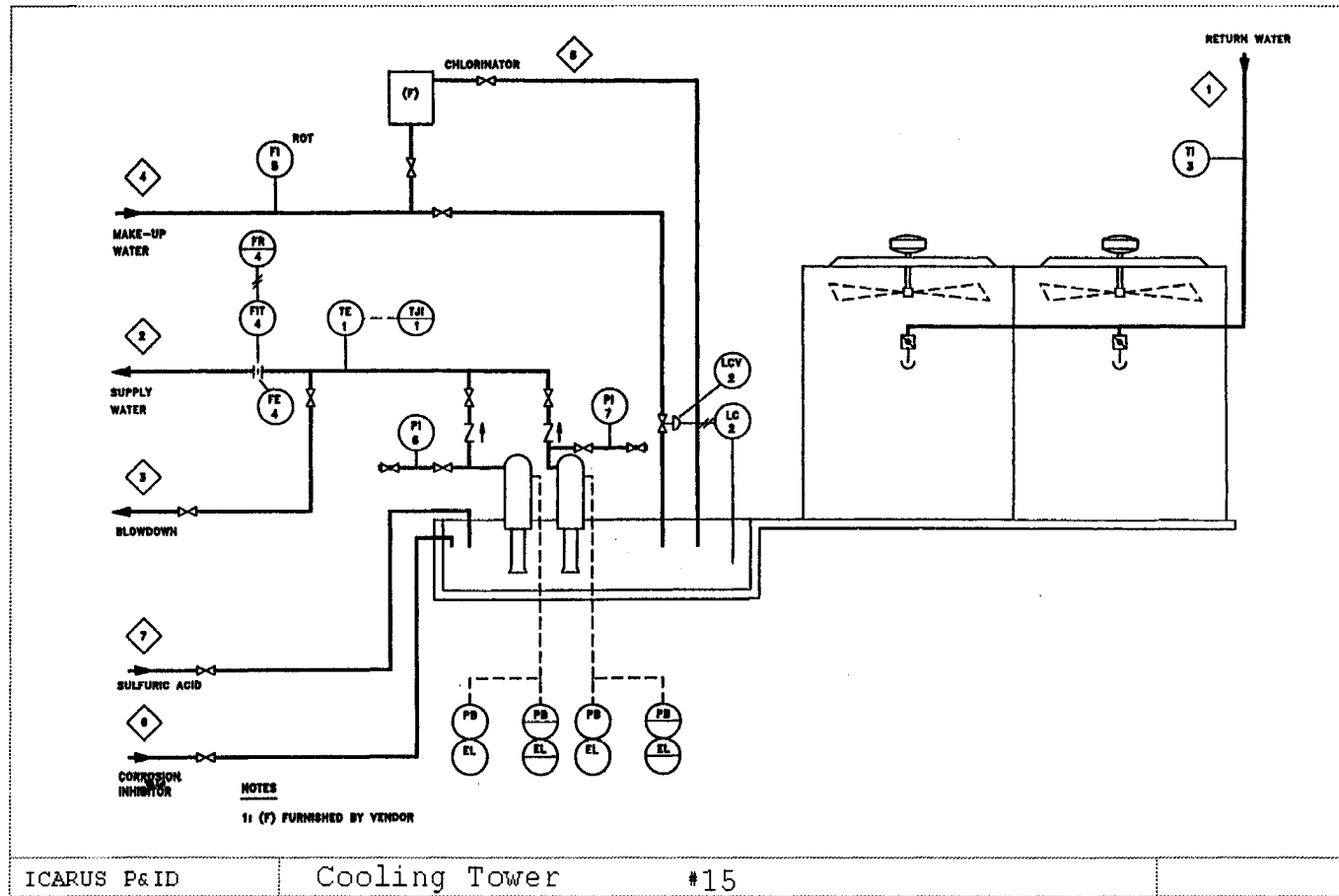
14 Water Chiller



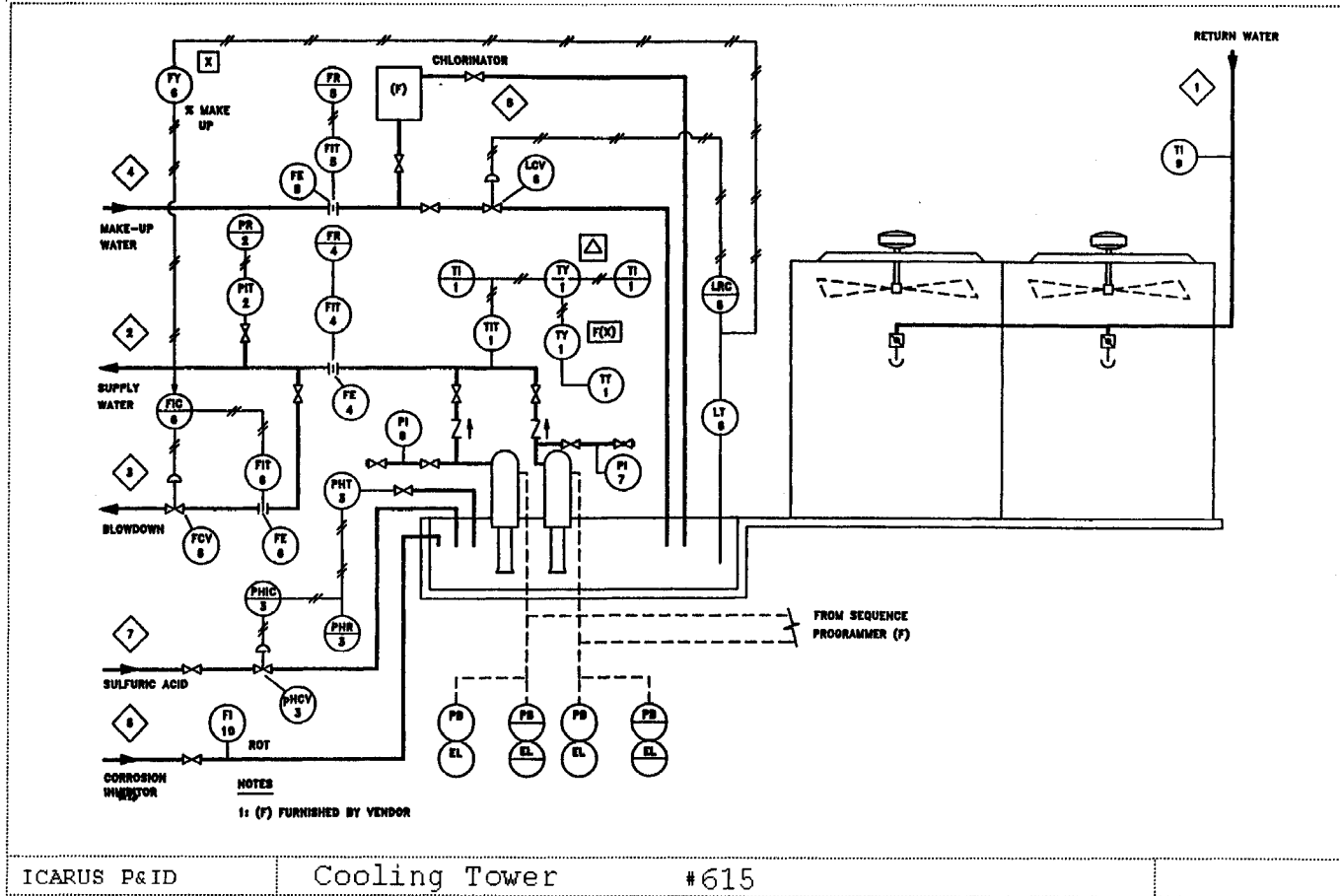
614 Water Chiller



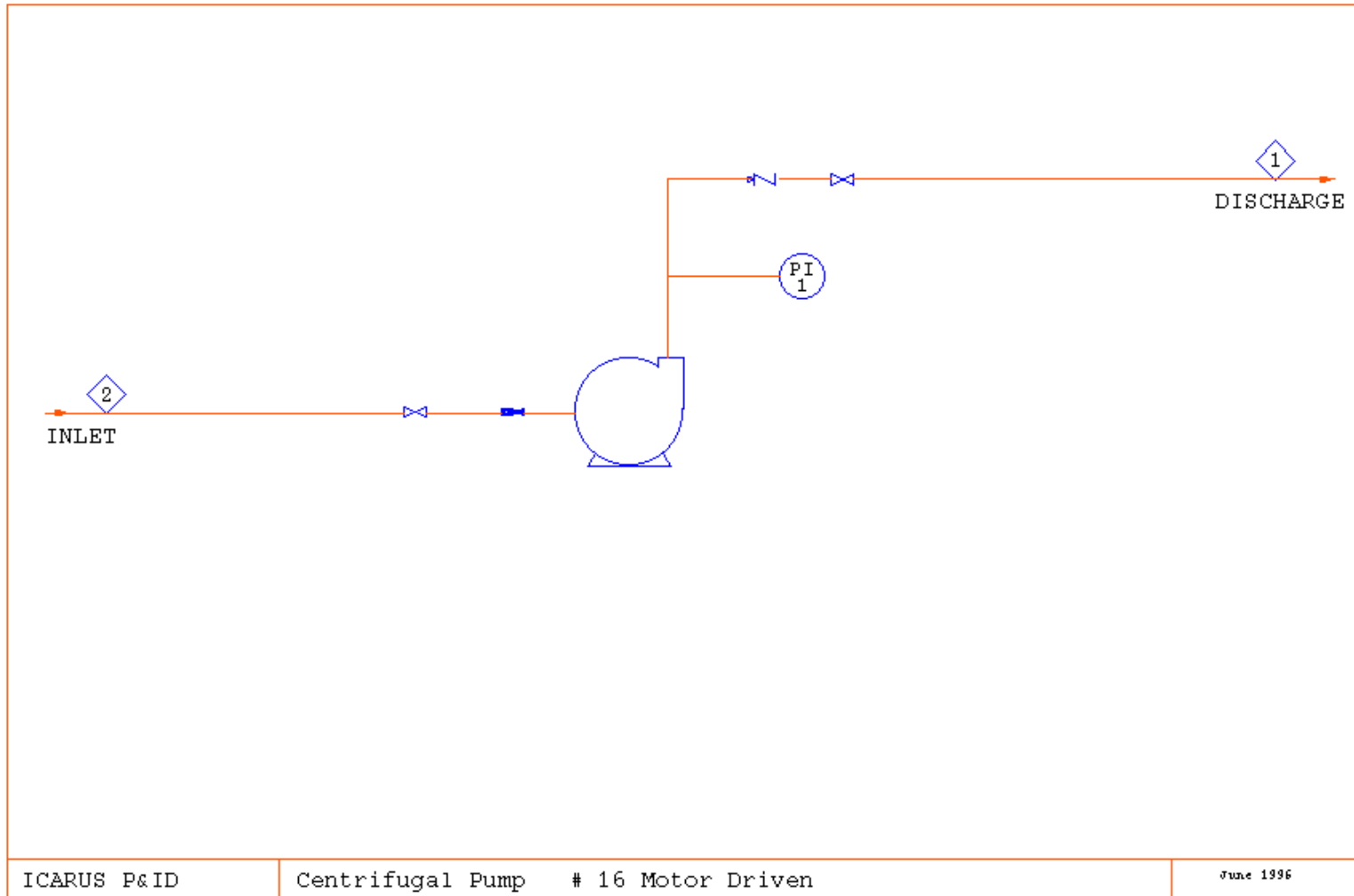
15 Cooling Tower



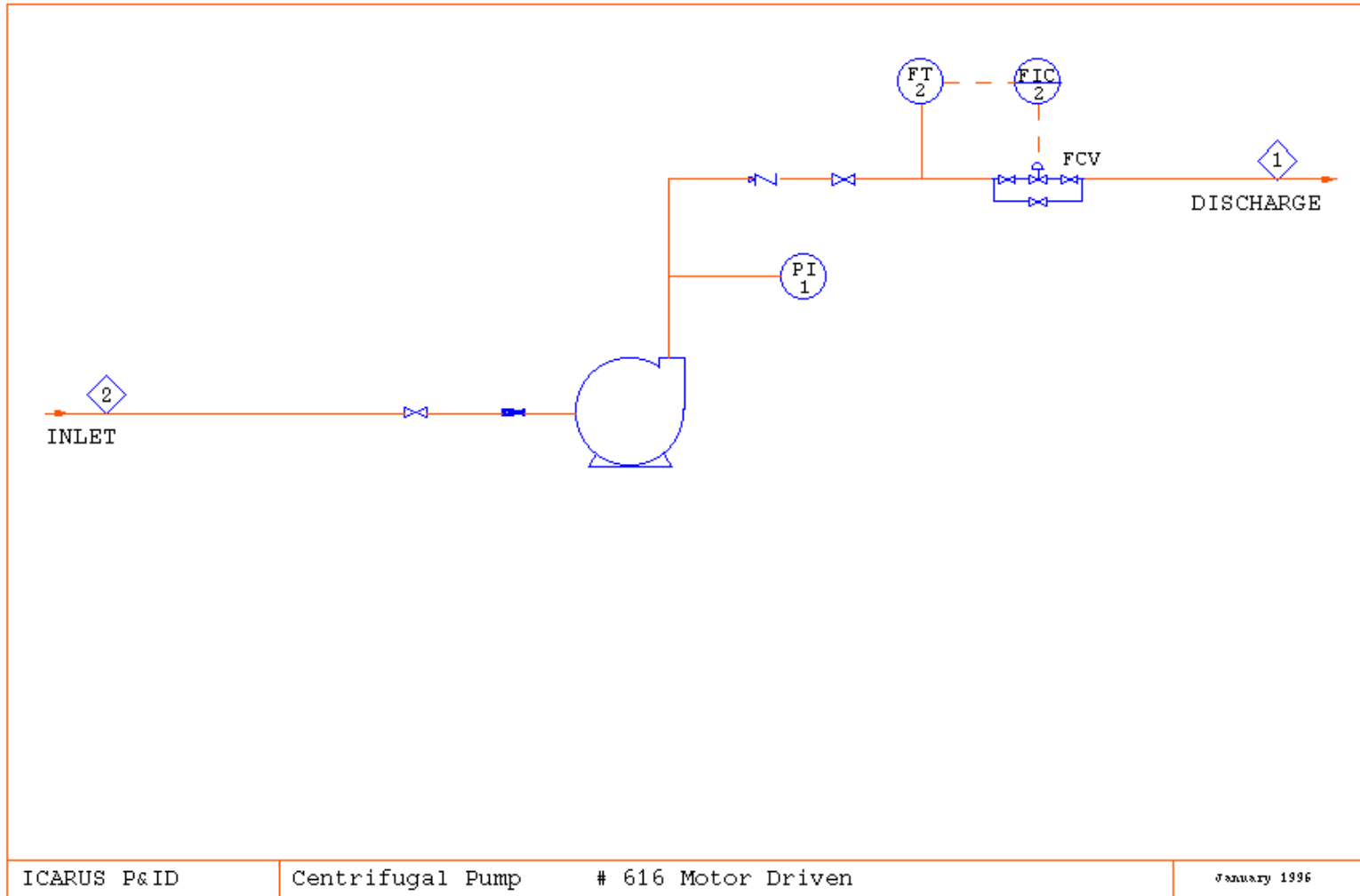
615 Cooling Tower



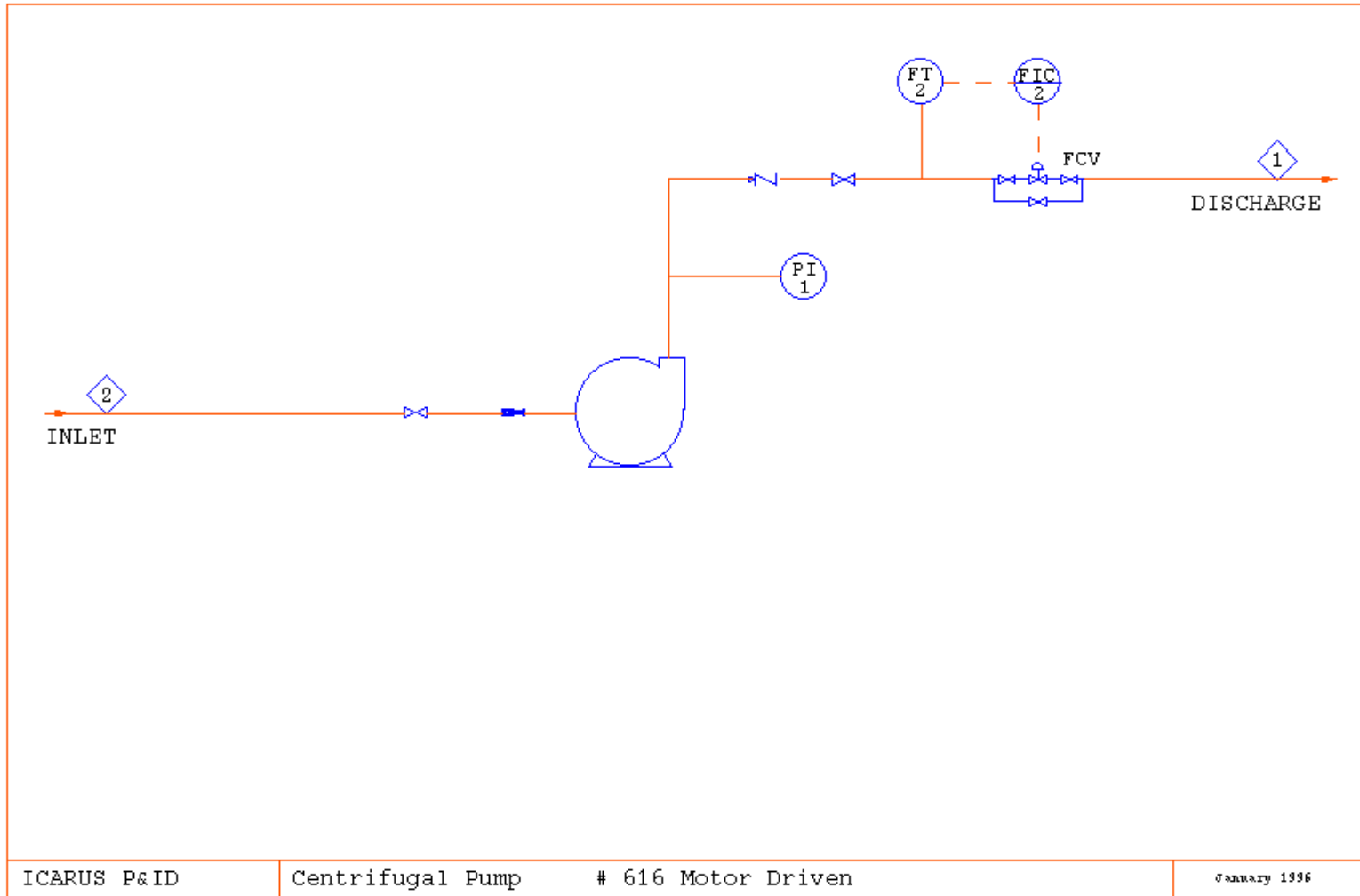
16 Motor Driven Centrifugal Pump



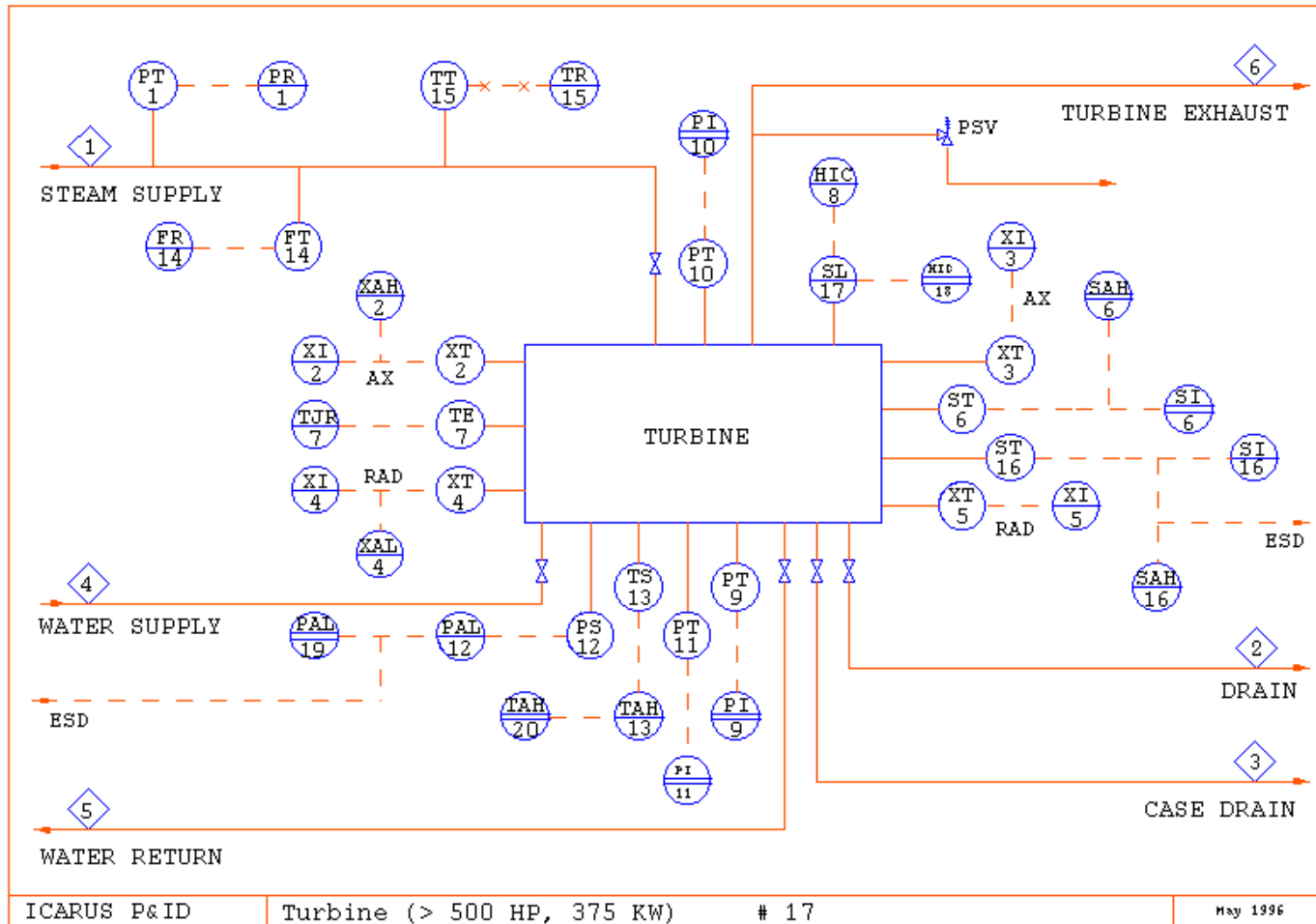
616 Motor Driven Centrifugal Pump



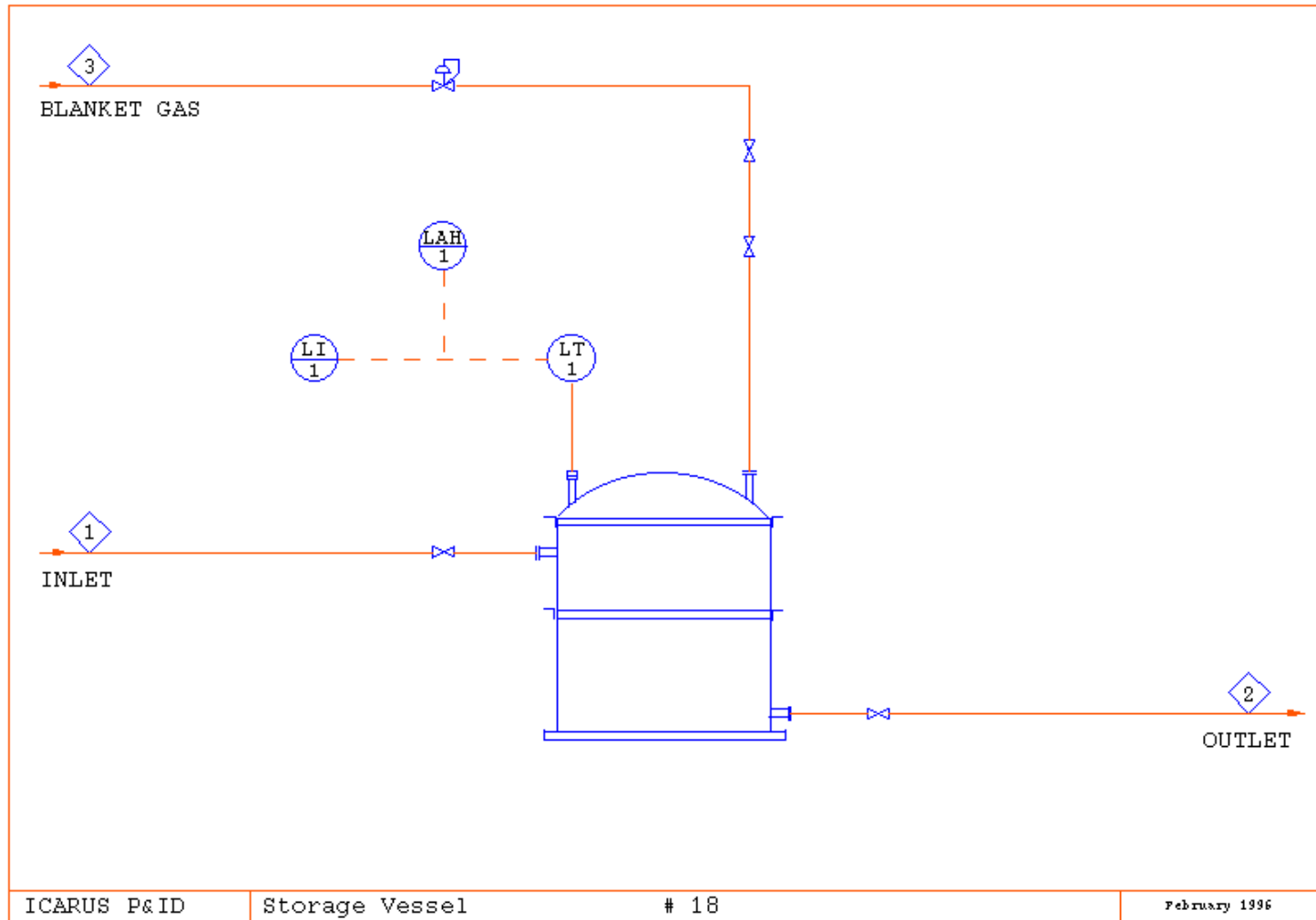
616 Motor Driven Spare Centrifugal Pump



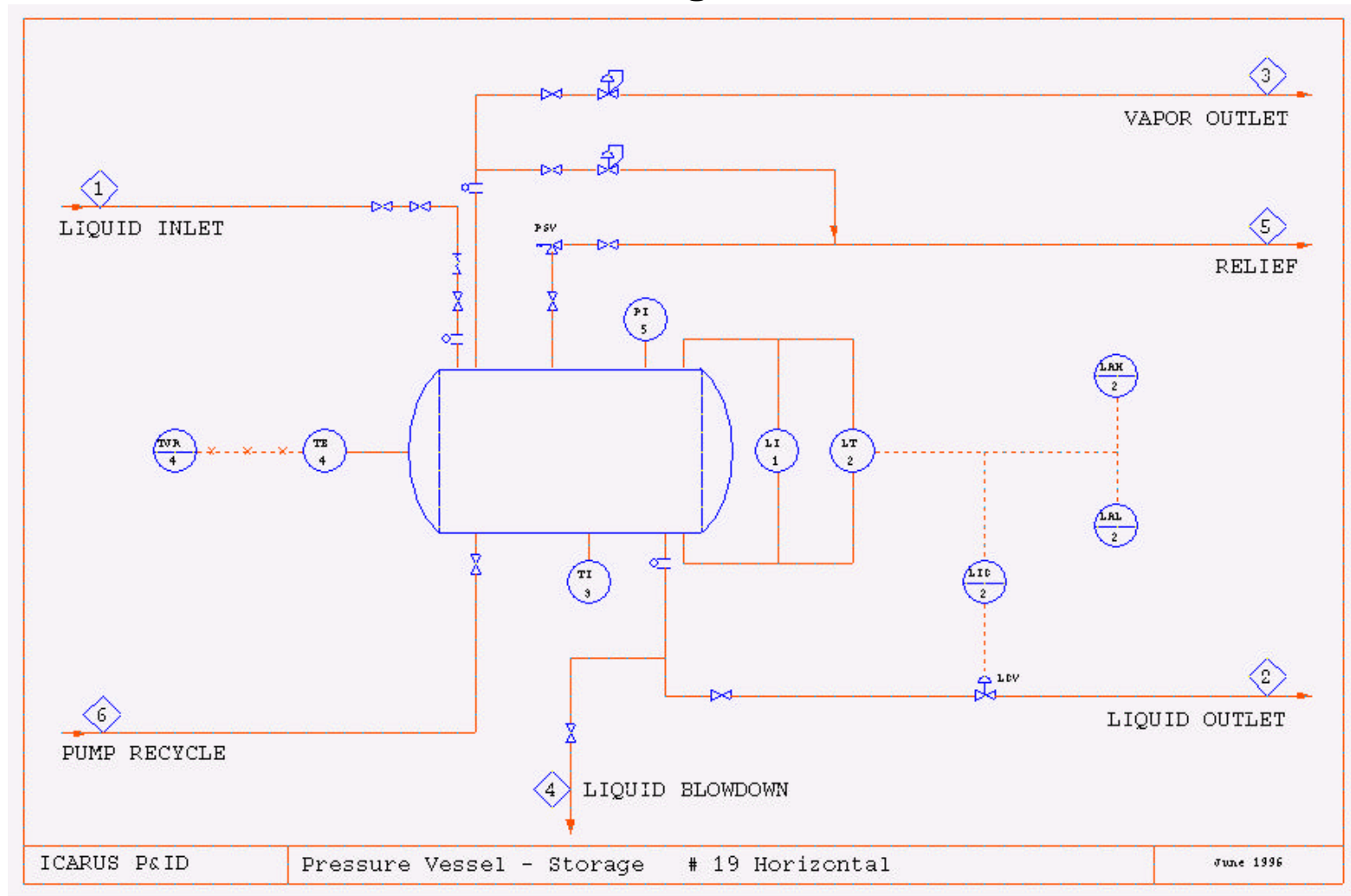
17 Turbine (>500 HP, 375 KW)



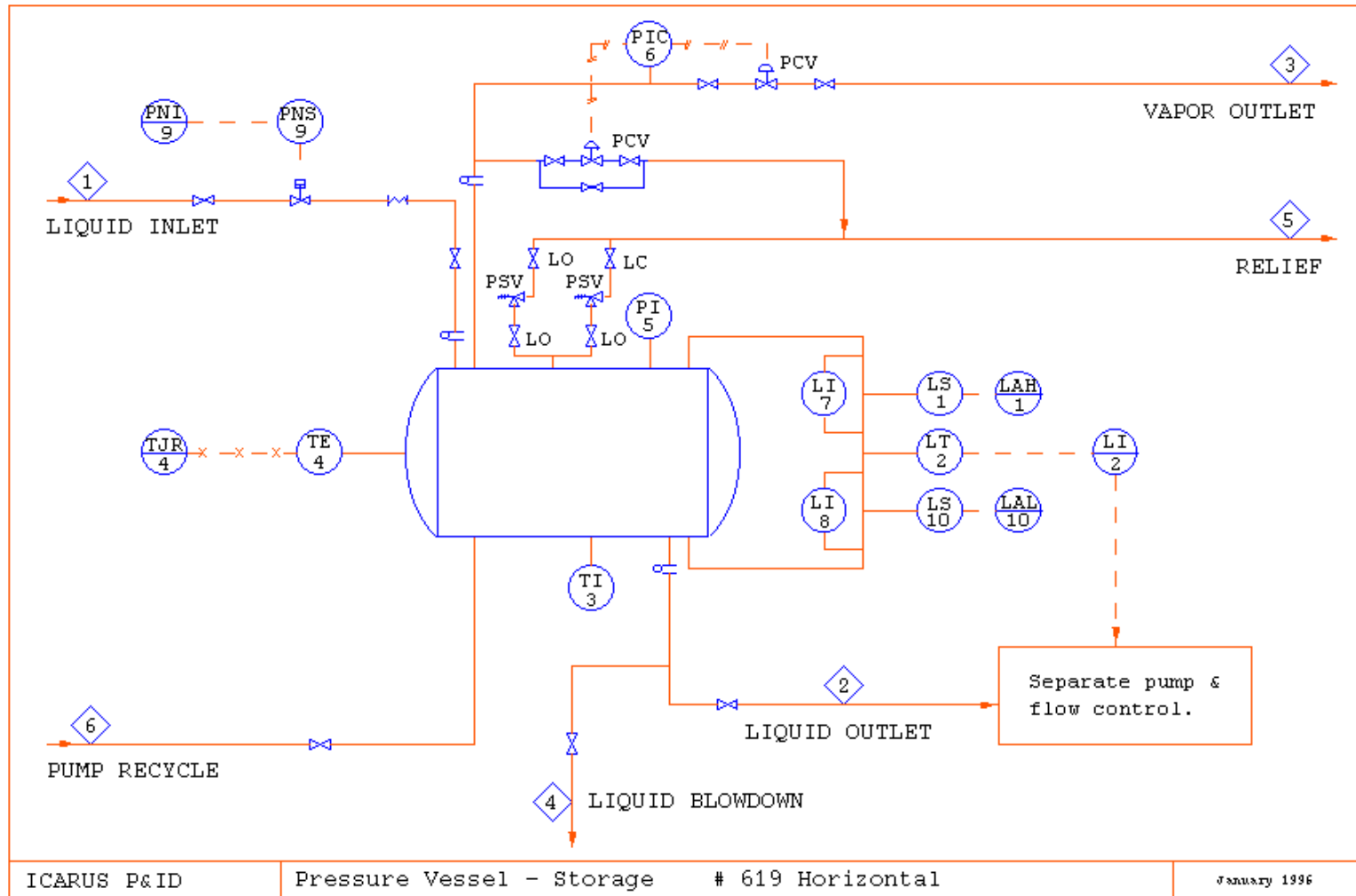
18 Storage Vessel



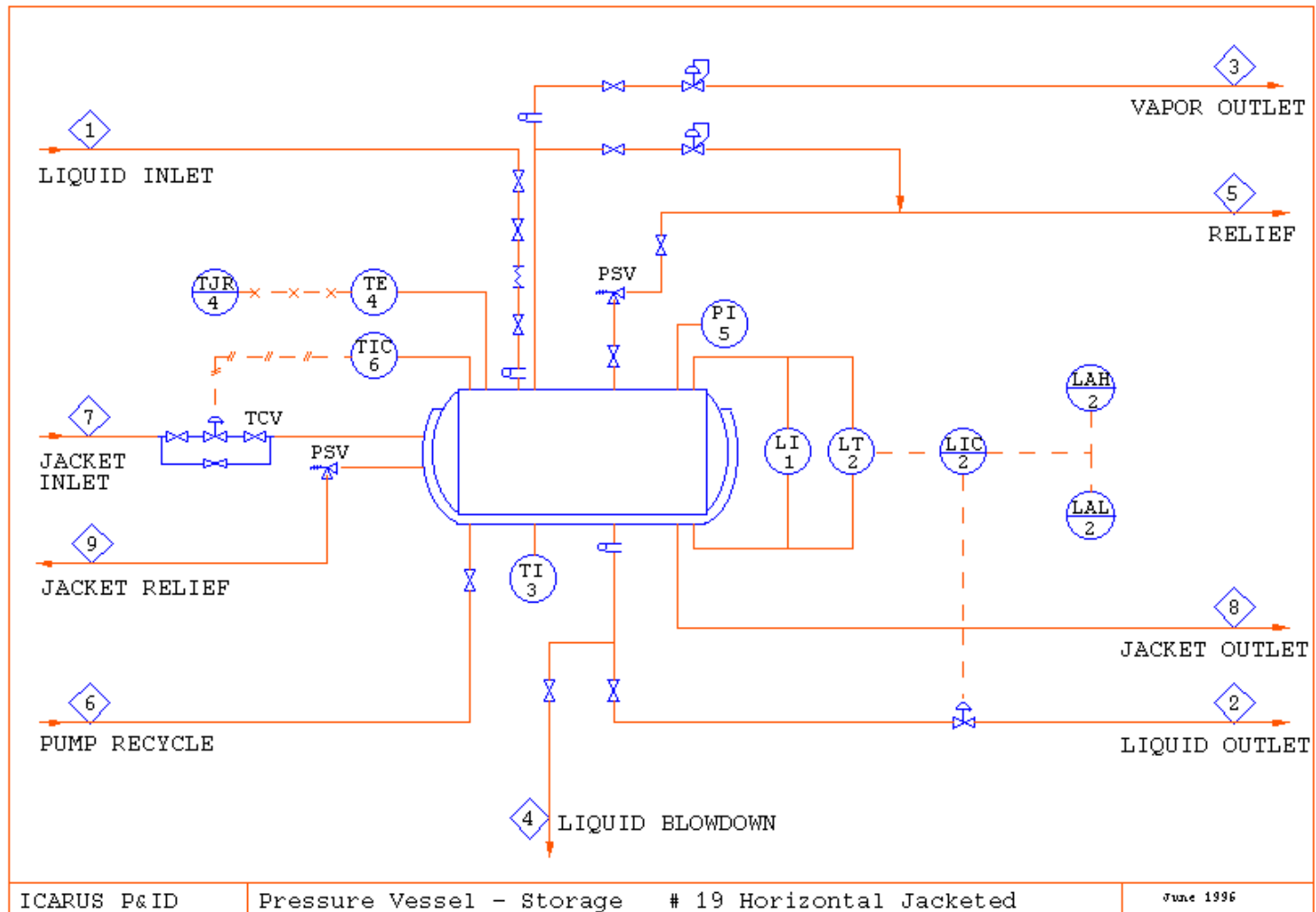
19 Horizontal Pressure Vessel – Storage



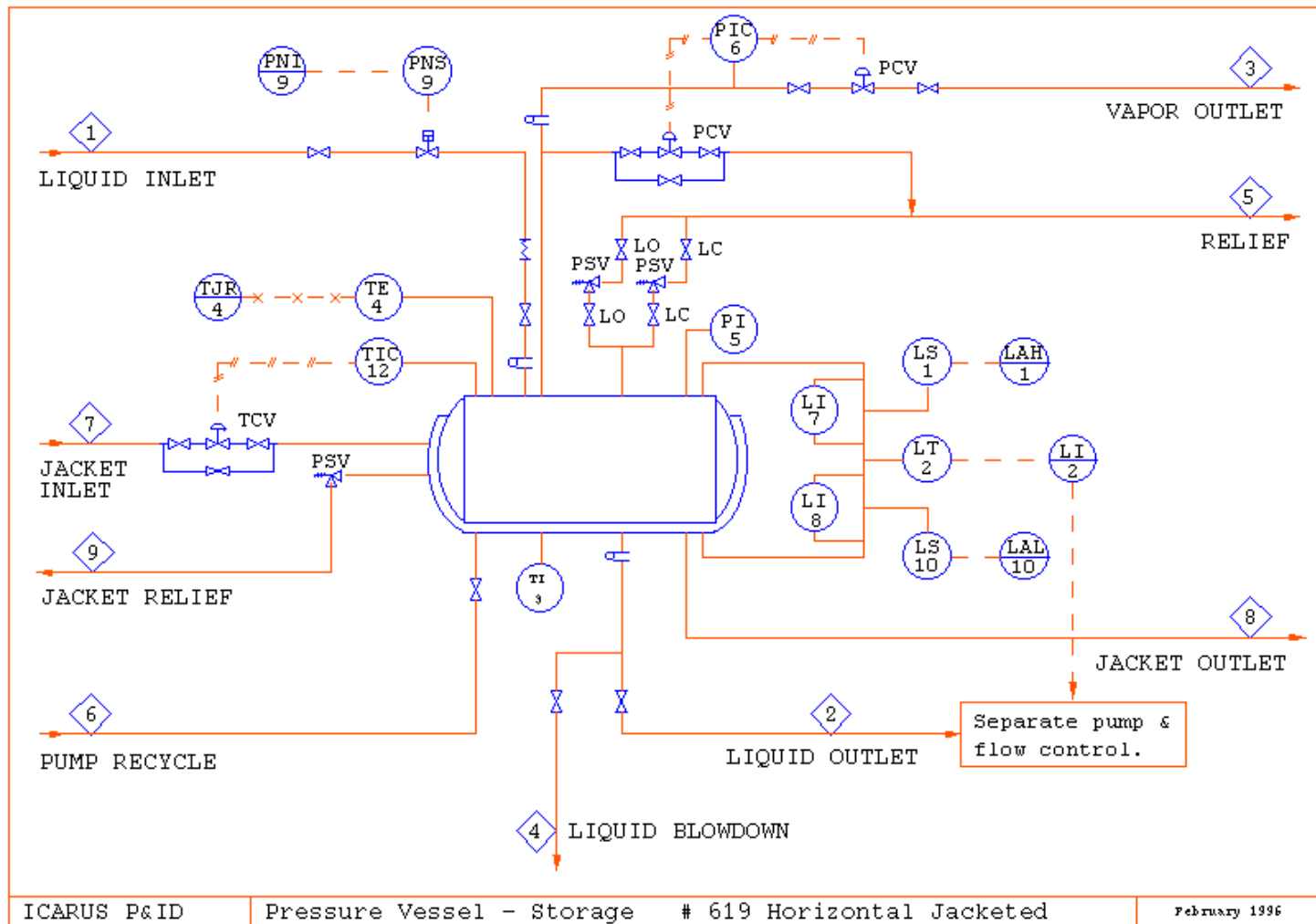
619 Horizontal Pressure Vessel – Storage



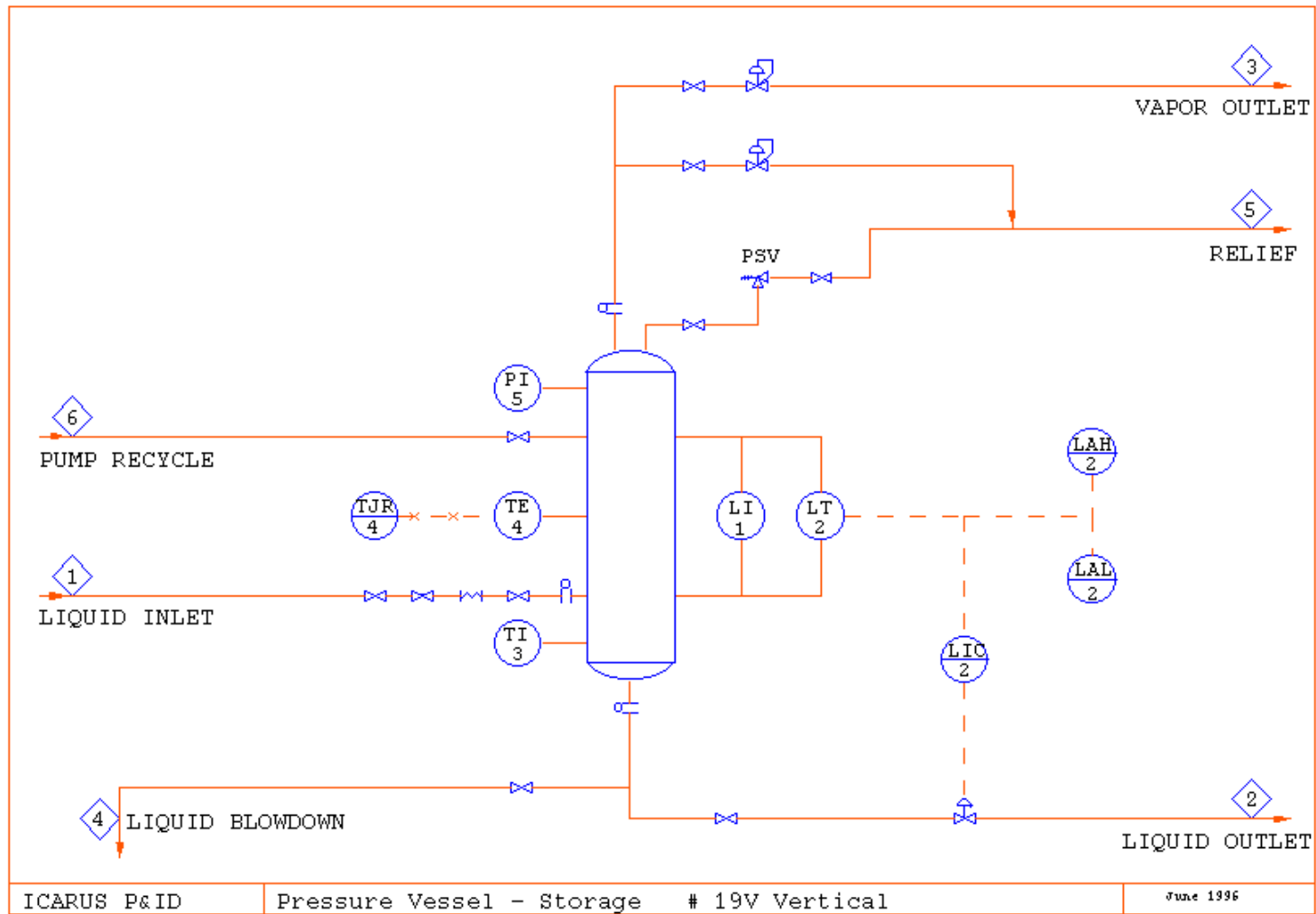
19 Horizontal Jacketed Pressure Vessel – Storage



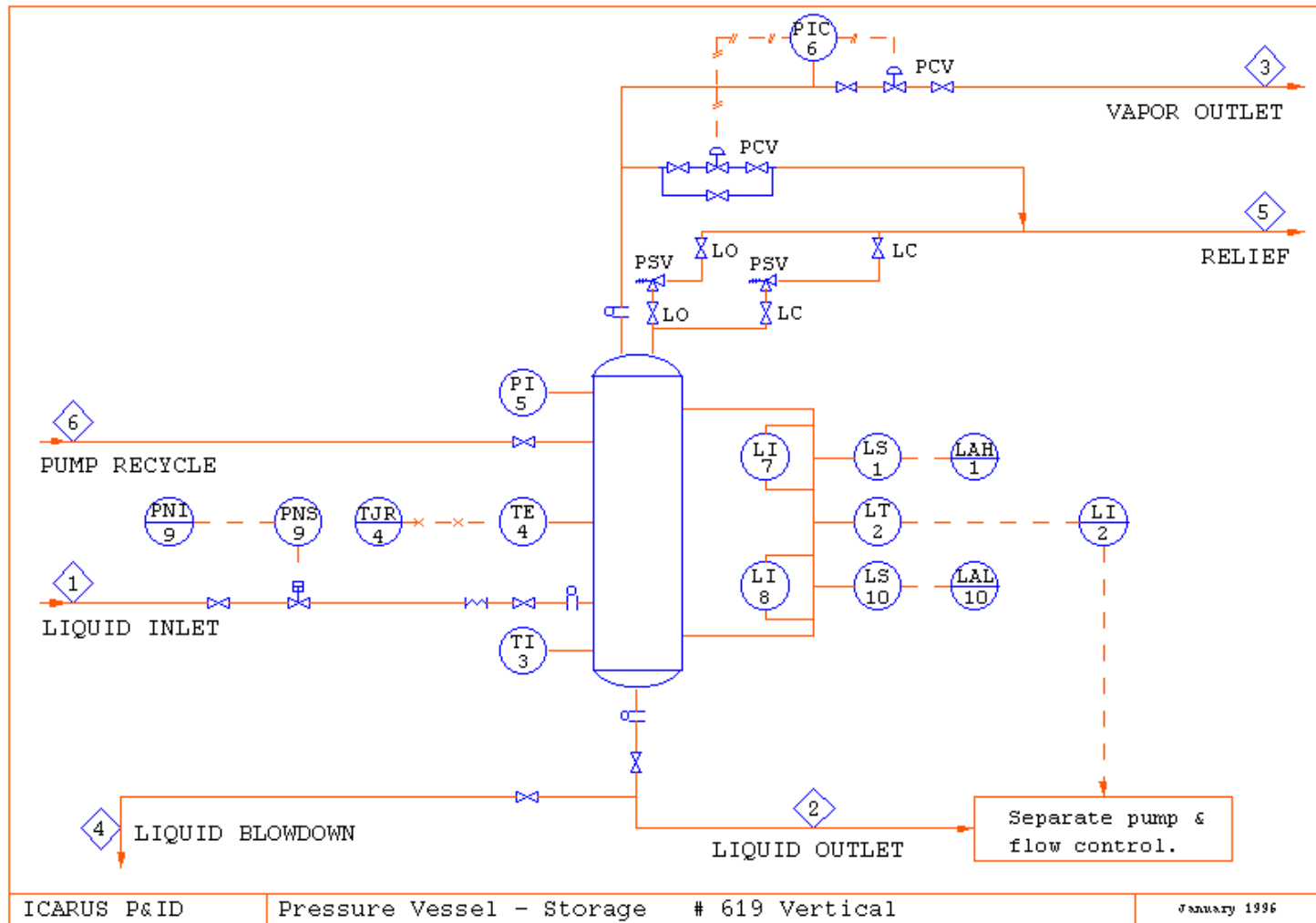
619 Horizontal Jacketed Pressure Vessel – Storage



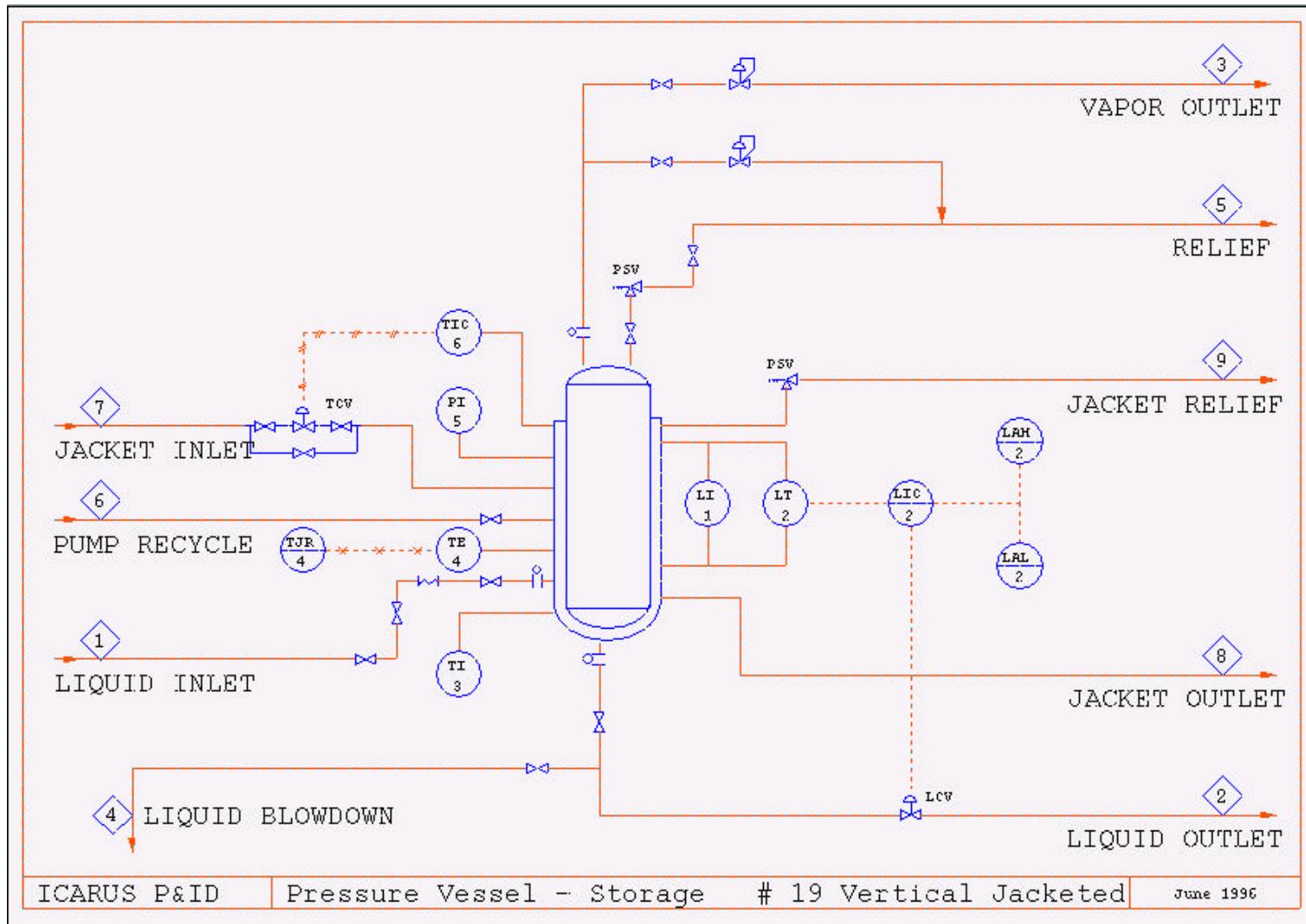
19 Vertical Pressure Vessel – Storage



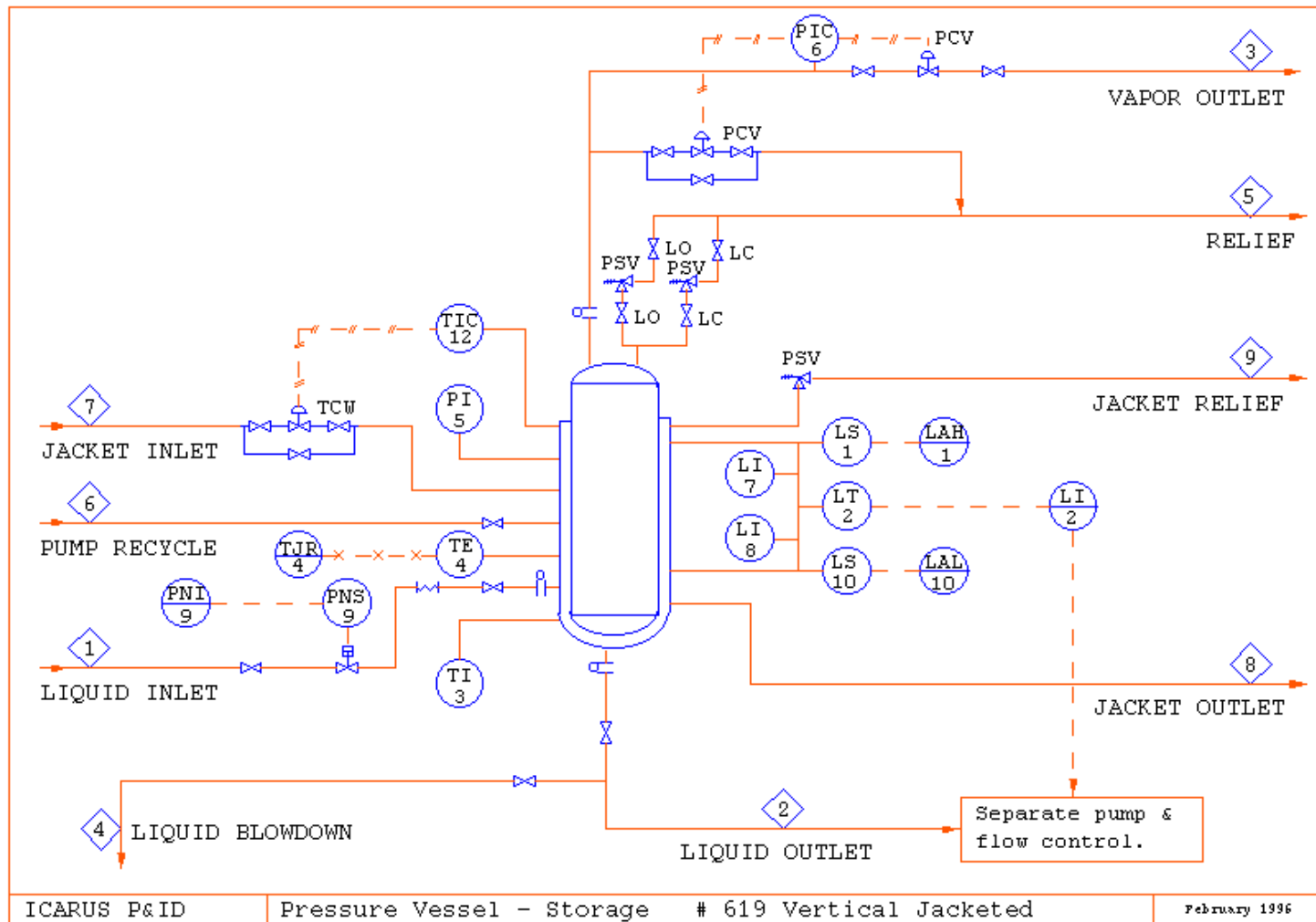
619 Vertical Pressure Vessel – Storage



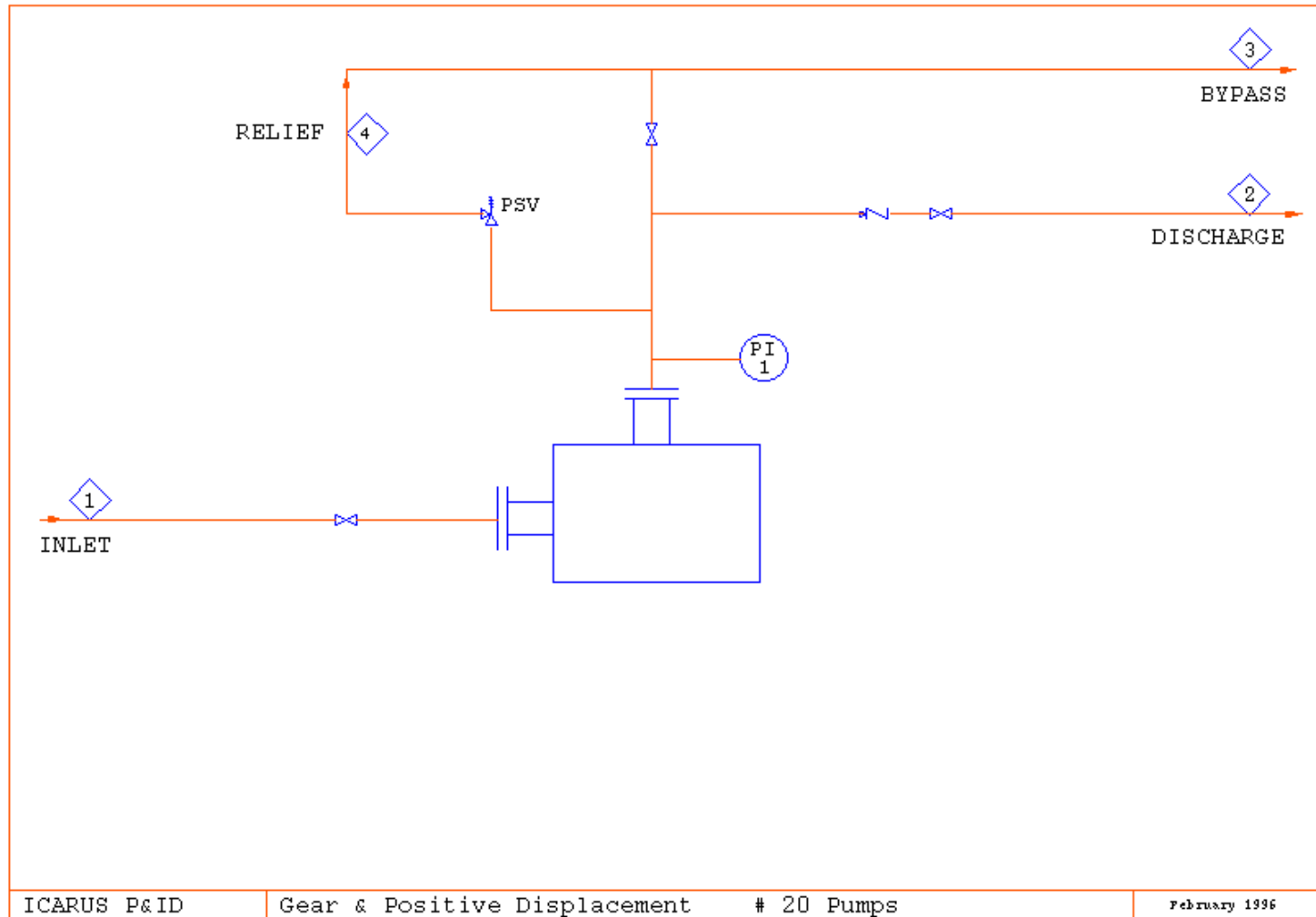
19 Vertical Jacketed Pressure Vessel – Storage



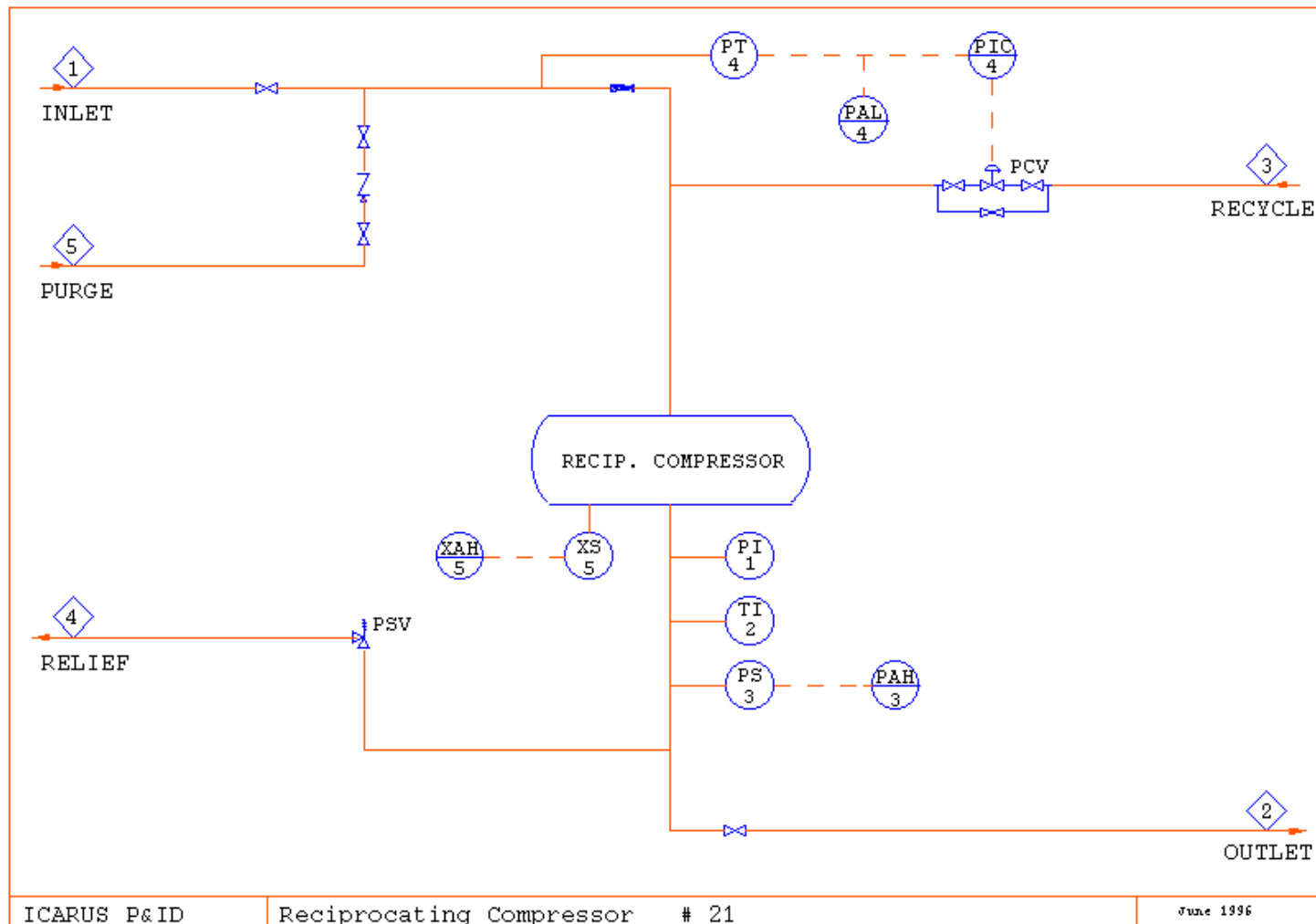
619 Vertical Jacketed Pressure Vessel – Storage



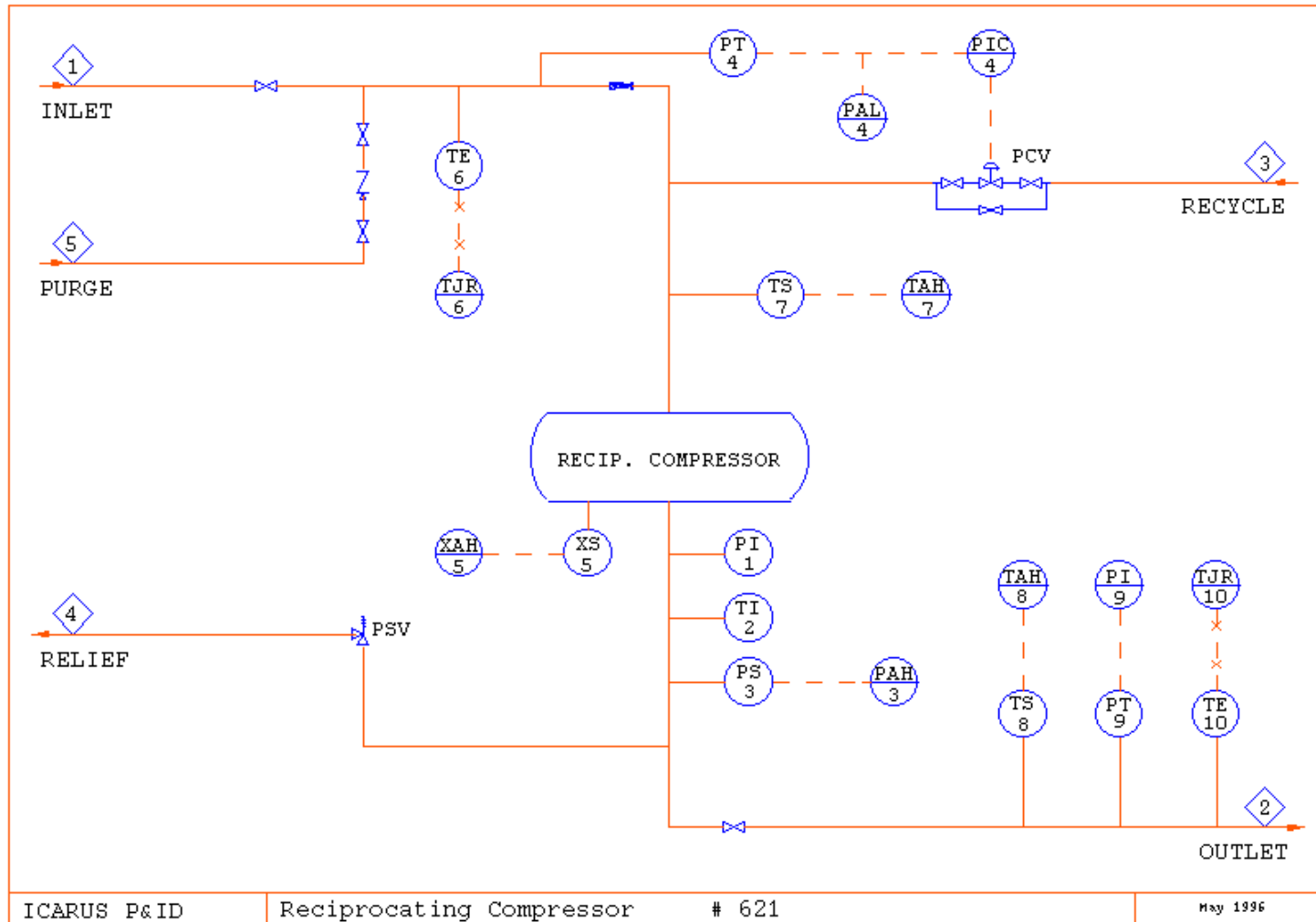
20 Pumps – Gear & Positive Displacement



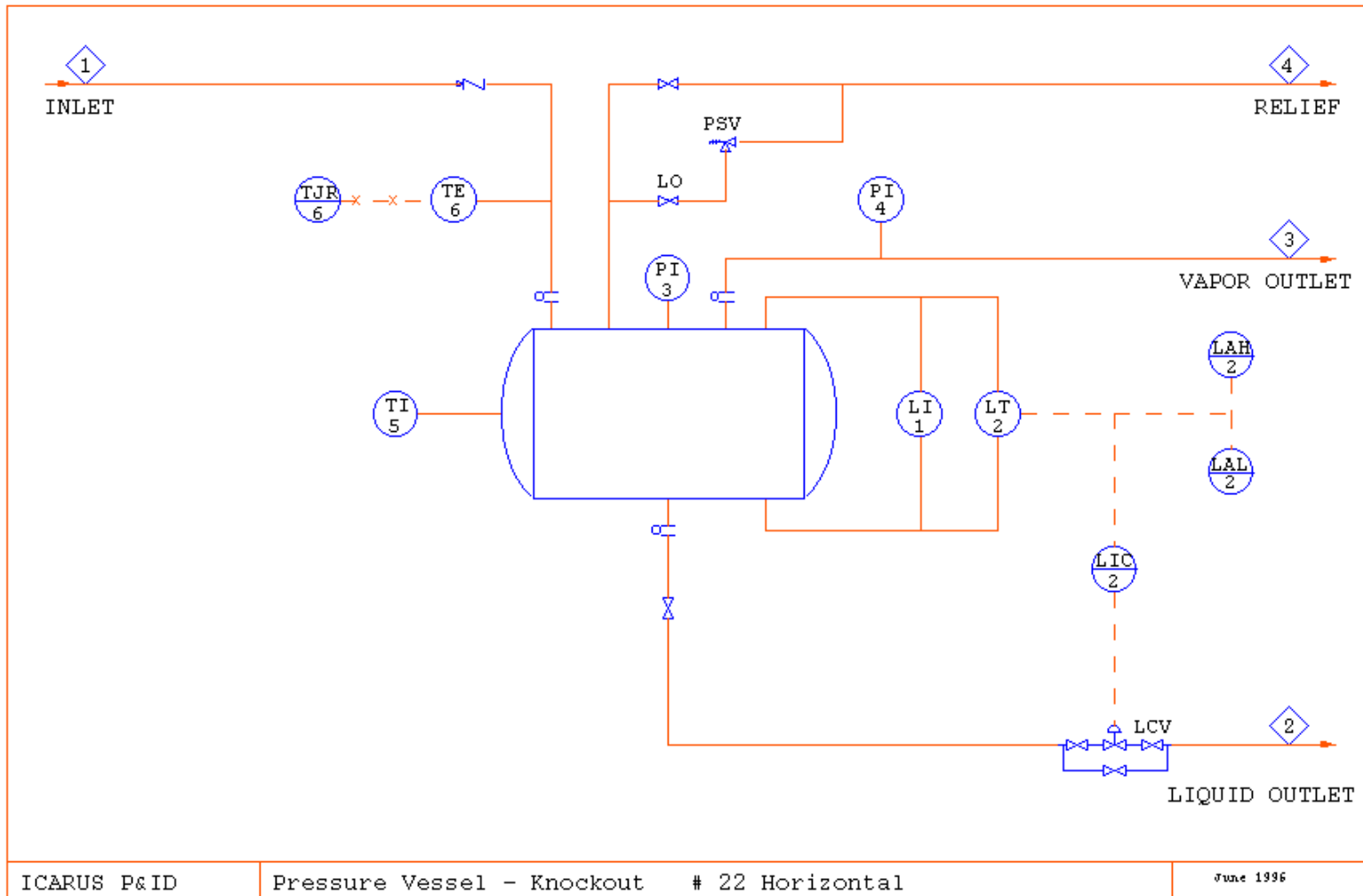
21 Reciprocating Compressor



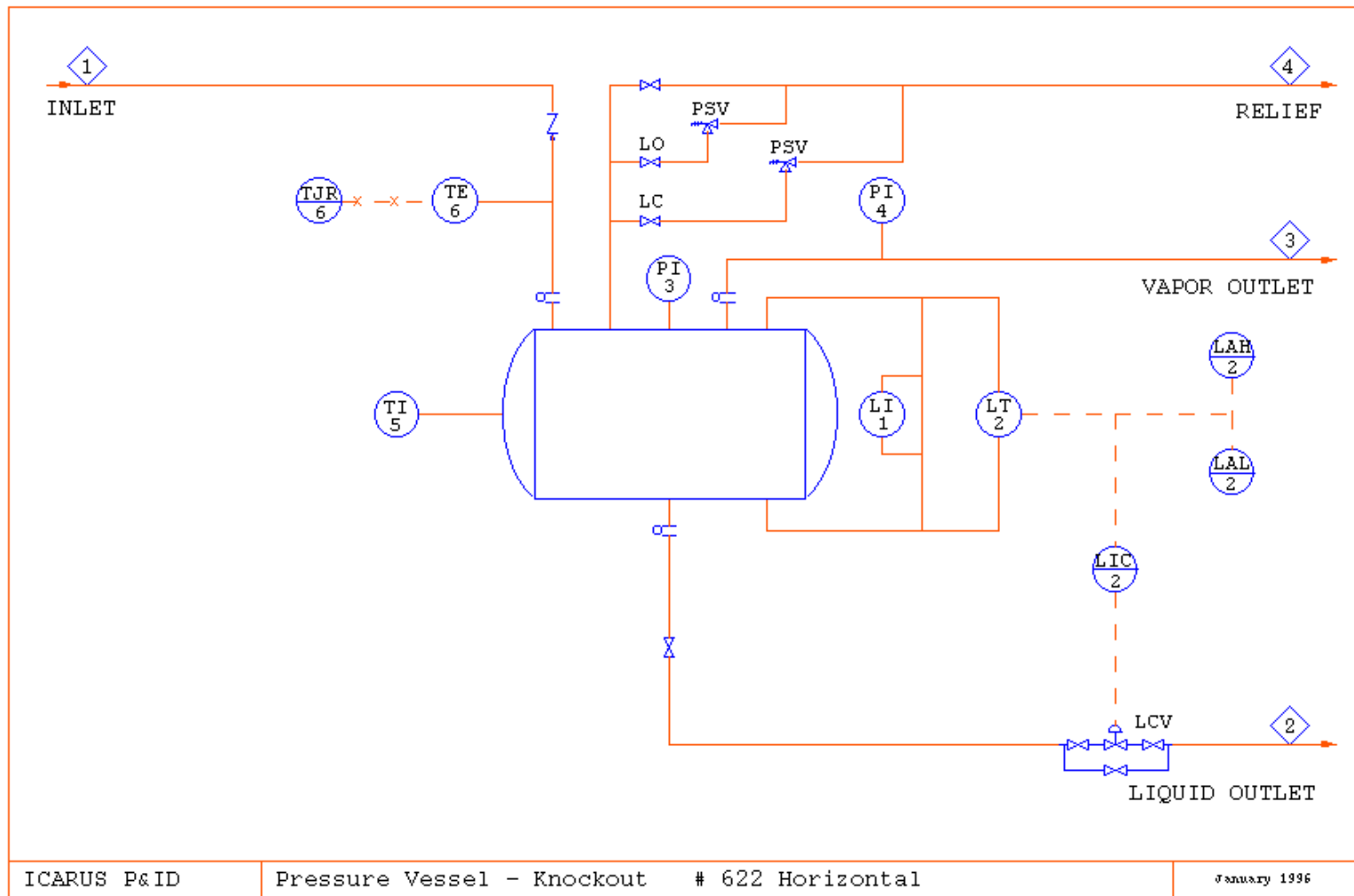
621 Reciprocating Compressor



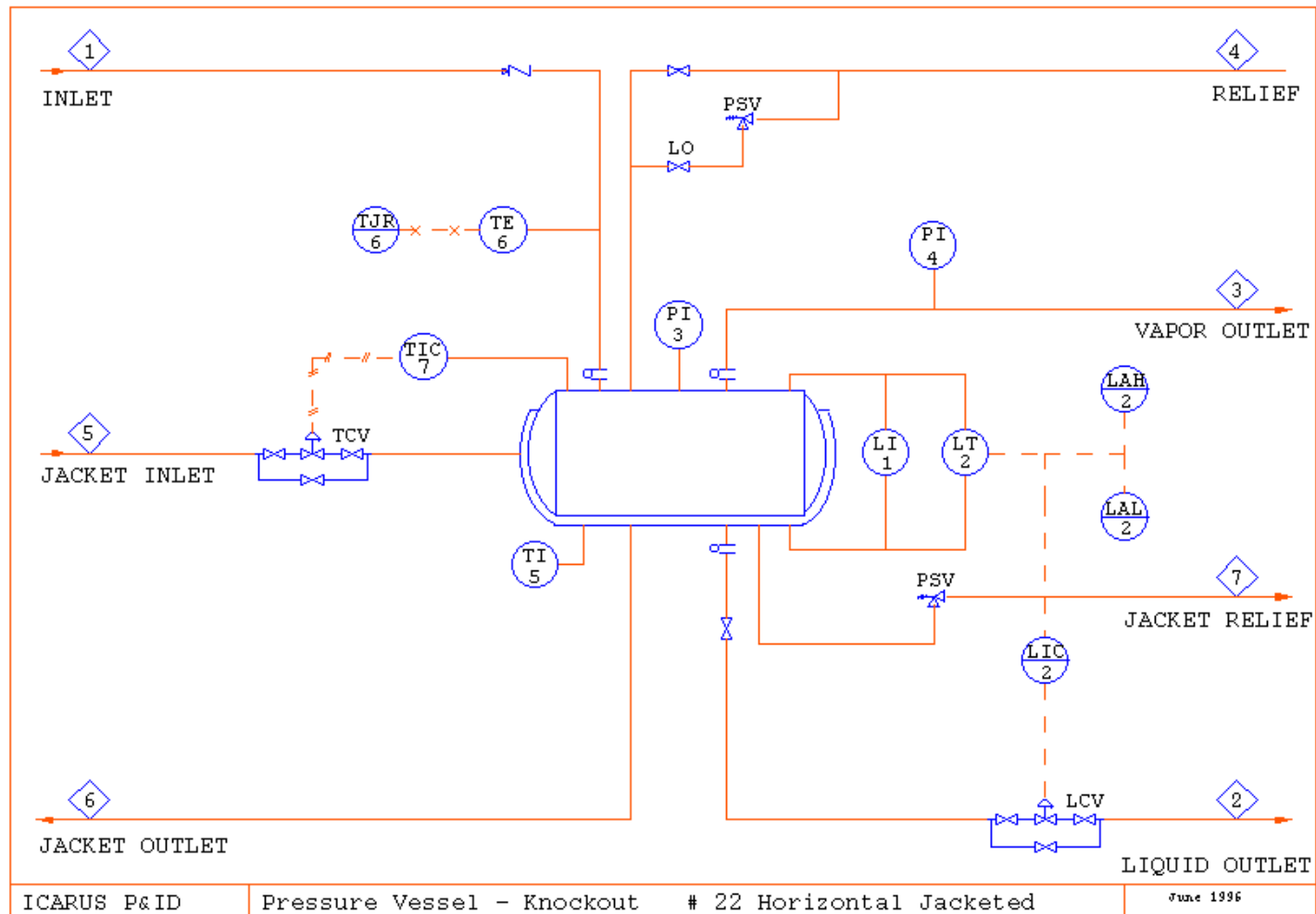
22 Horizontal Pressure Vessel – Knockout



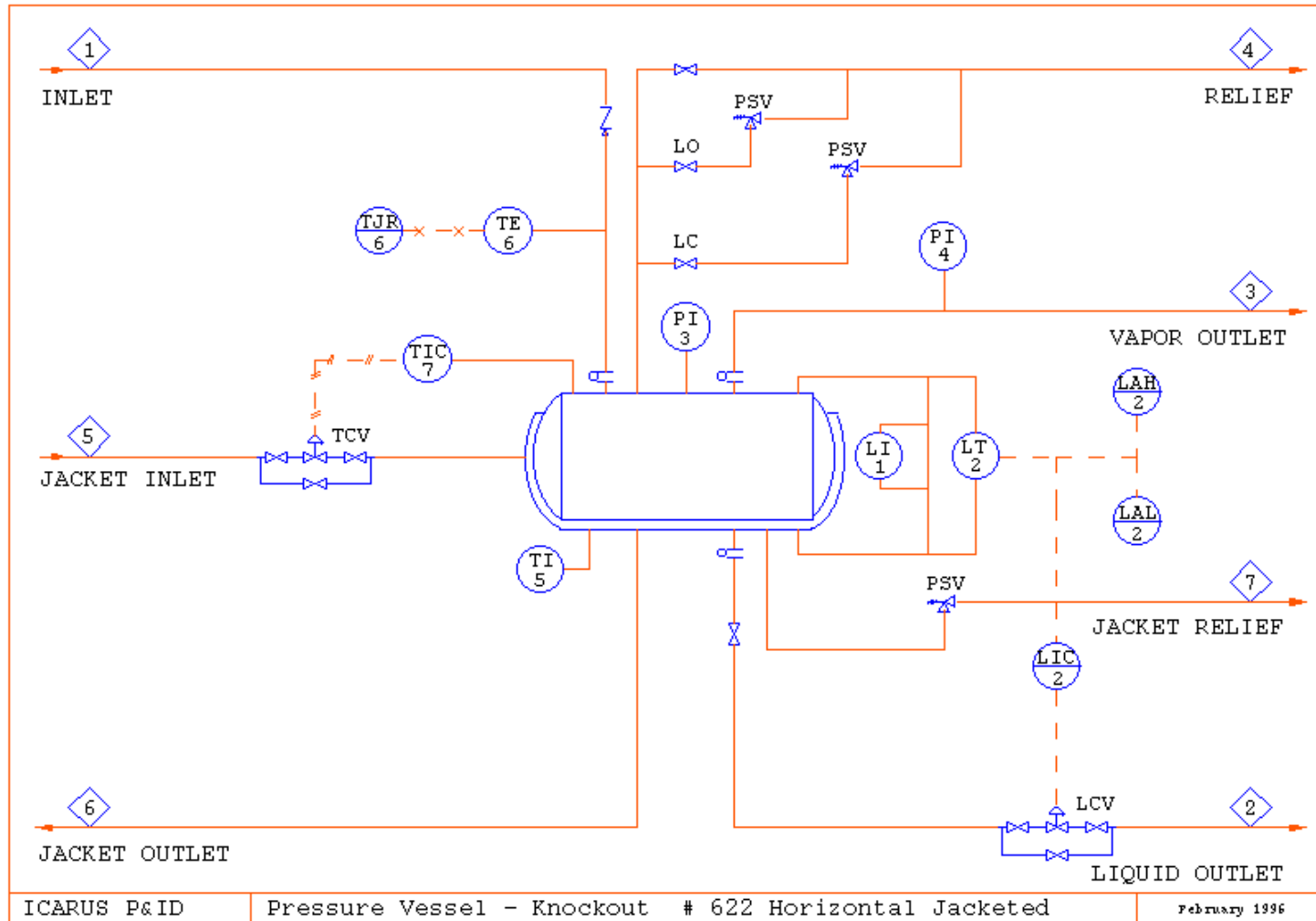
622 Horizontal Pressure Vessel – Knockout



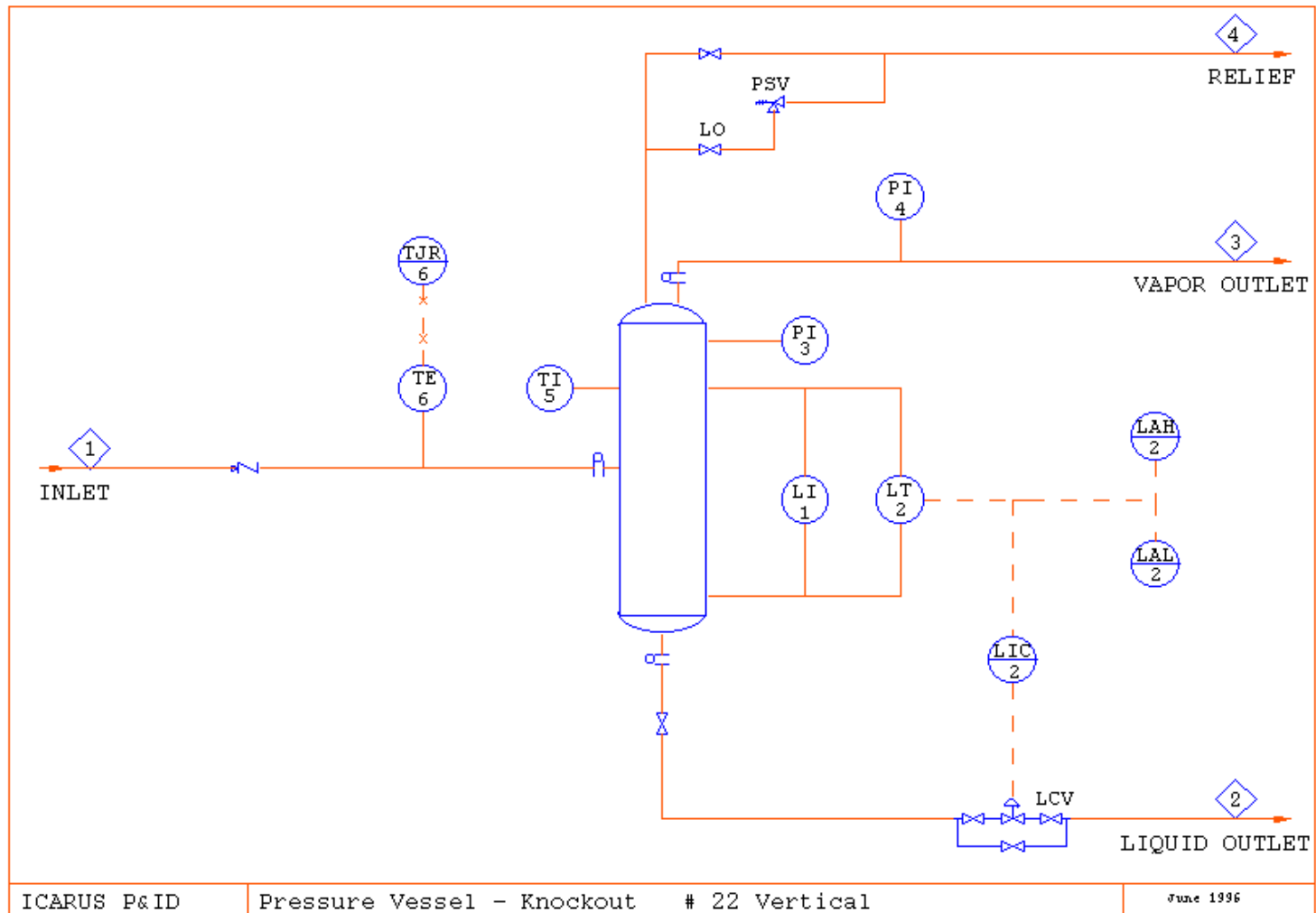
22 Horizontal Jacketed Pressure Vessel – Knockout



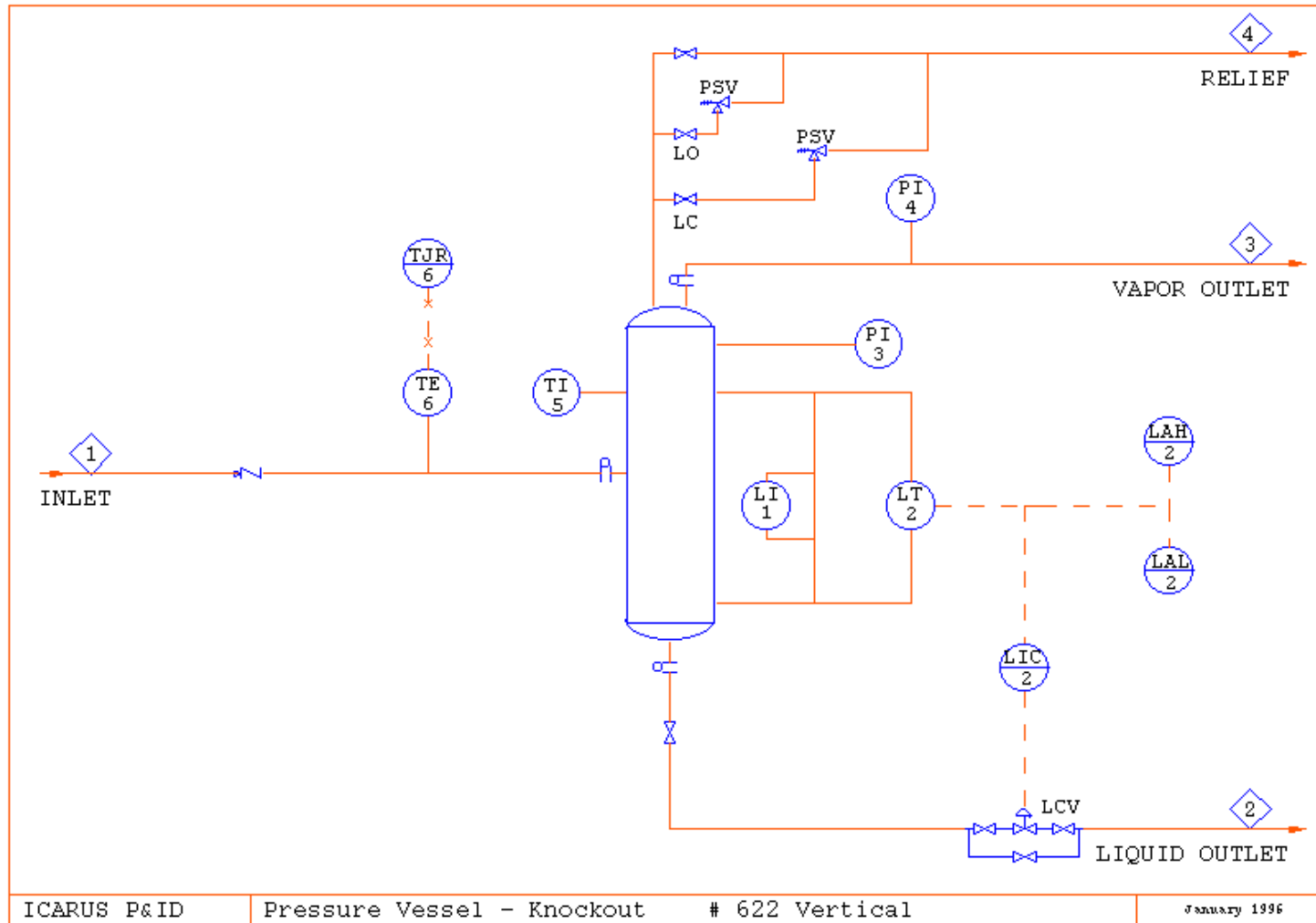
622 Horizontal Jacketed Pressure Vessel – Knockout



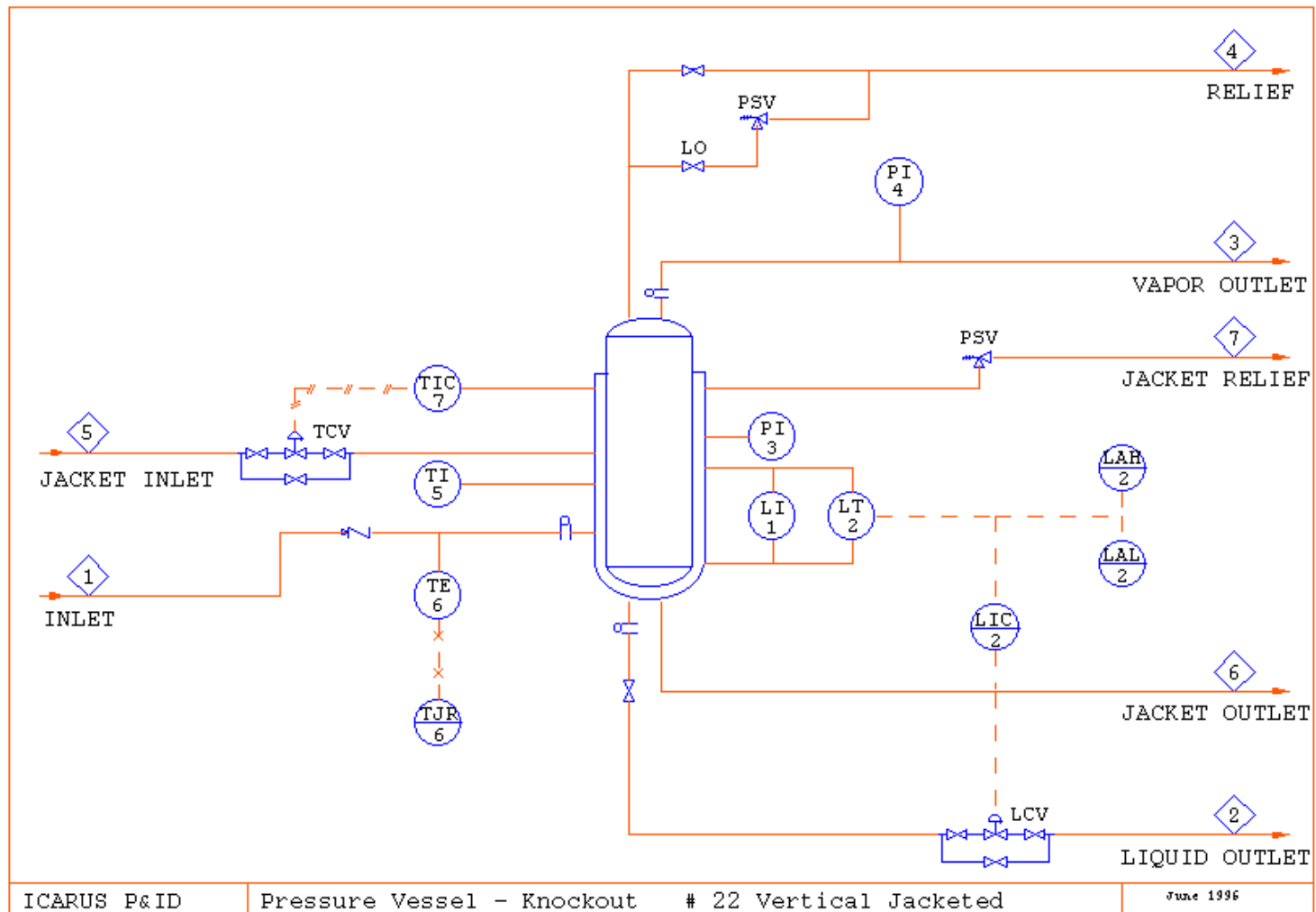
22 Vertical Pressure – Knockout



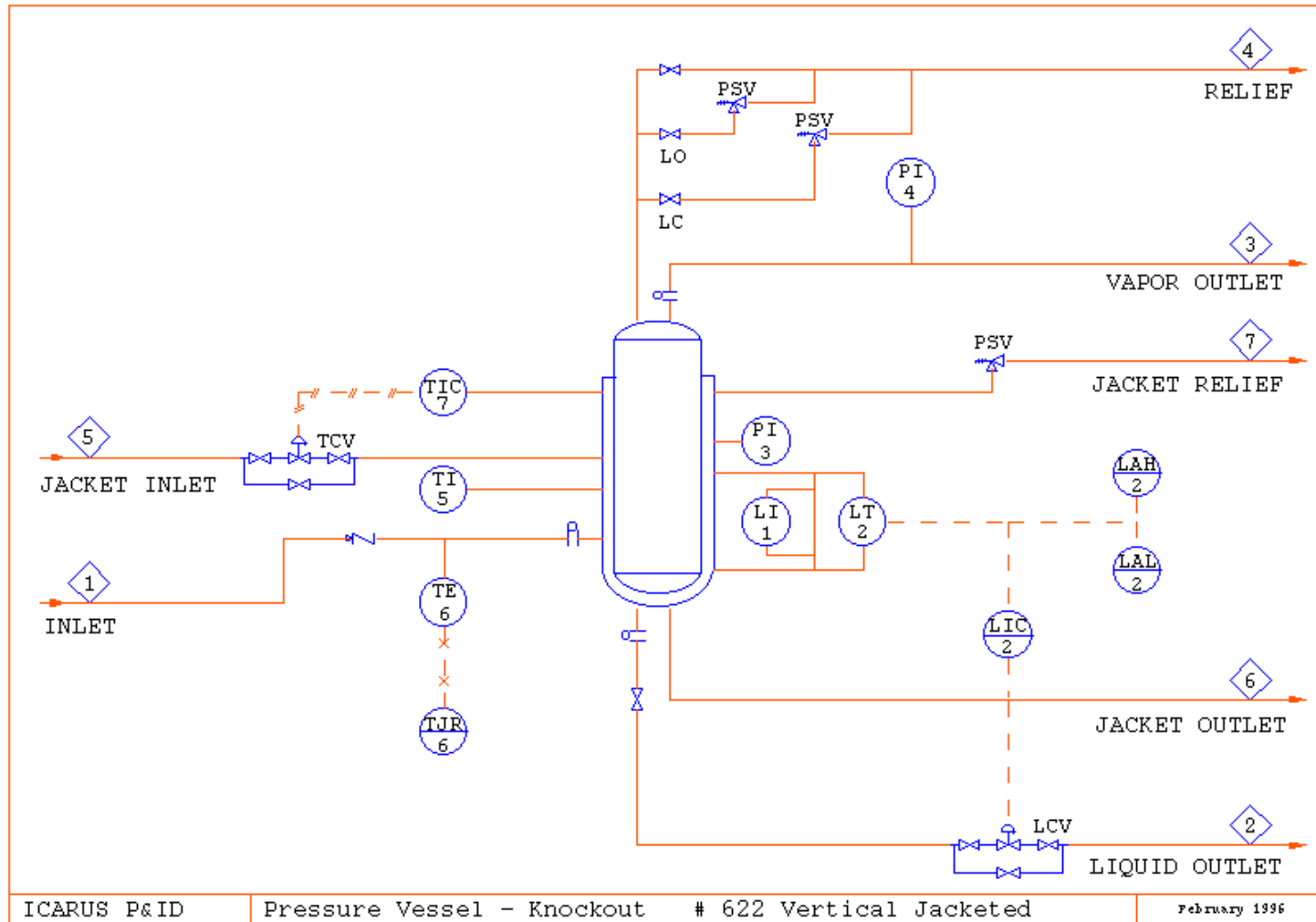
622 Vertical Pressure Vessel – Knockout



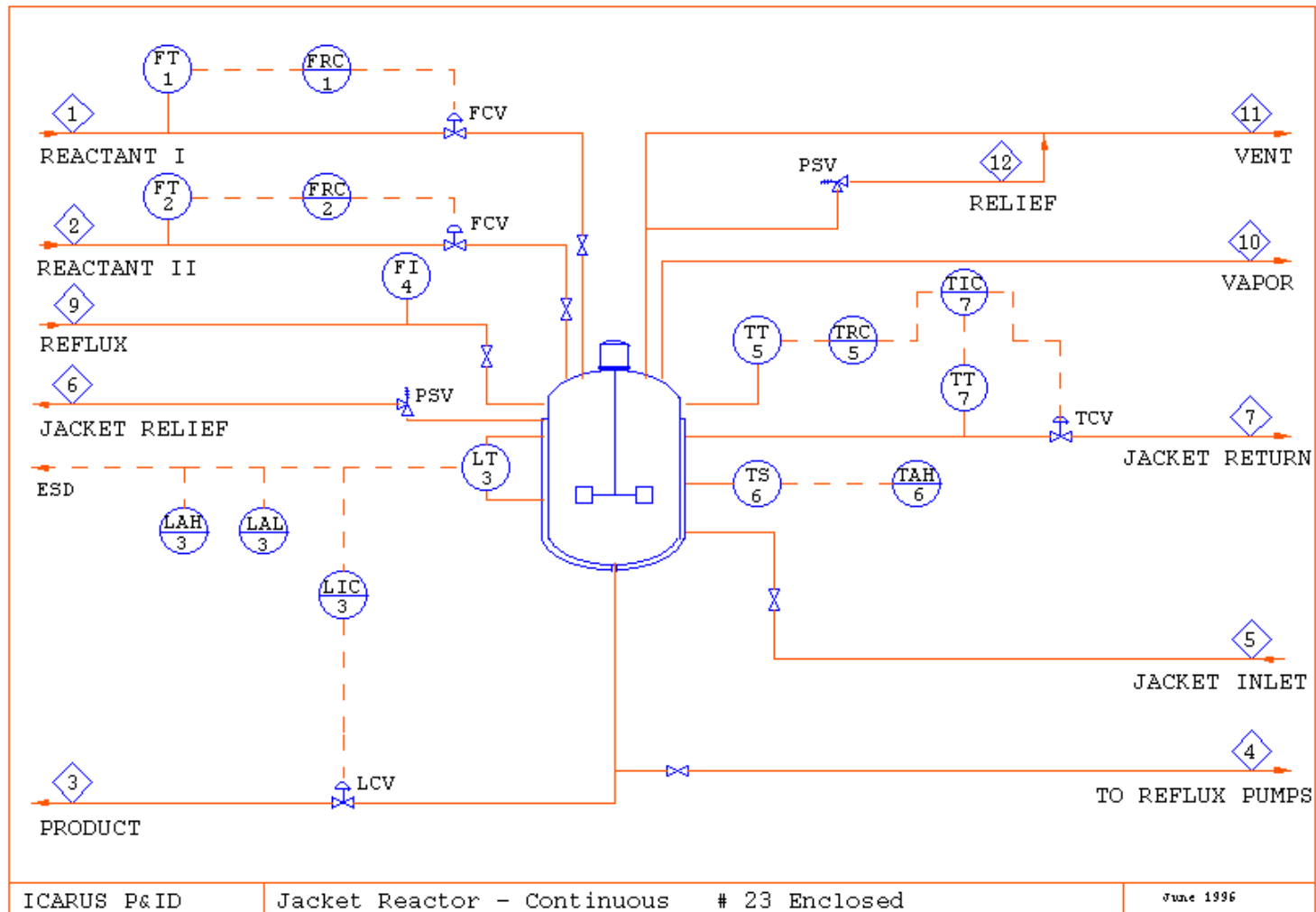
22 Vertical Jacketed Pressure Vessel – Knockout



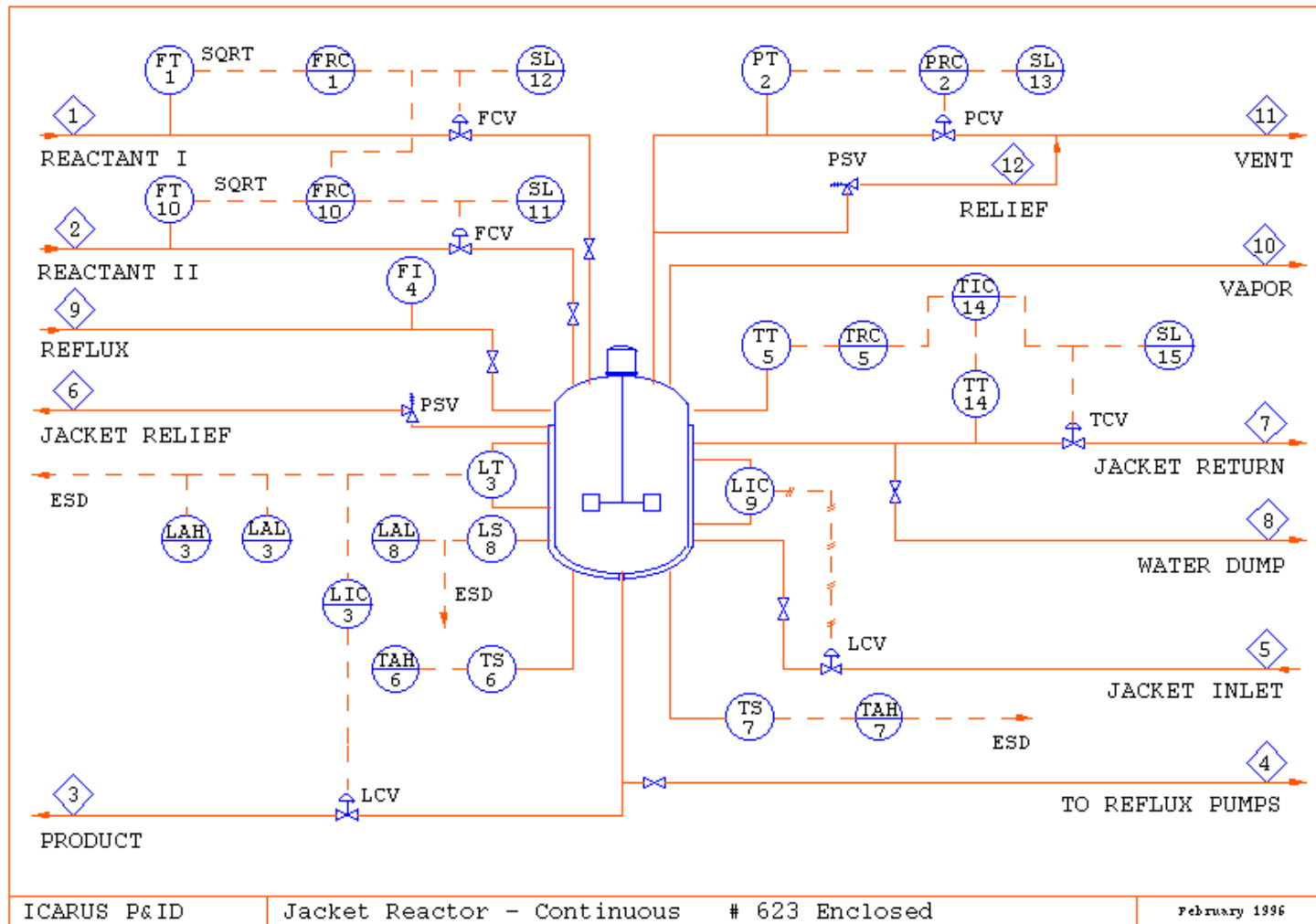
622 Vertical Jacketed Pressure Vessel – Knockout



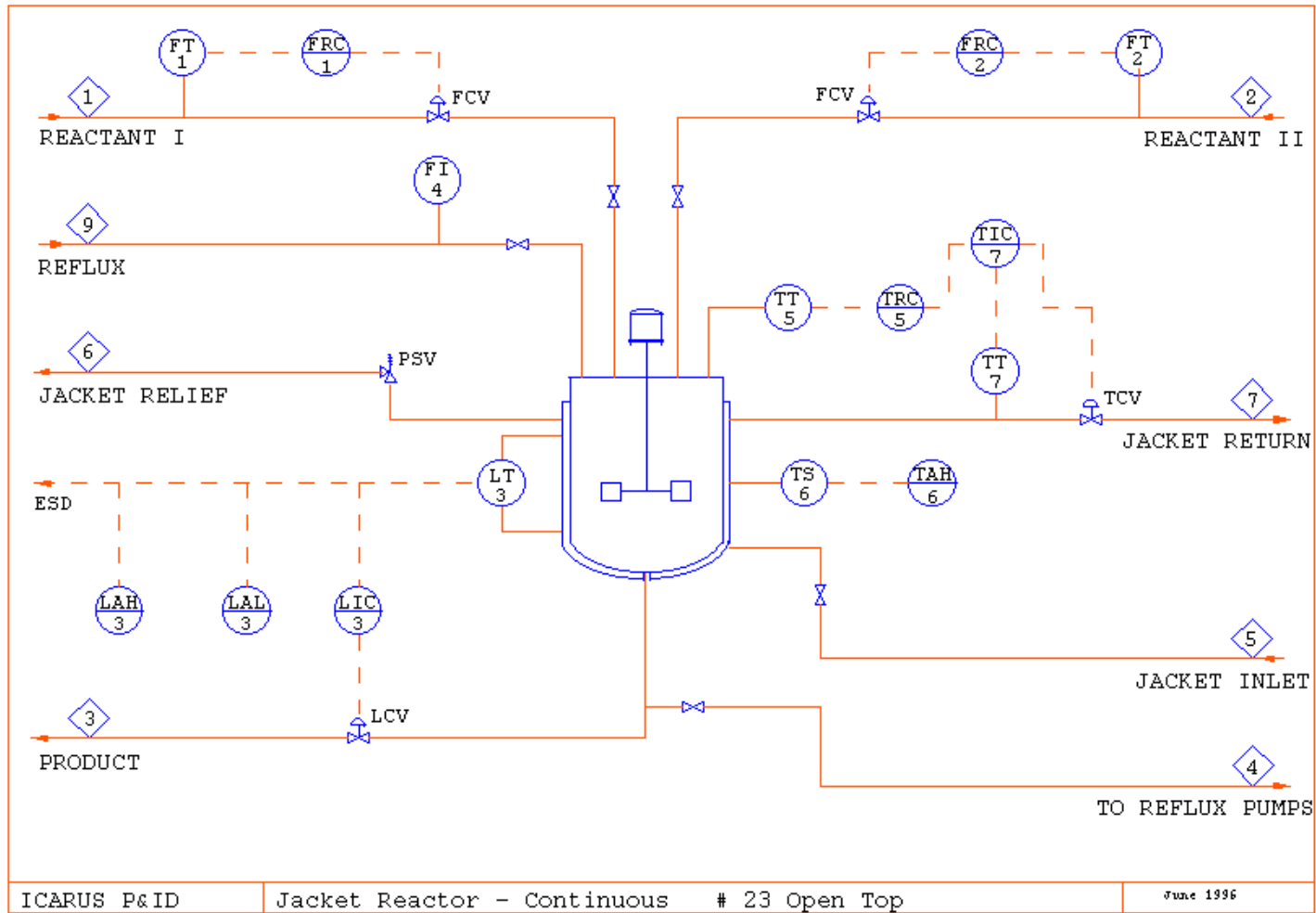
23 Enclosed Jacket Reactor – Continuous



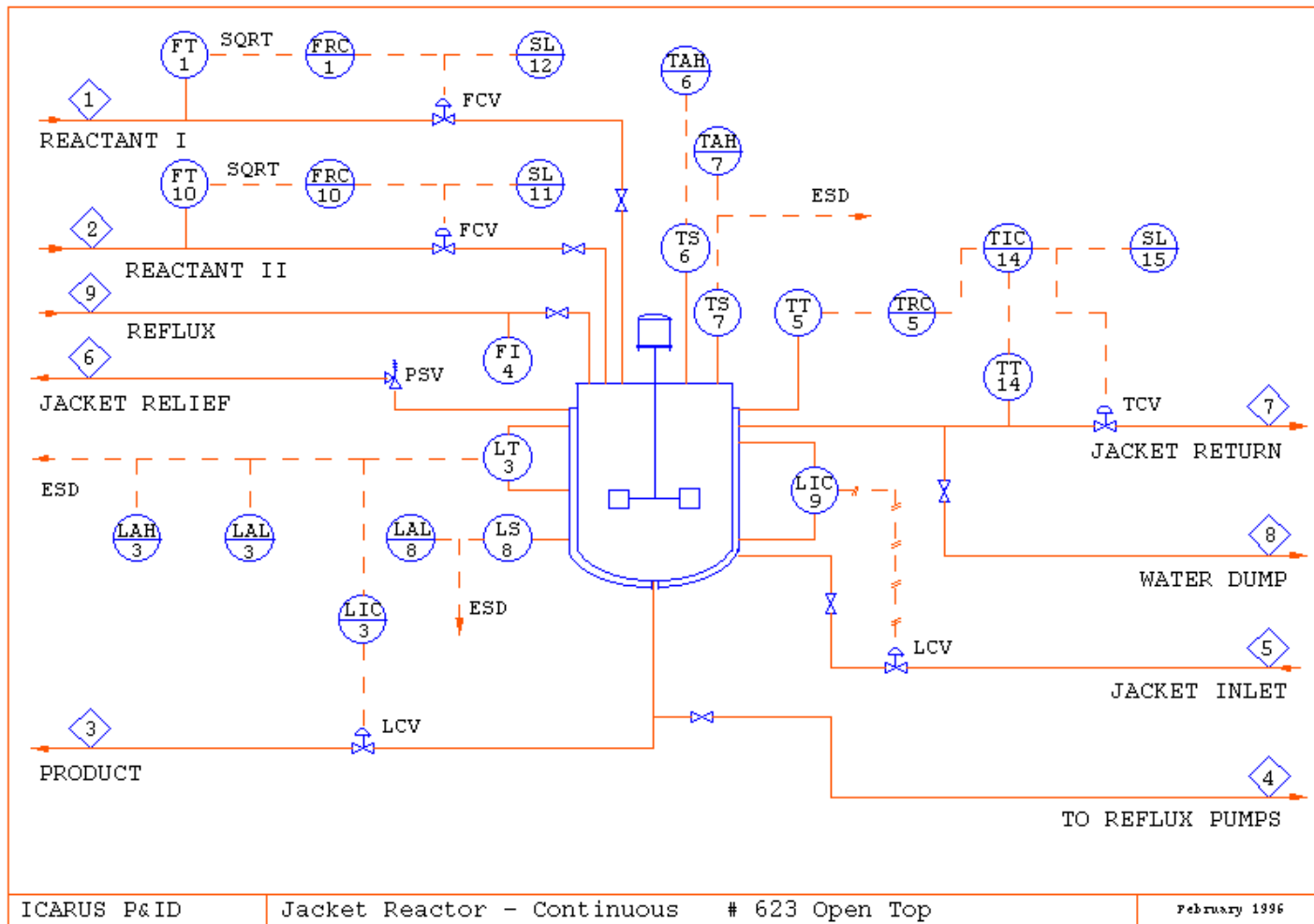
623 Enclosed Jacket Reactor – Continuous



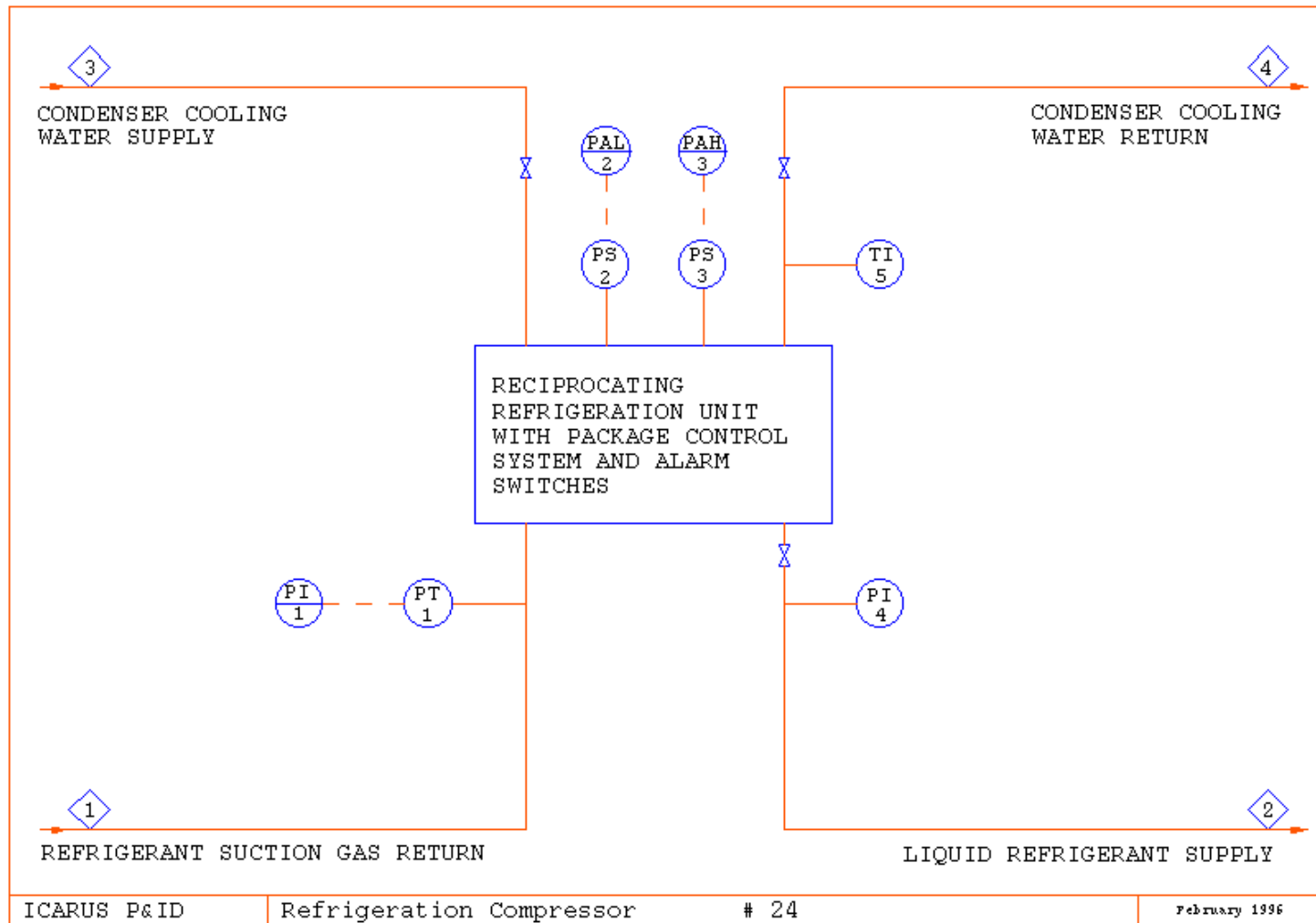
23 Open Top Jacket Reactor – Continuous



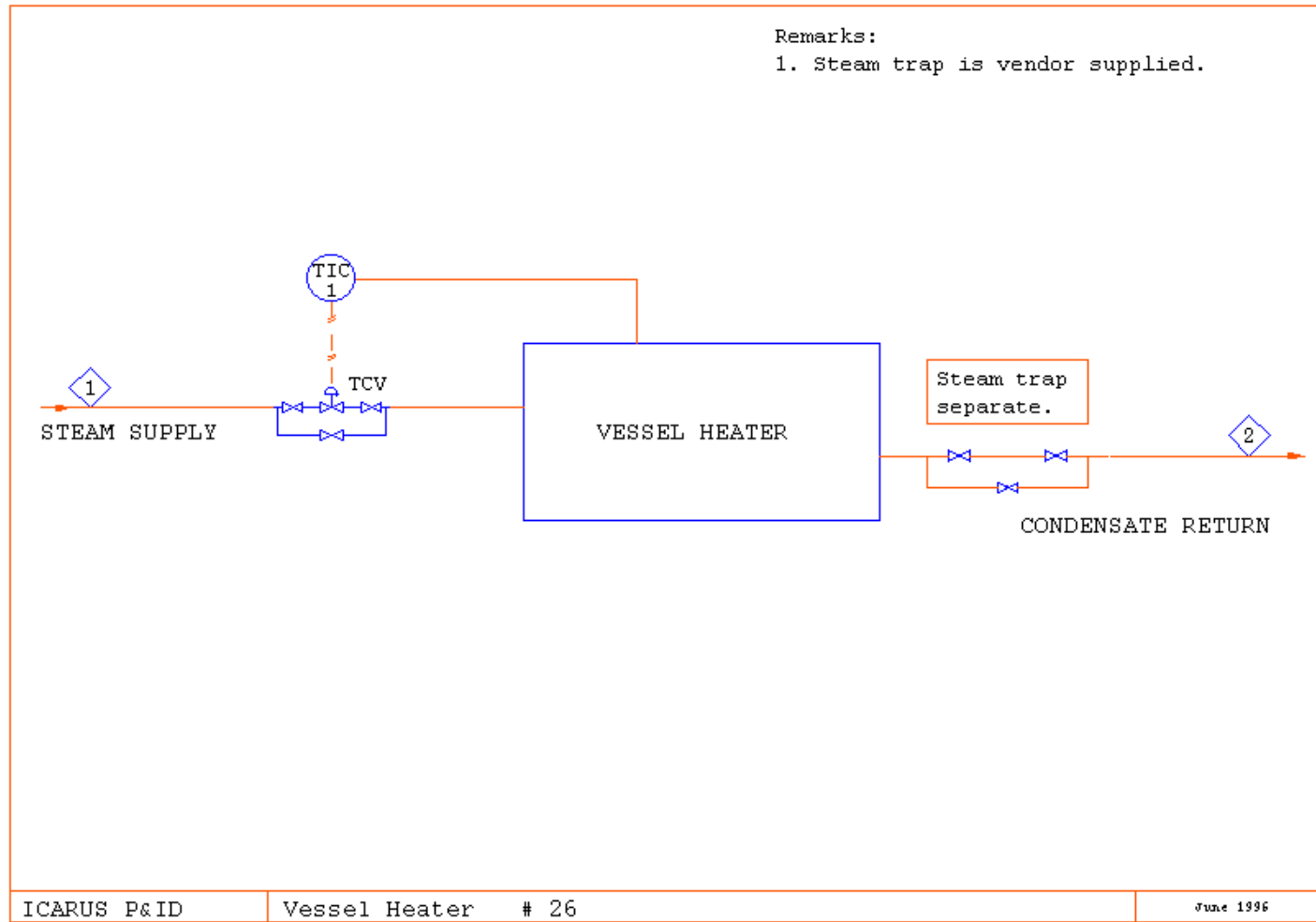
23 Open Top Jacket Reactor – Continuous



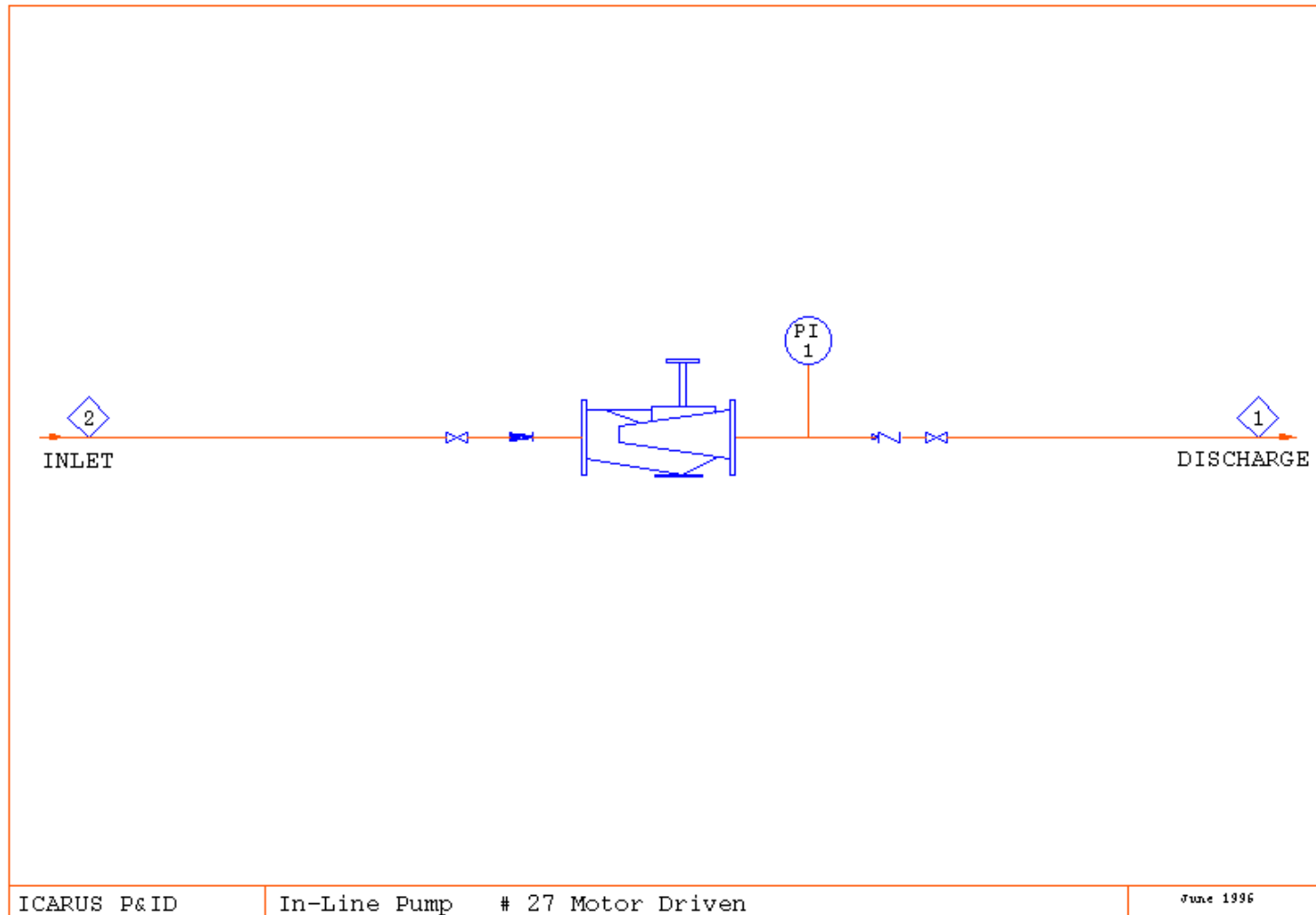
24 Refrigeration Compressor



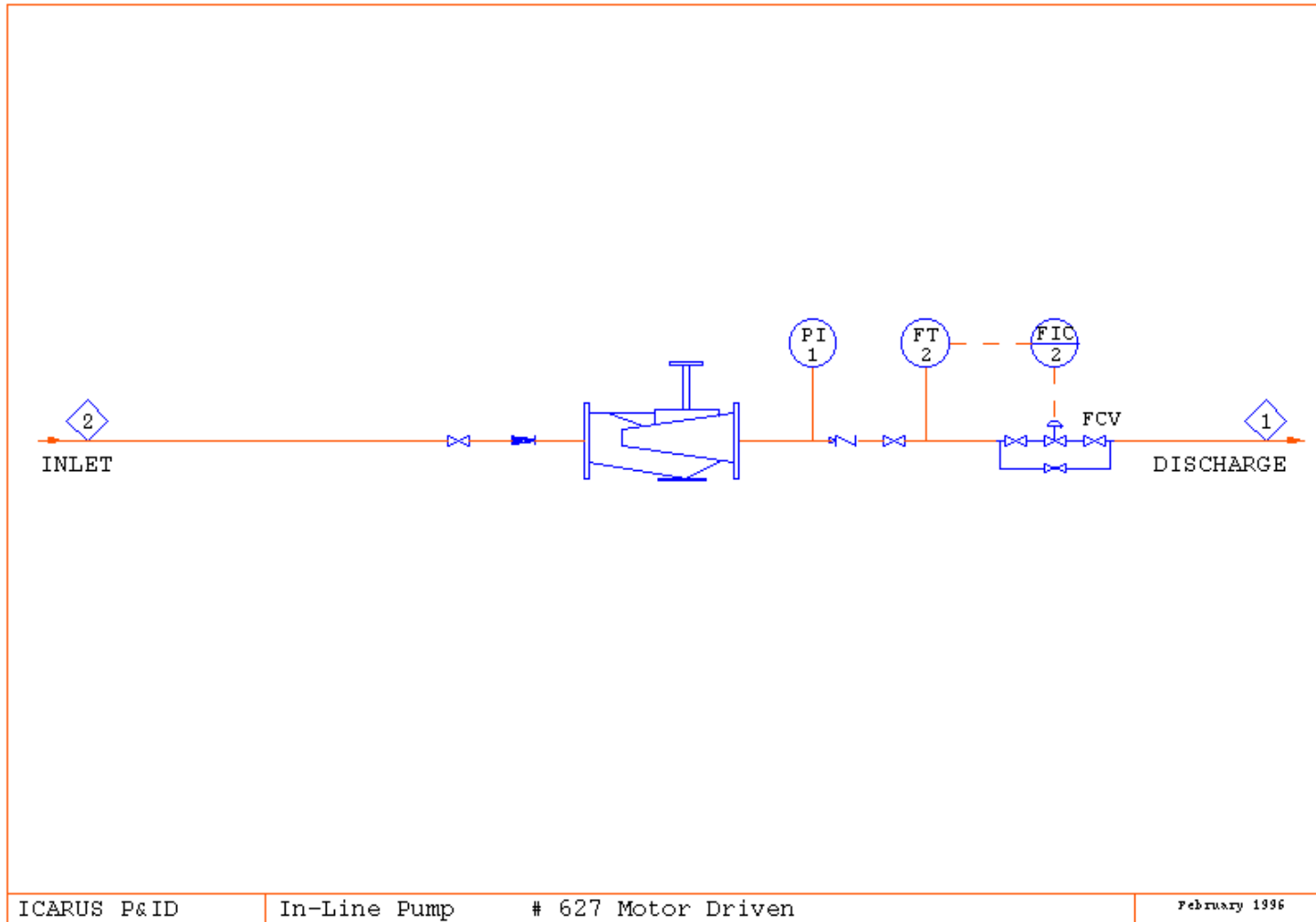
26 Vessel Heater



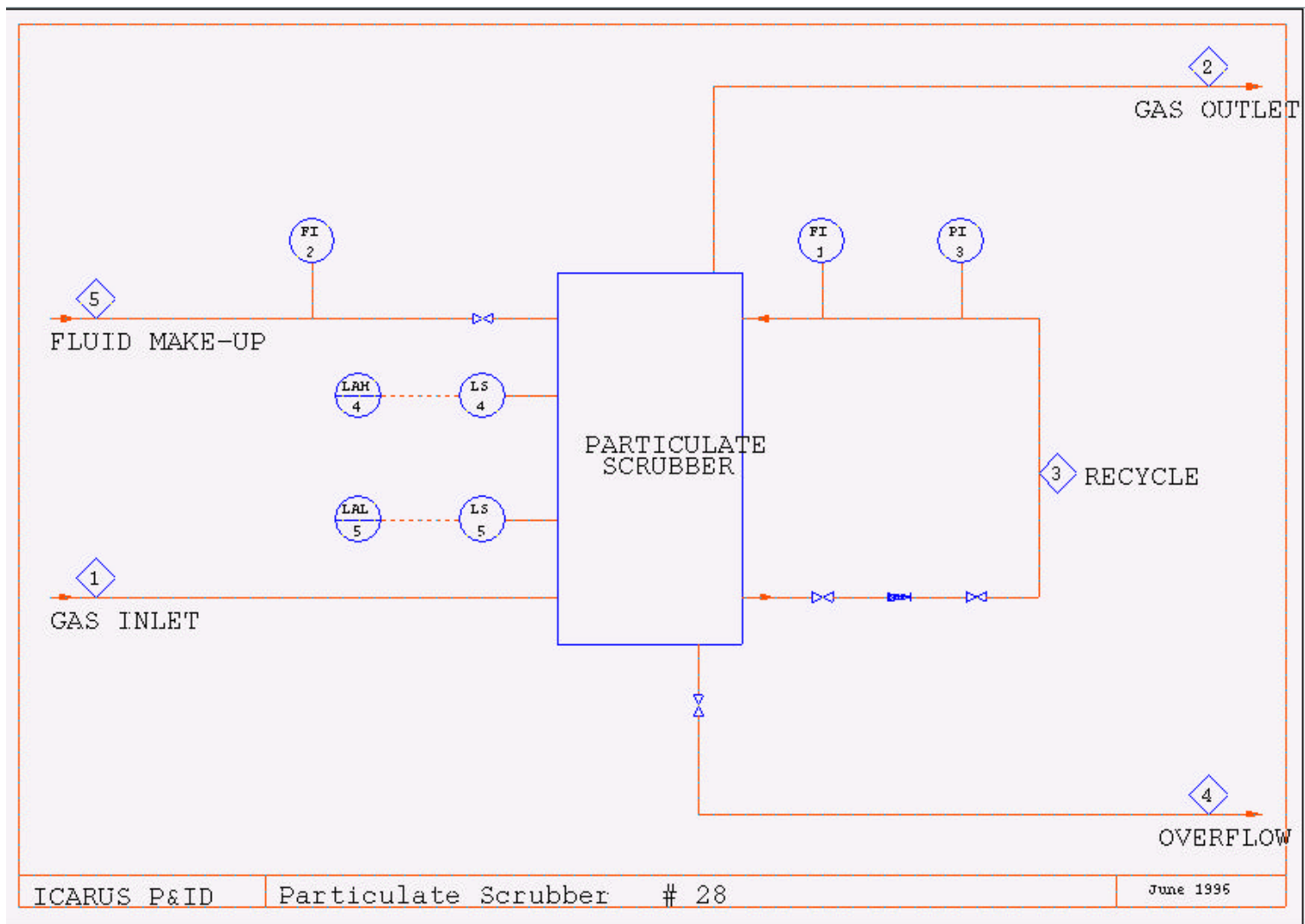
27 Motor Driven In-Line Pump



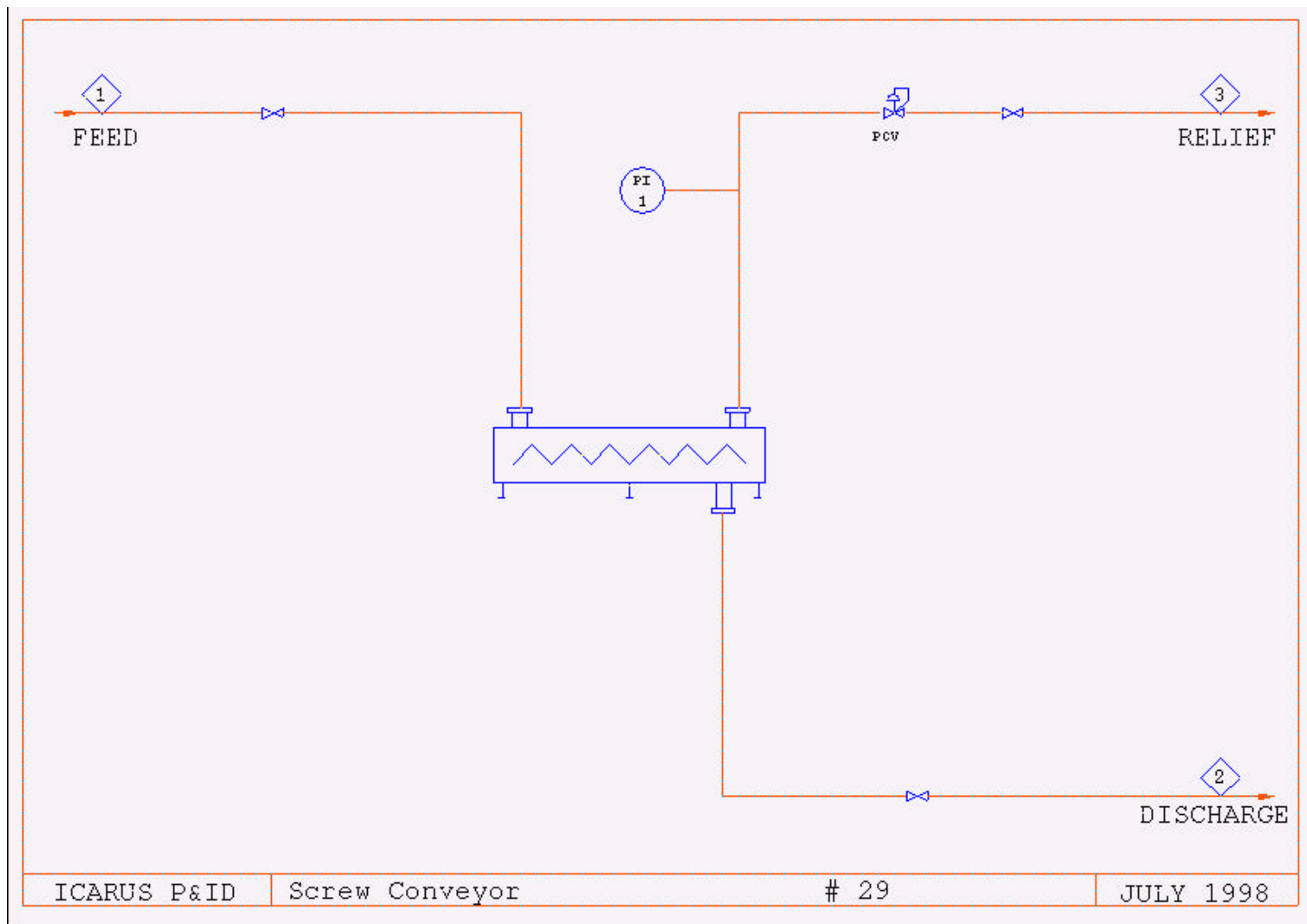
627 Motor Driven In-Line Pump



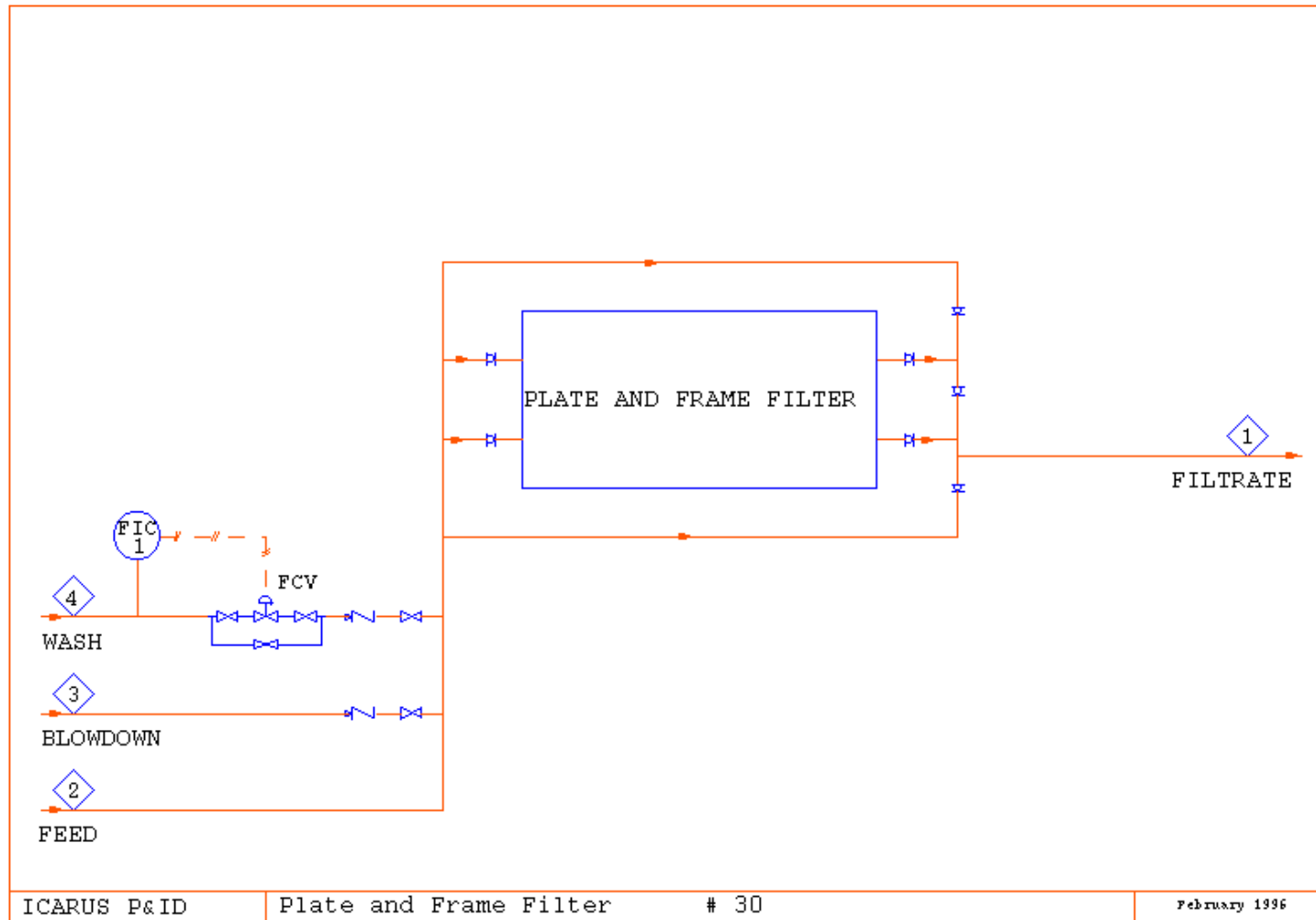
28 Particulate Scrubber



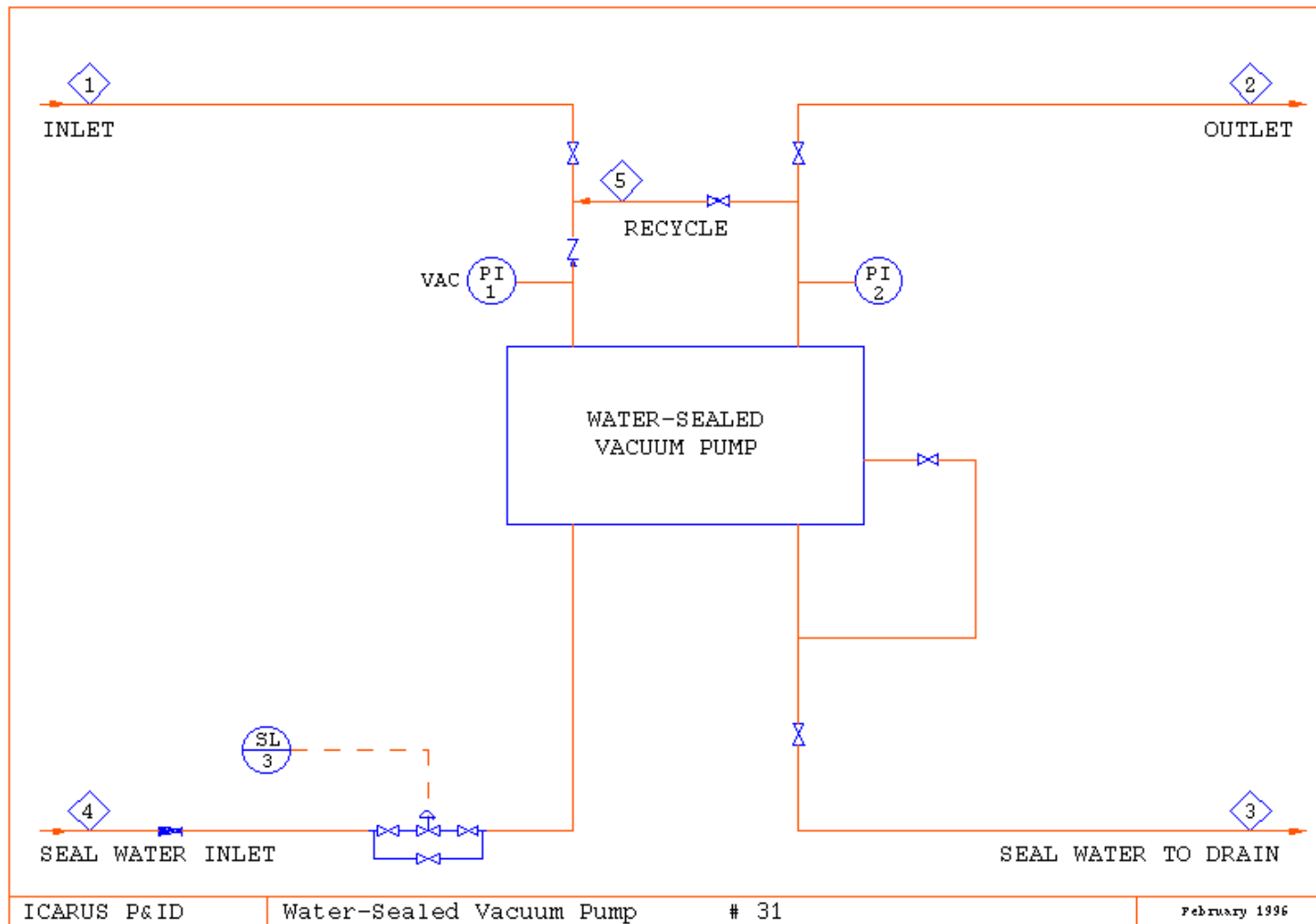
29 Screw Conveyor



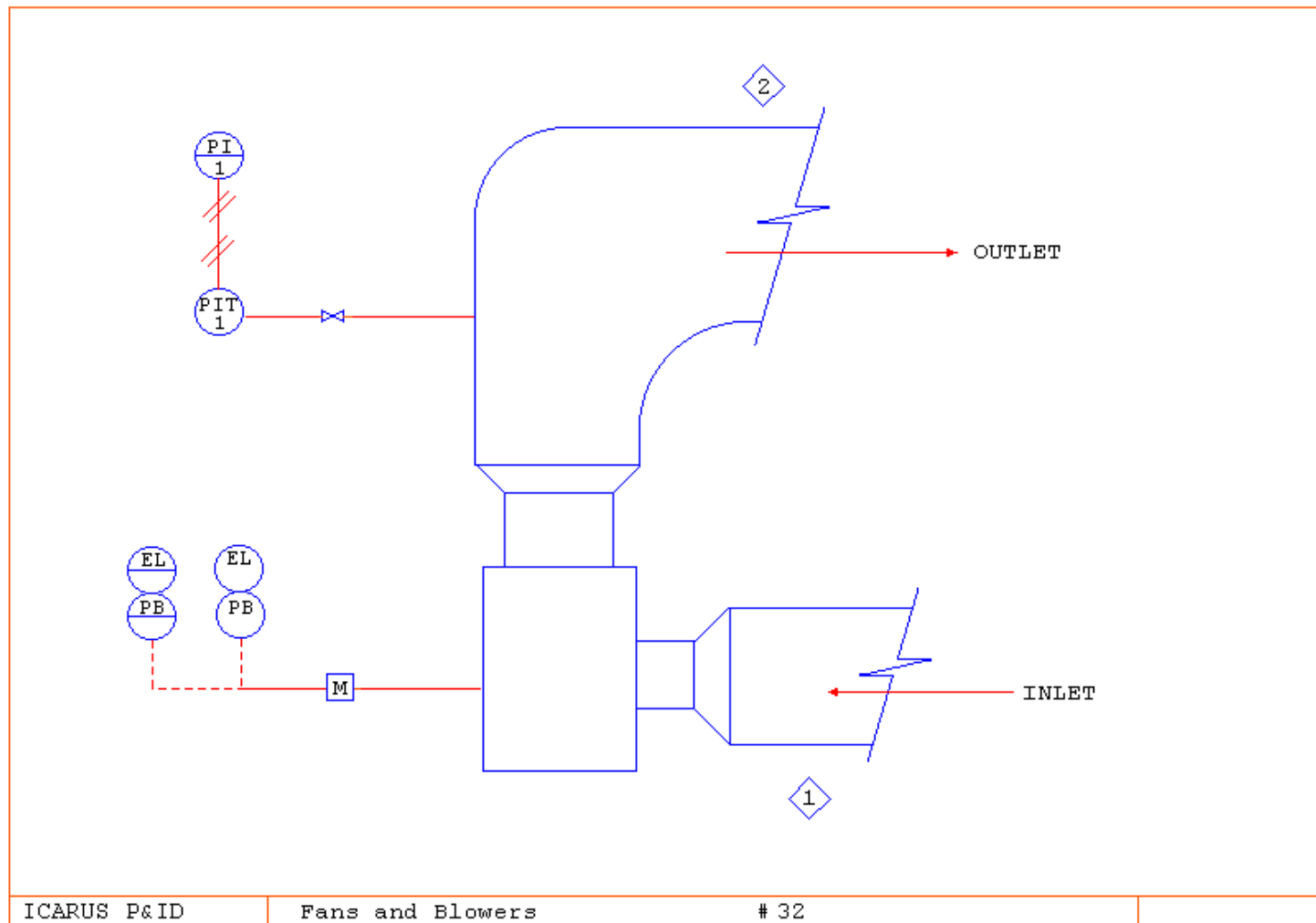
30 Plate and Frame Filter



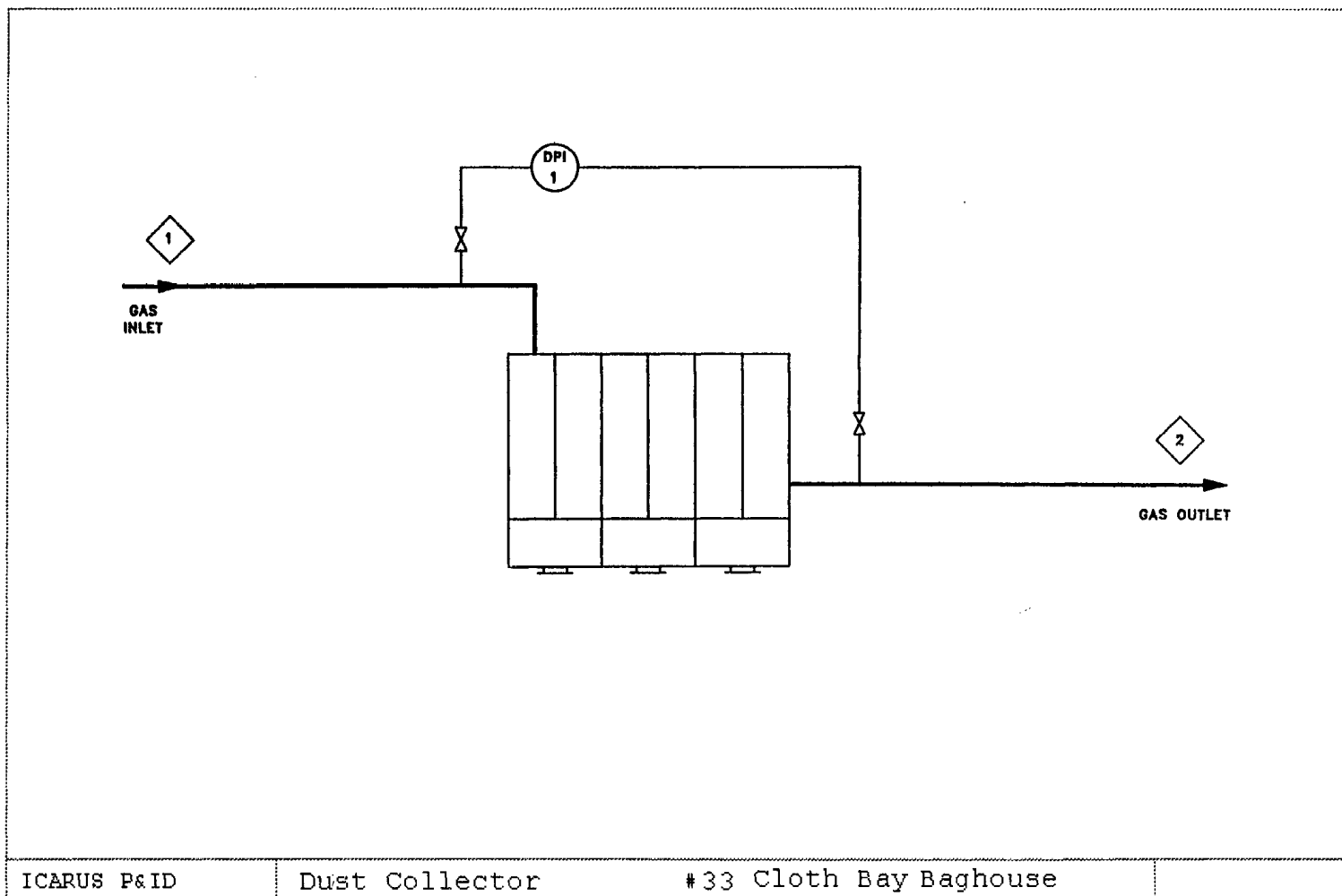
31 Water-Sealed Vacuum Pump



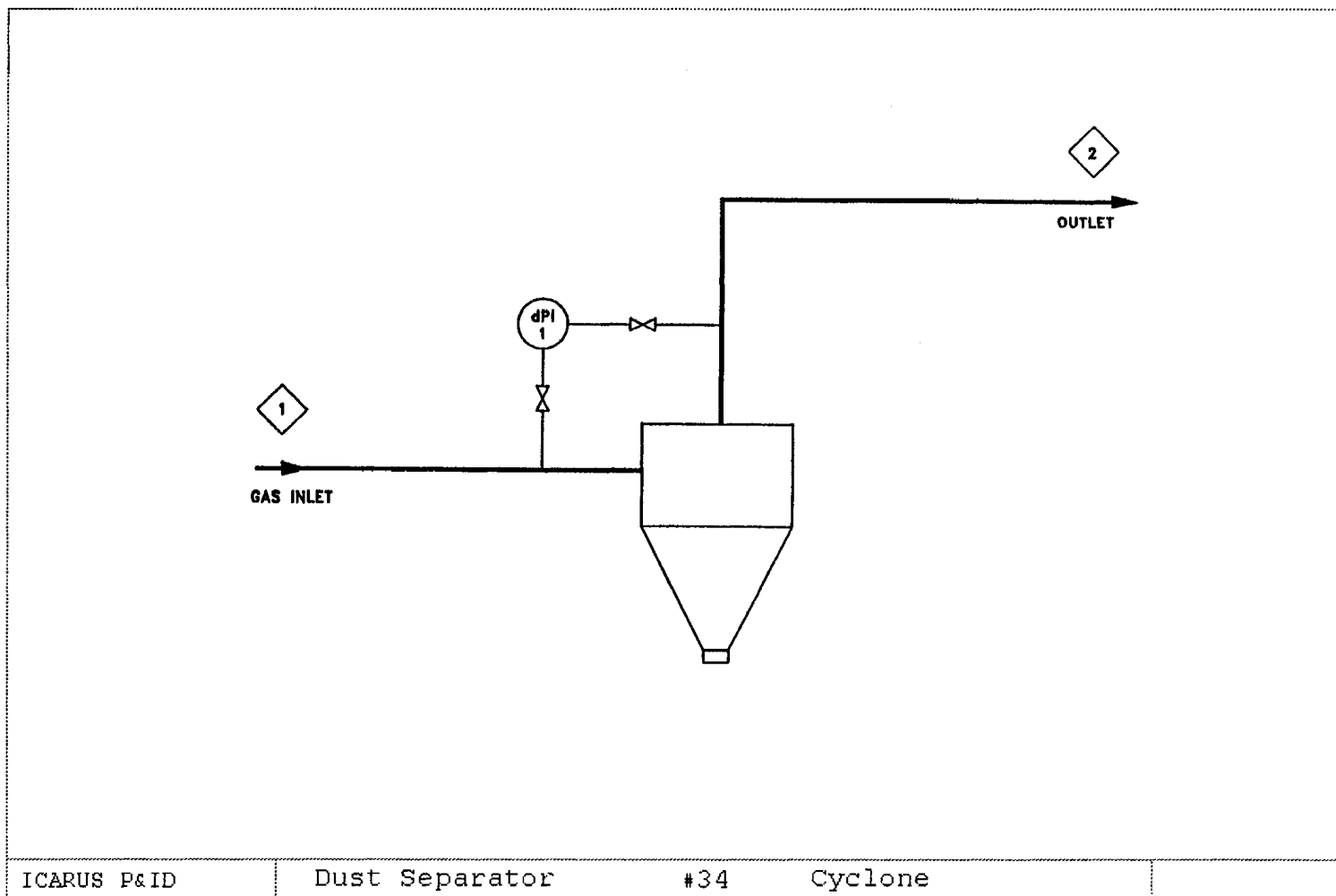
32 Fans and Blowers



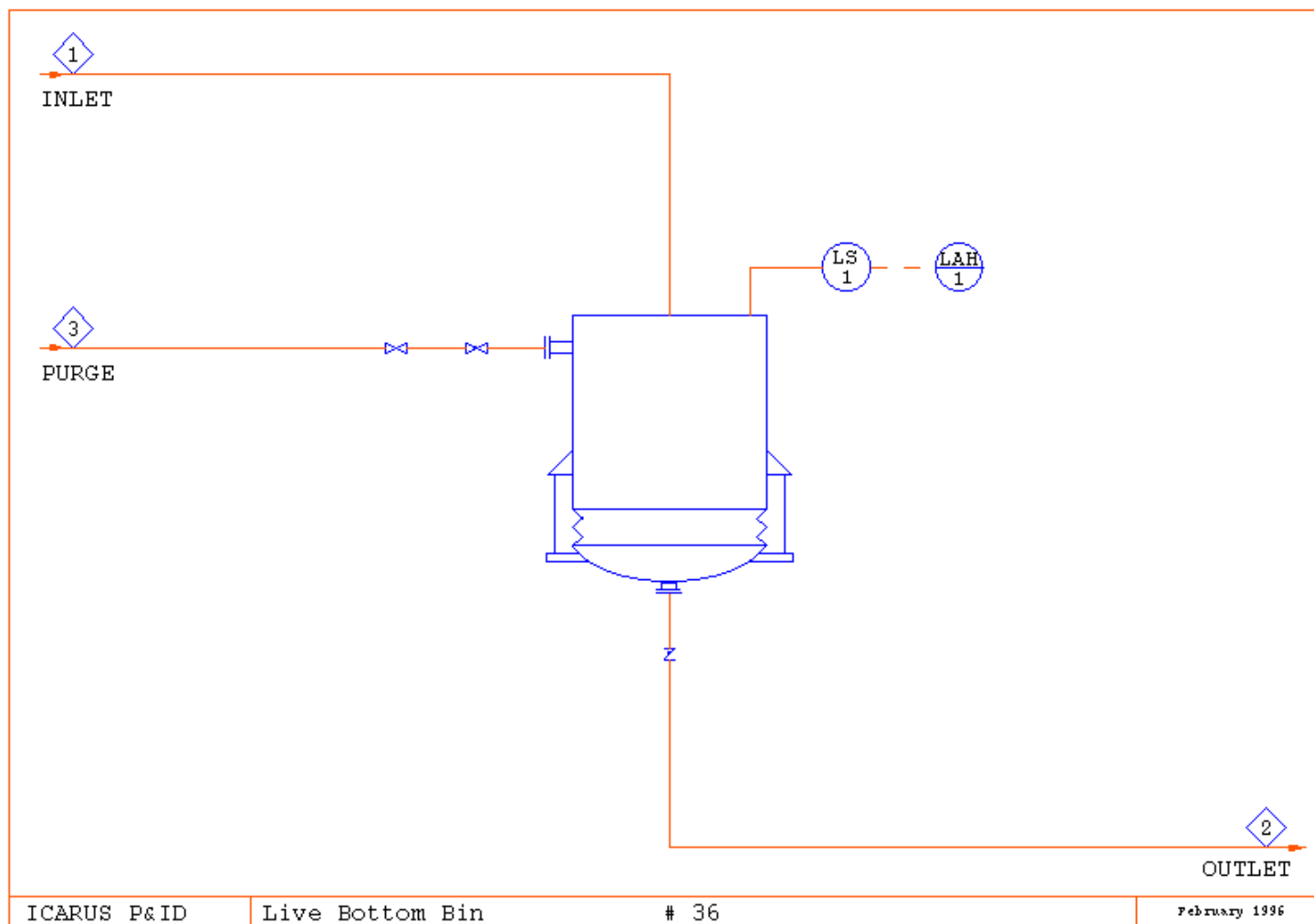
33 Cloth Bay Baghouse Dust Collector



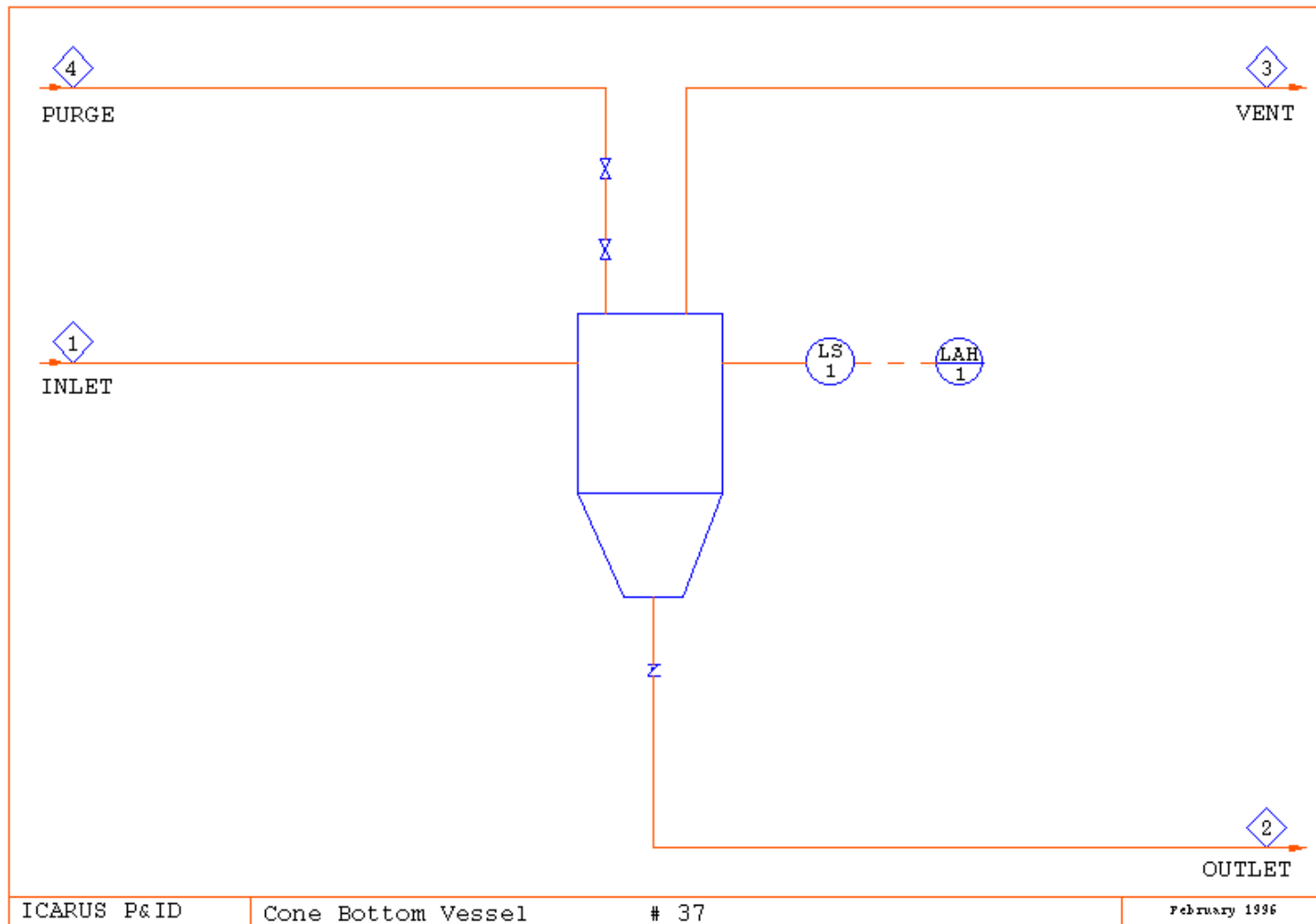
34 Cyclone Dust Collector



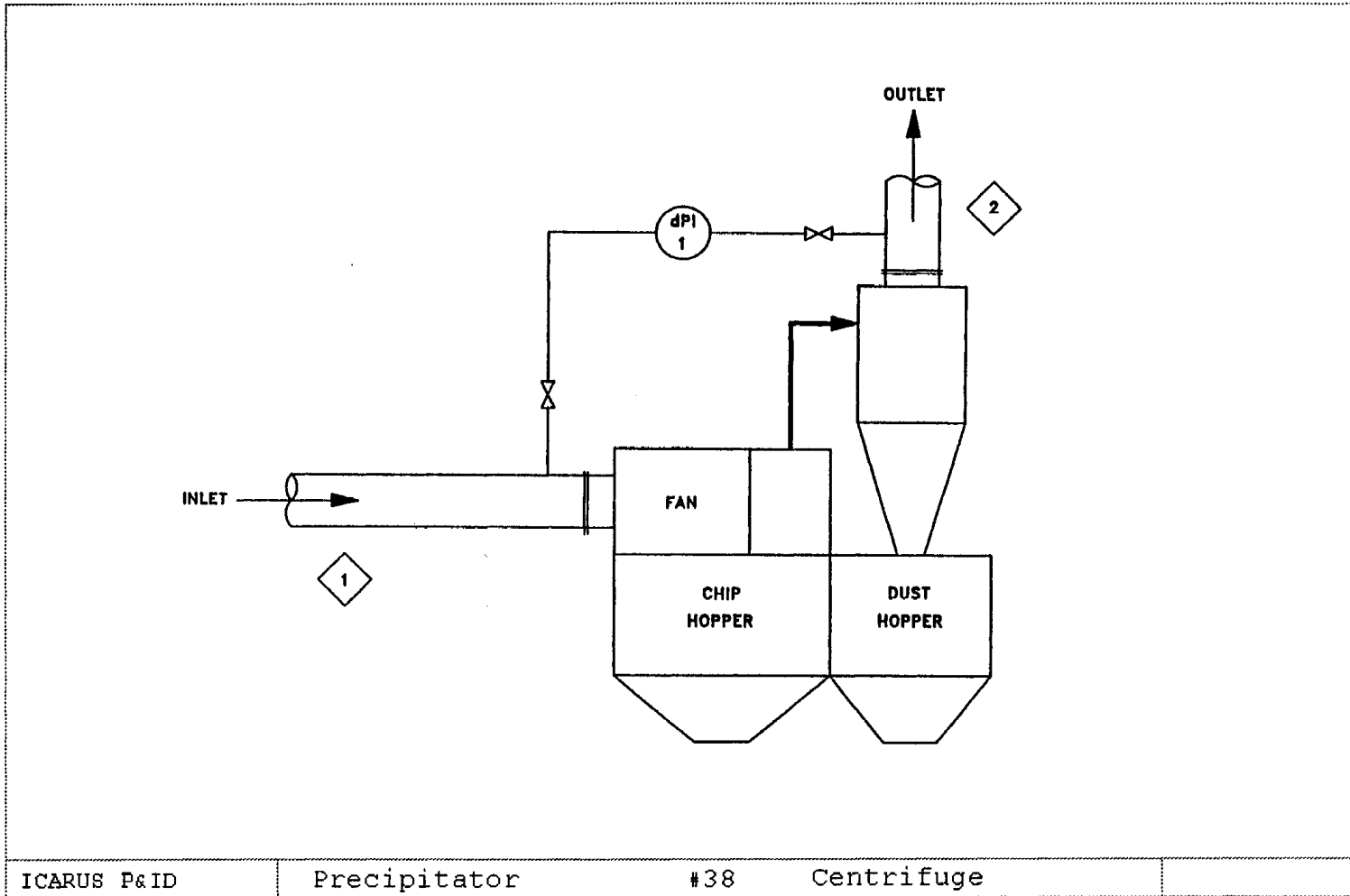
36 Live Bottom Bin



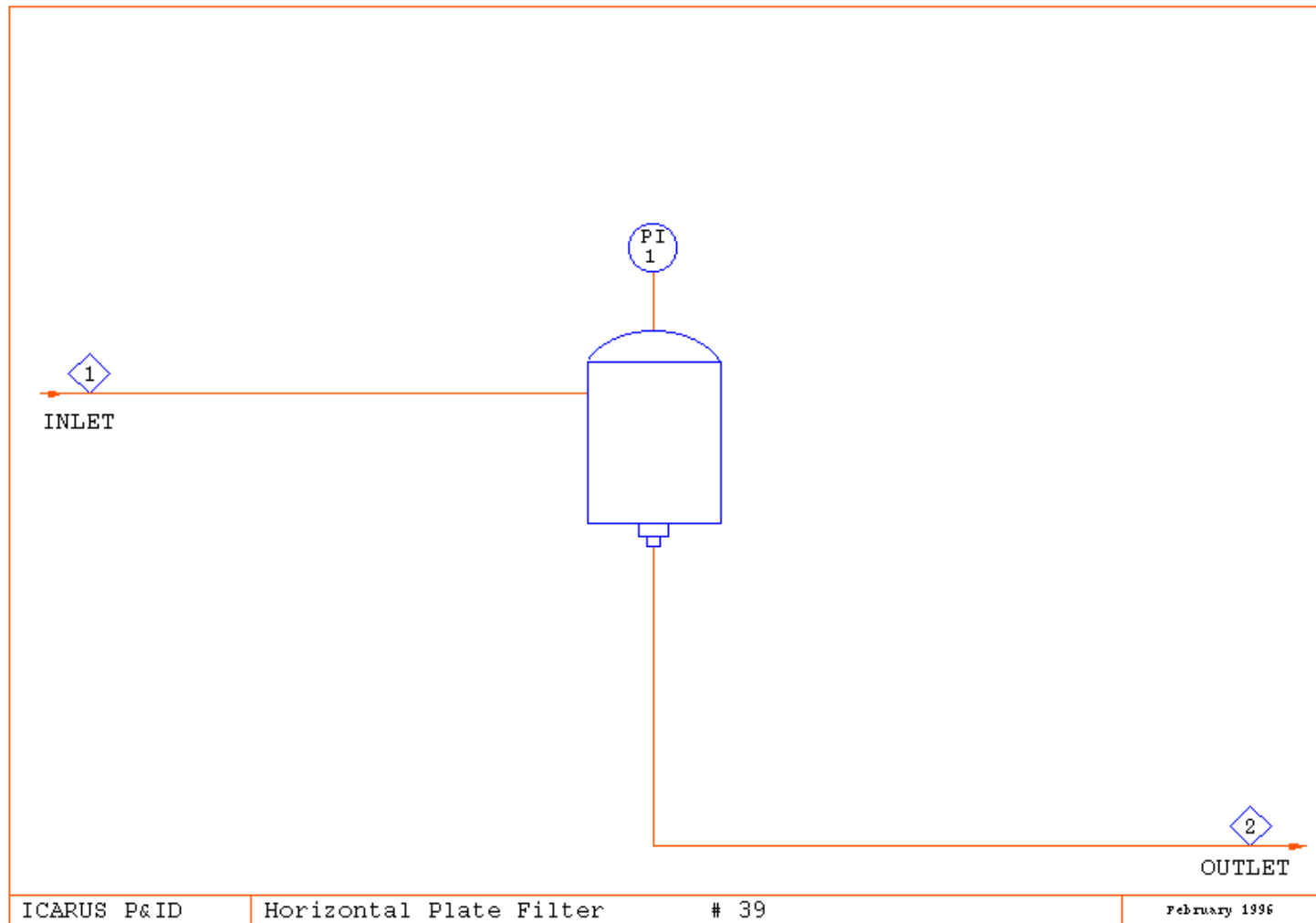
37 Cone Bottom Vessel



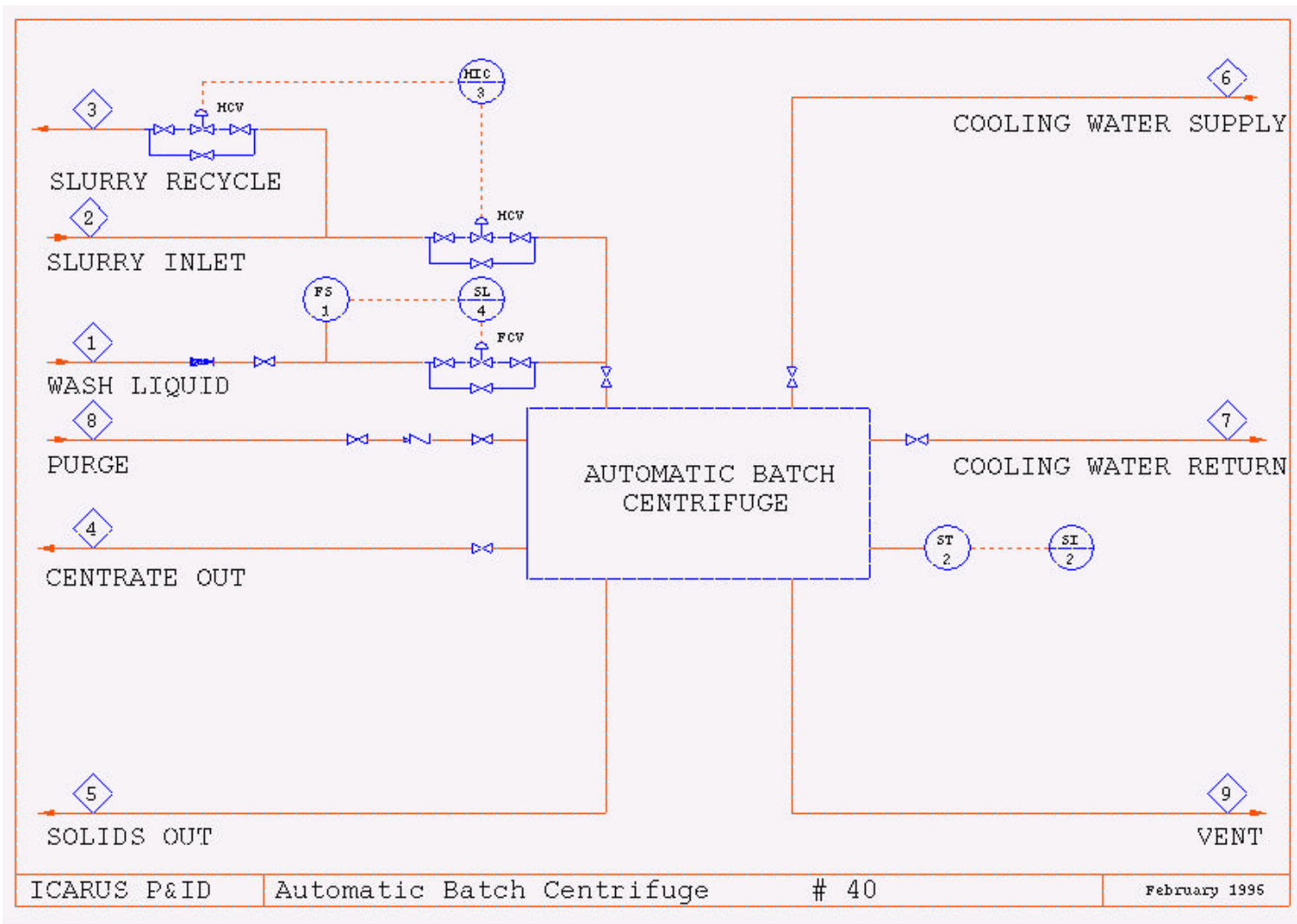
38 Centrifuge Precipitator



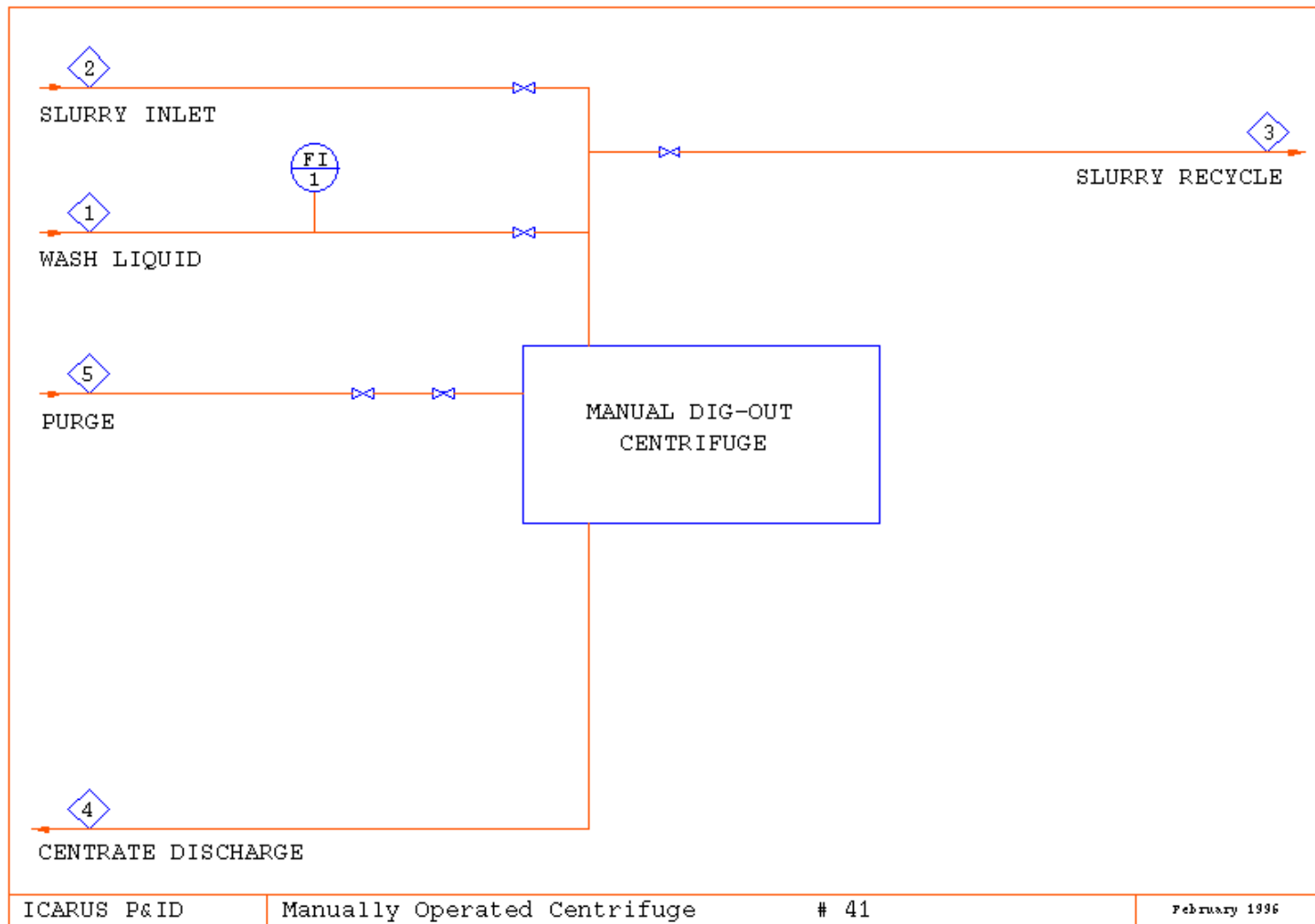
39 Horizontal Plate Filter



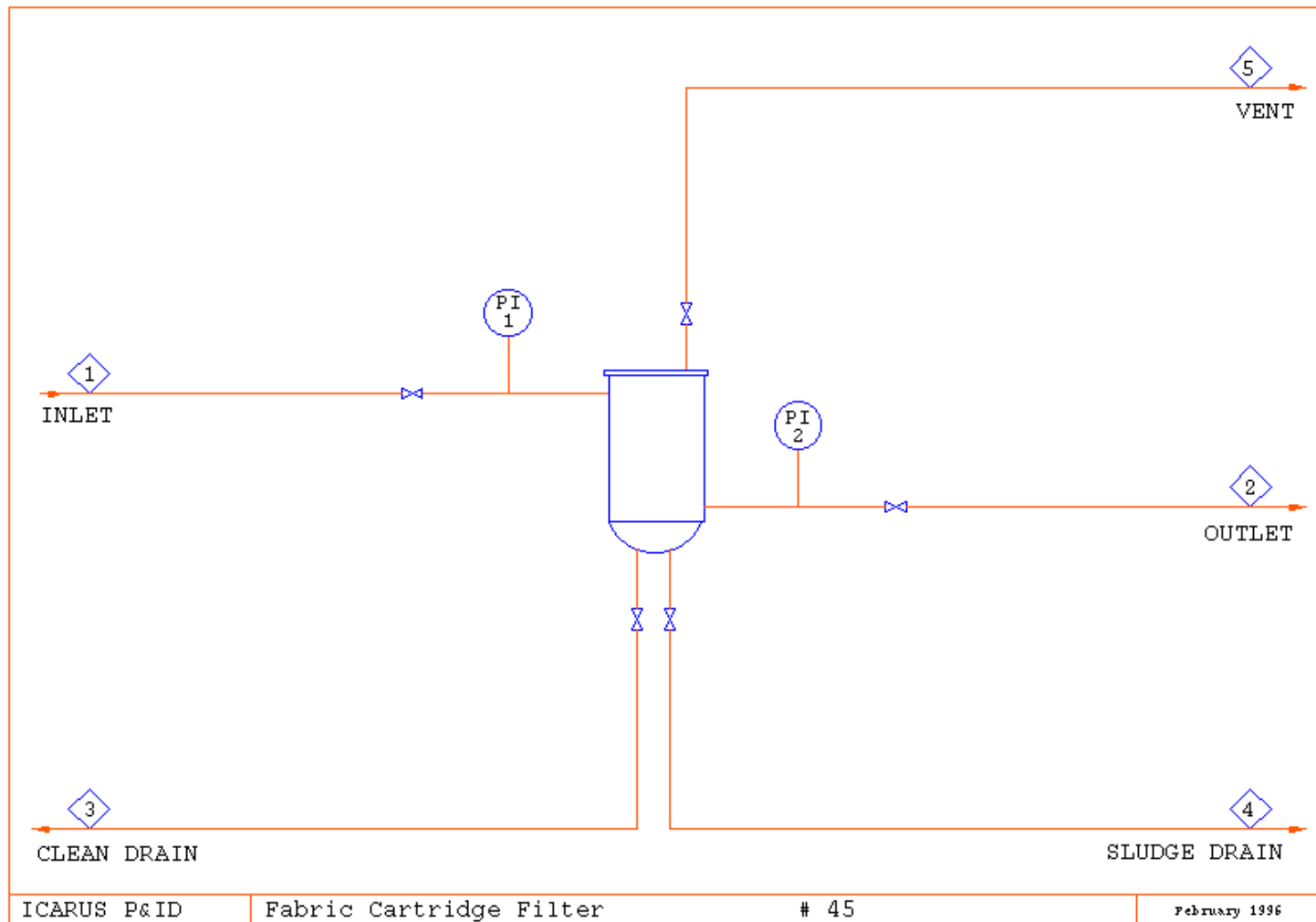
40 Automatic Batch Centrifuge



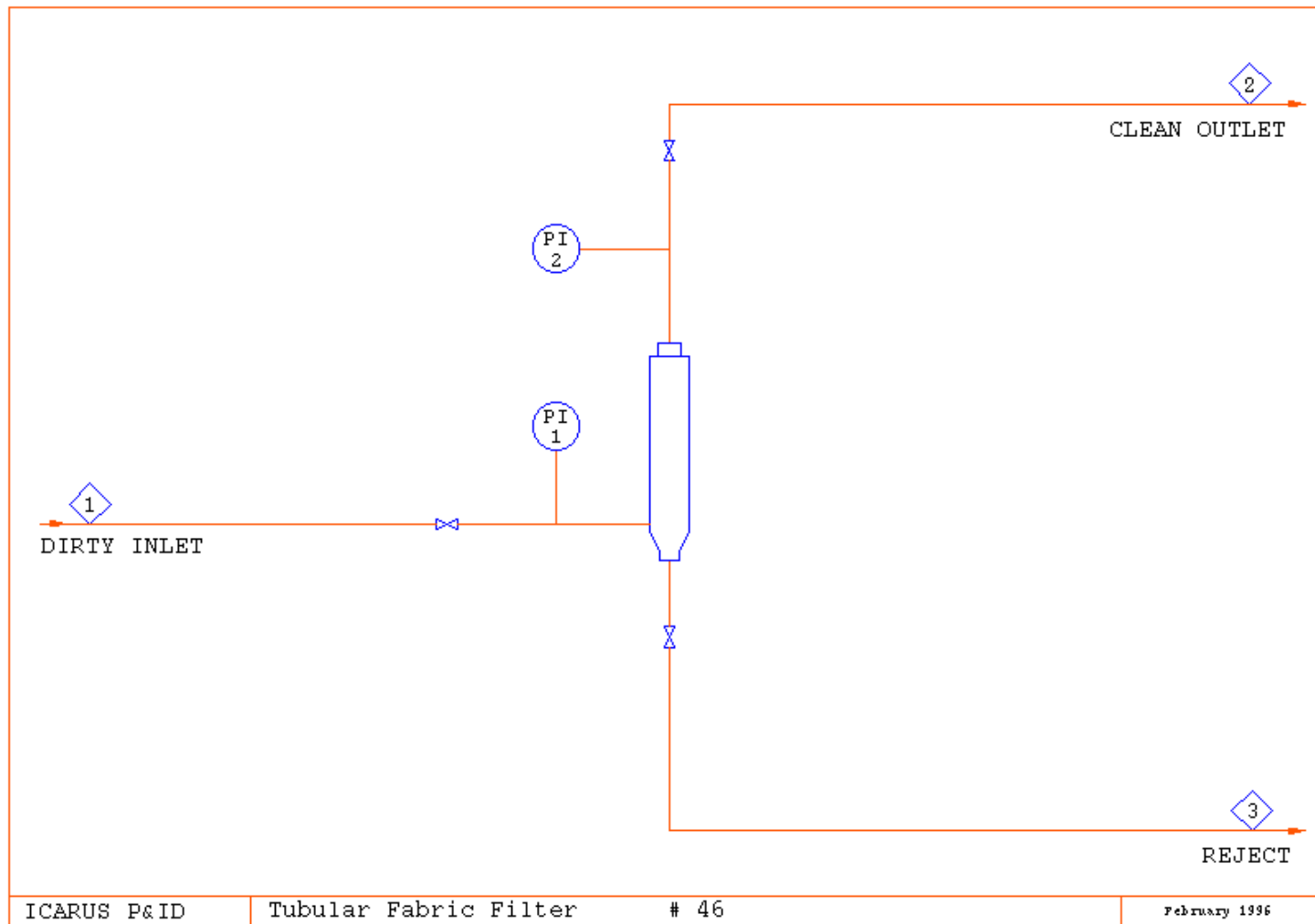
41 Manually Operated Centrifuge



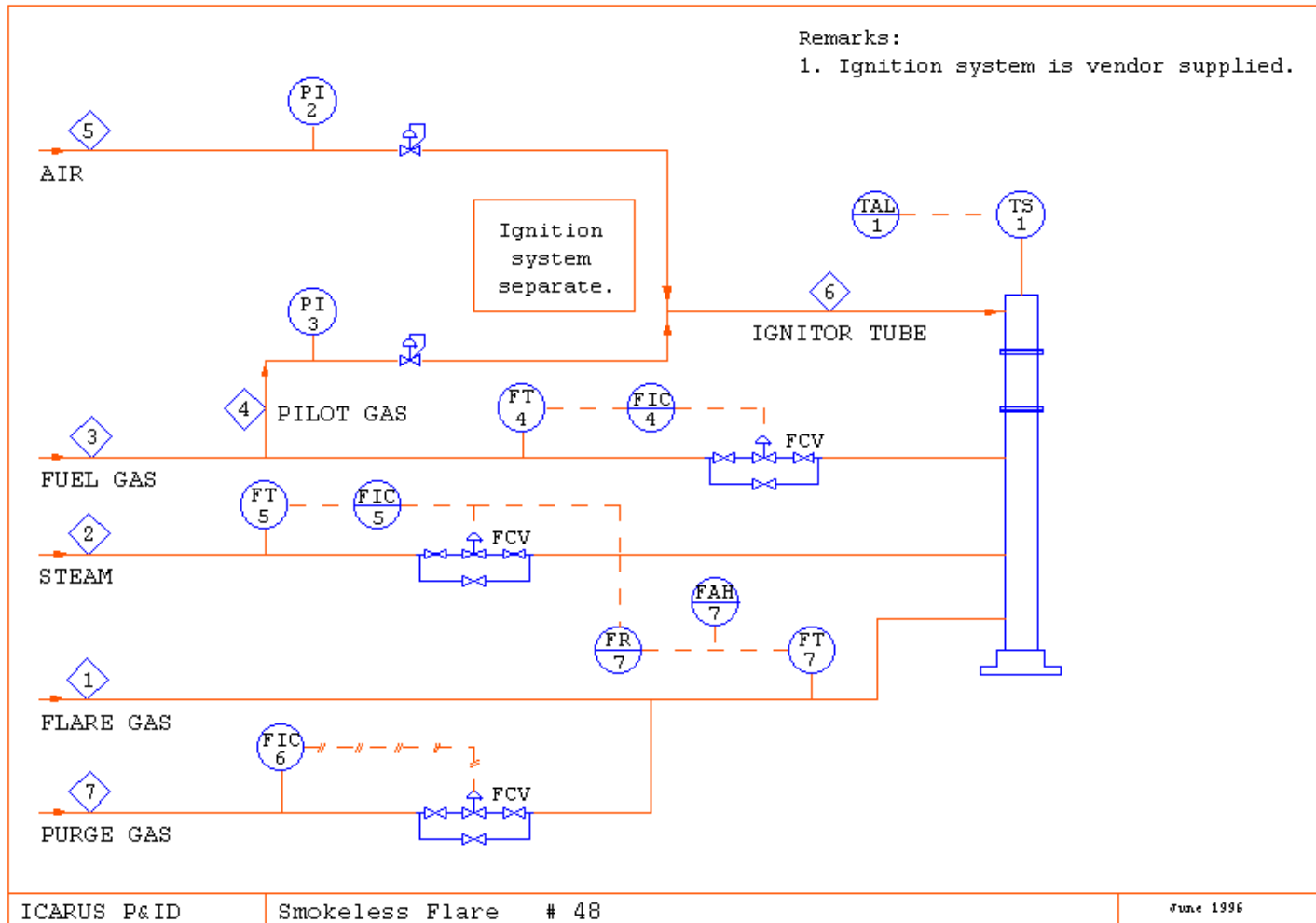
45 Fabric Cartridge Filter



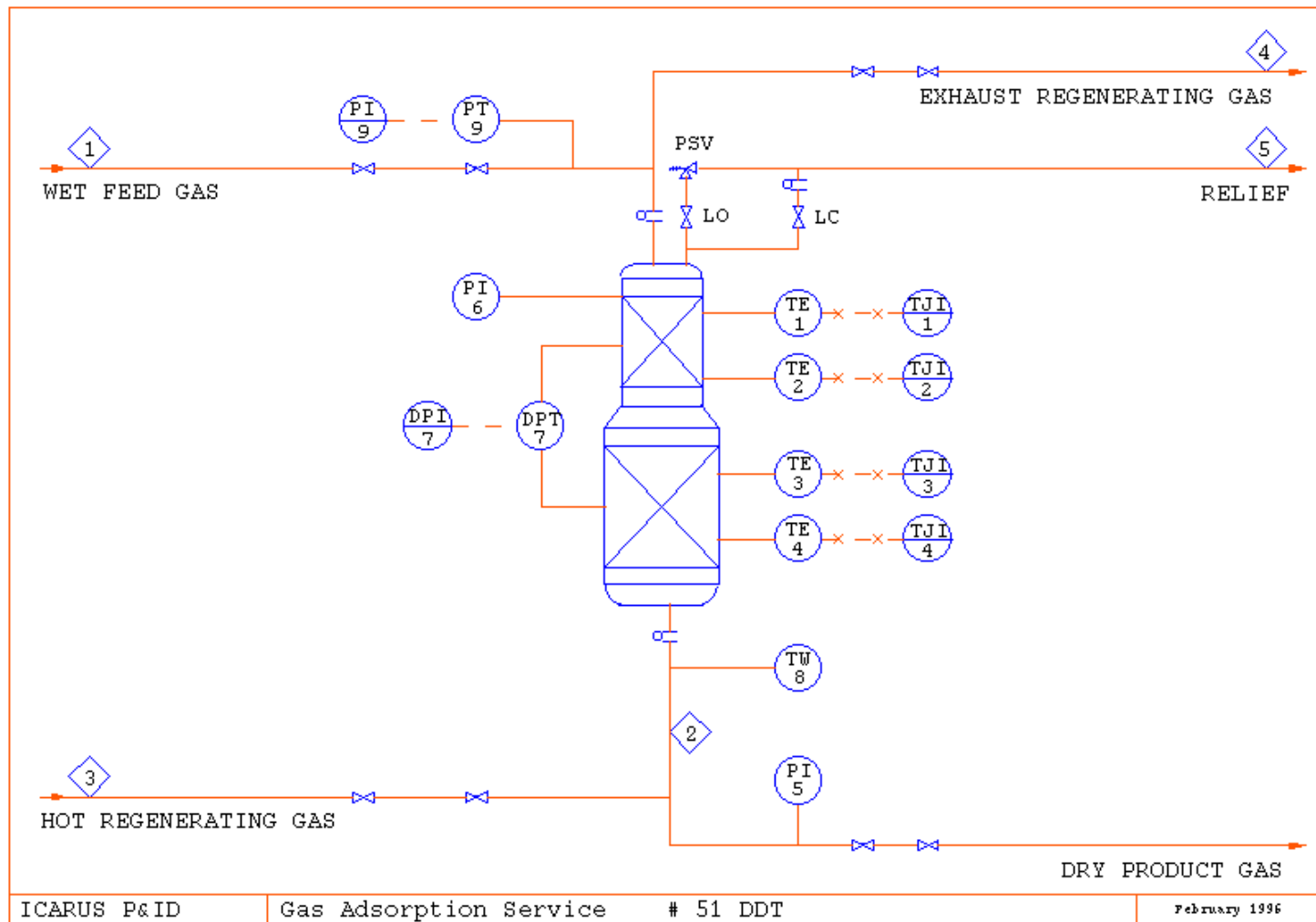
46 Tubular Fabric Filter



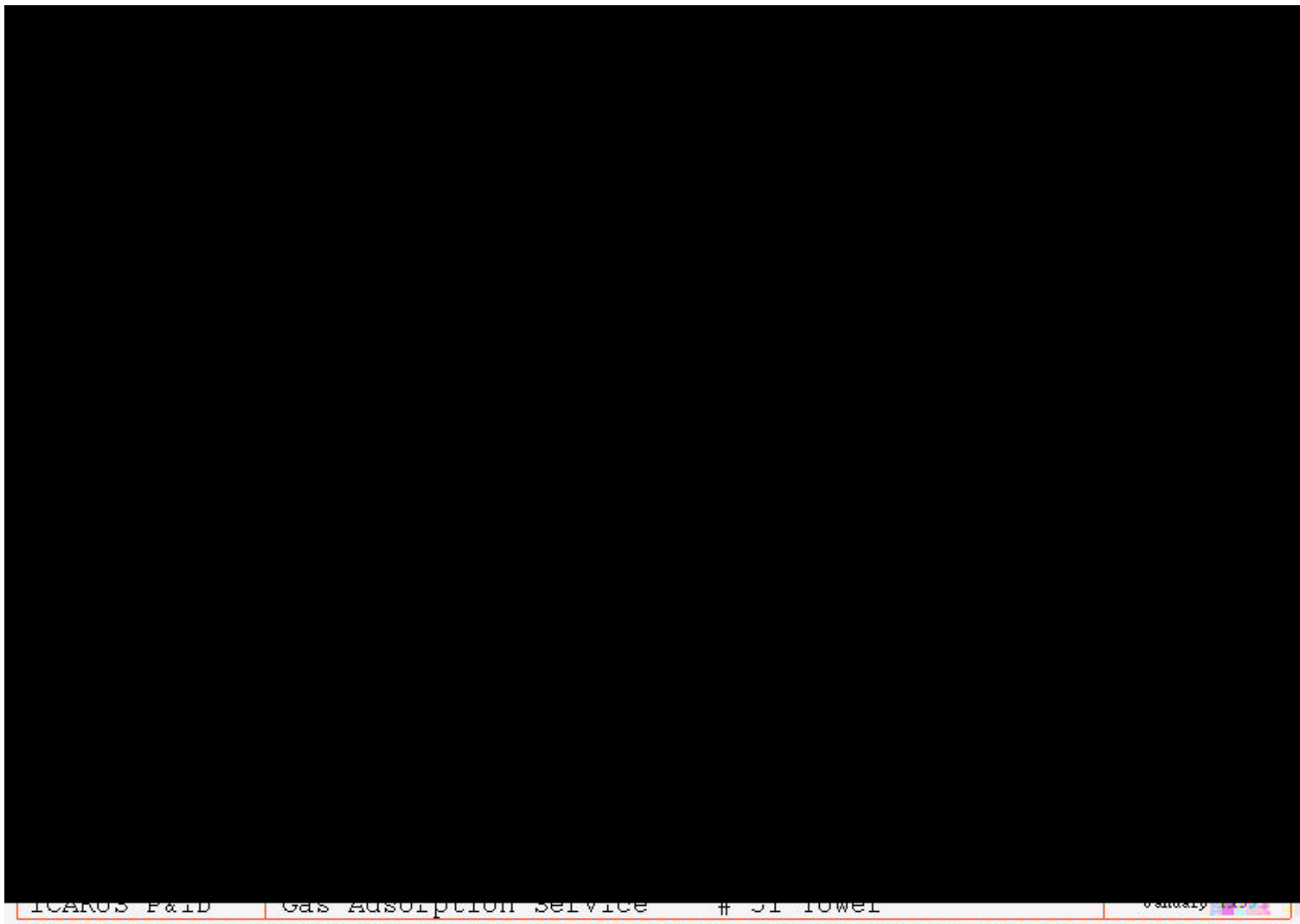
48 Smokeless Flare



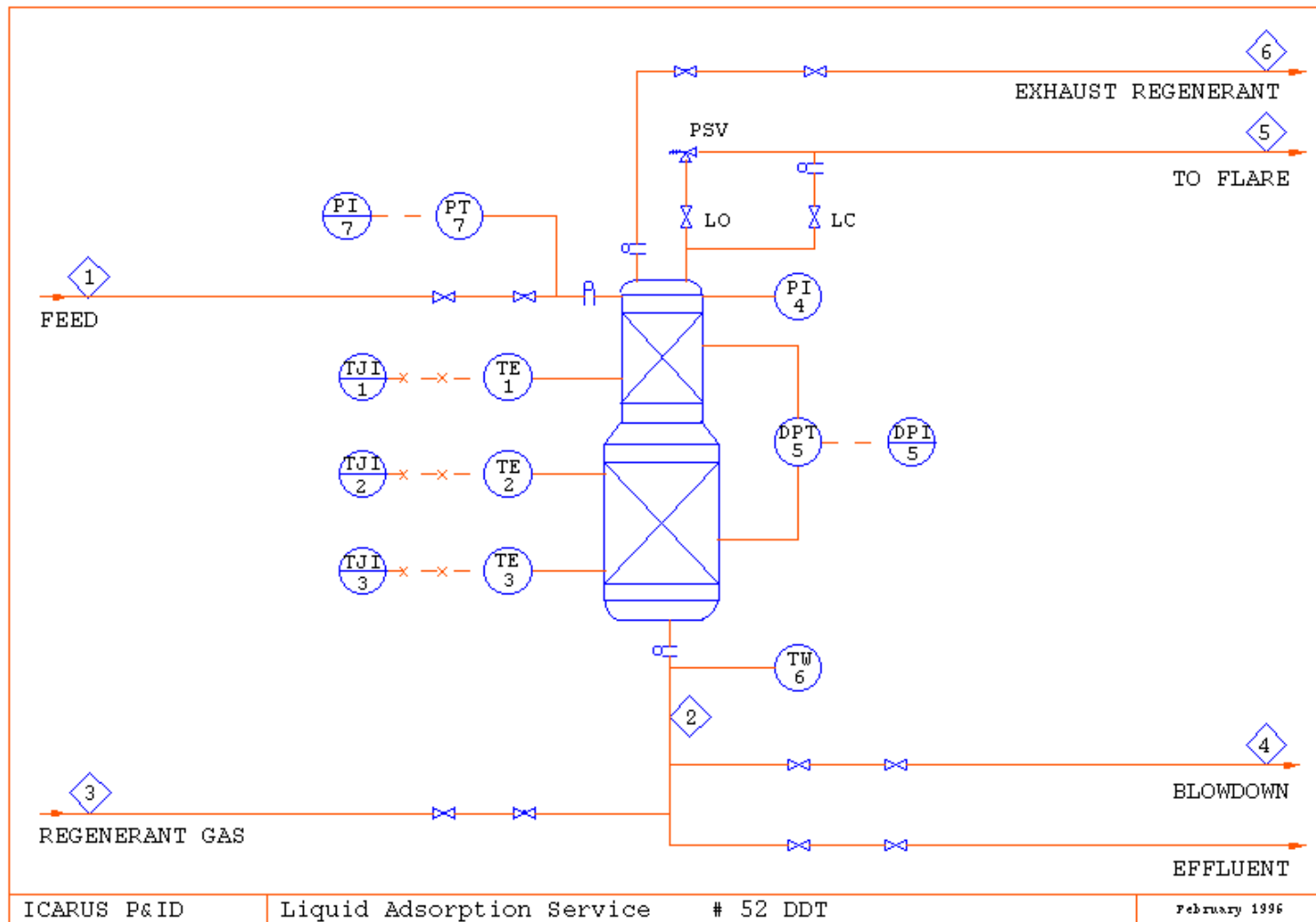
51 DDT – Gas Adsorption Service



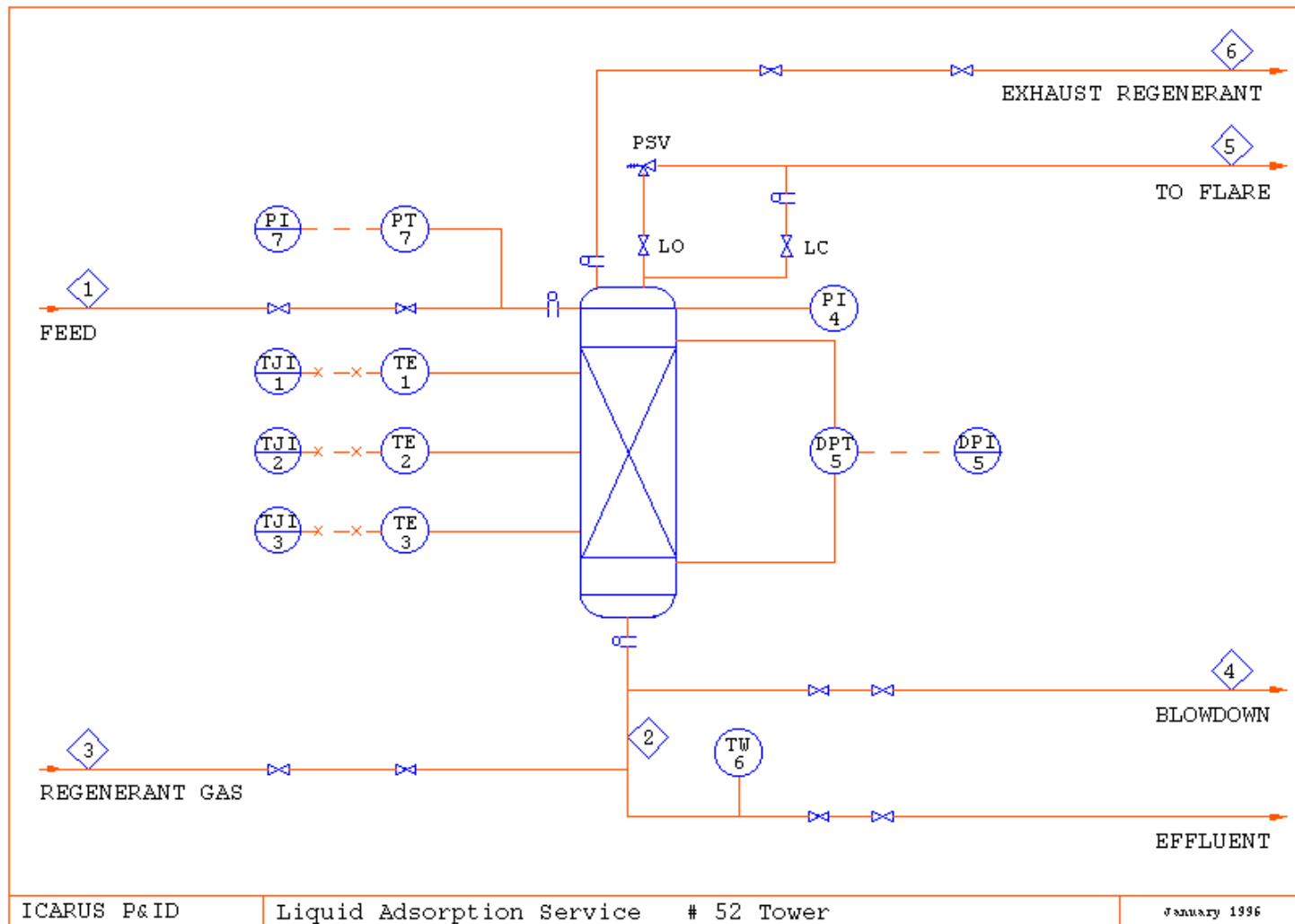
51 Tower – Gas Adsorption Service



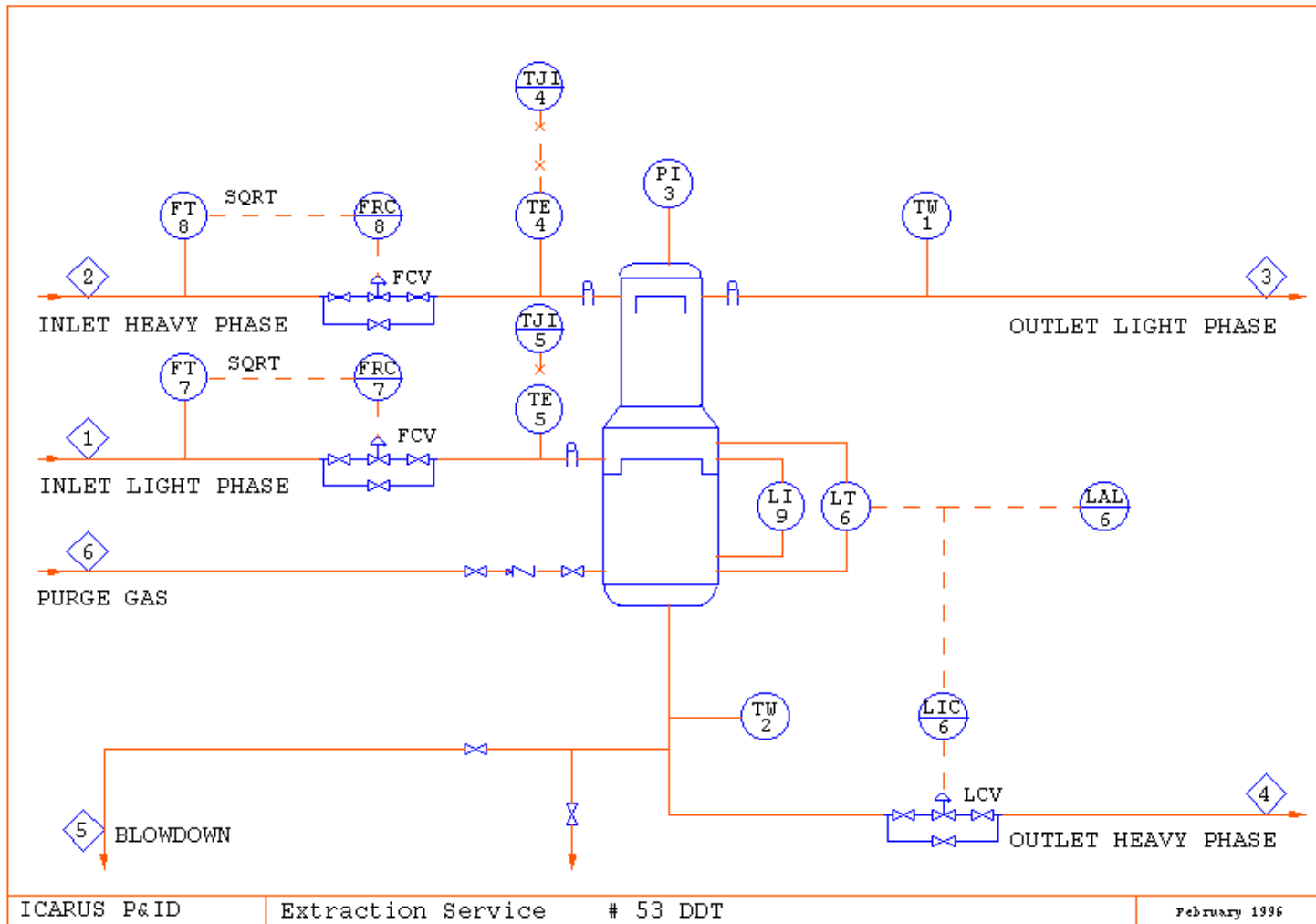
52 DDT – Liquid Adsorption Service



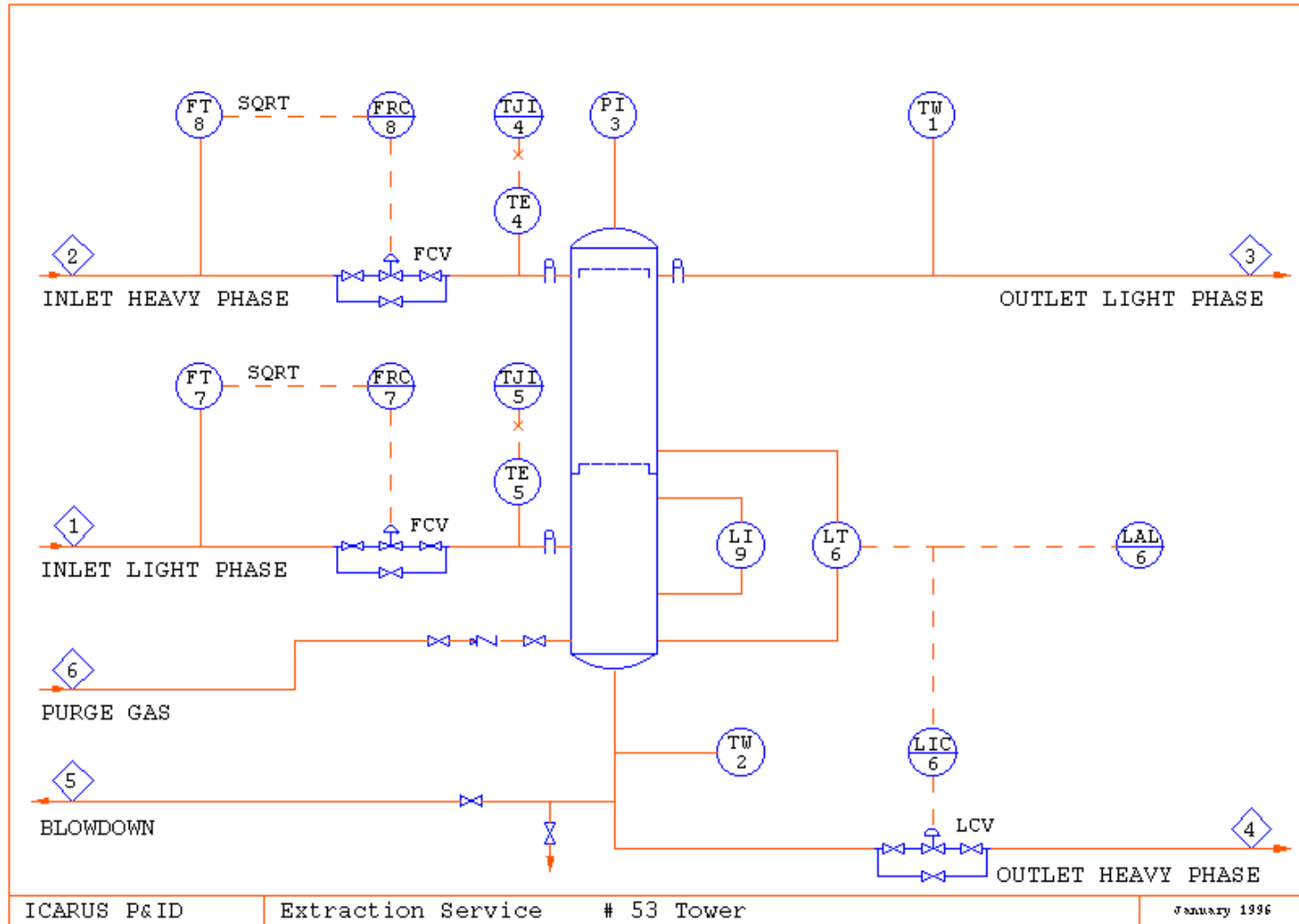
52 Tower – Liquid Adsorption Service



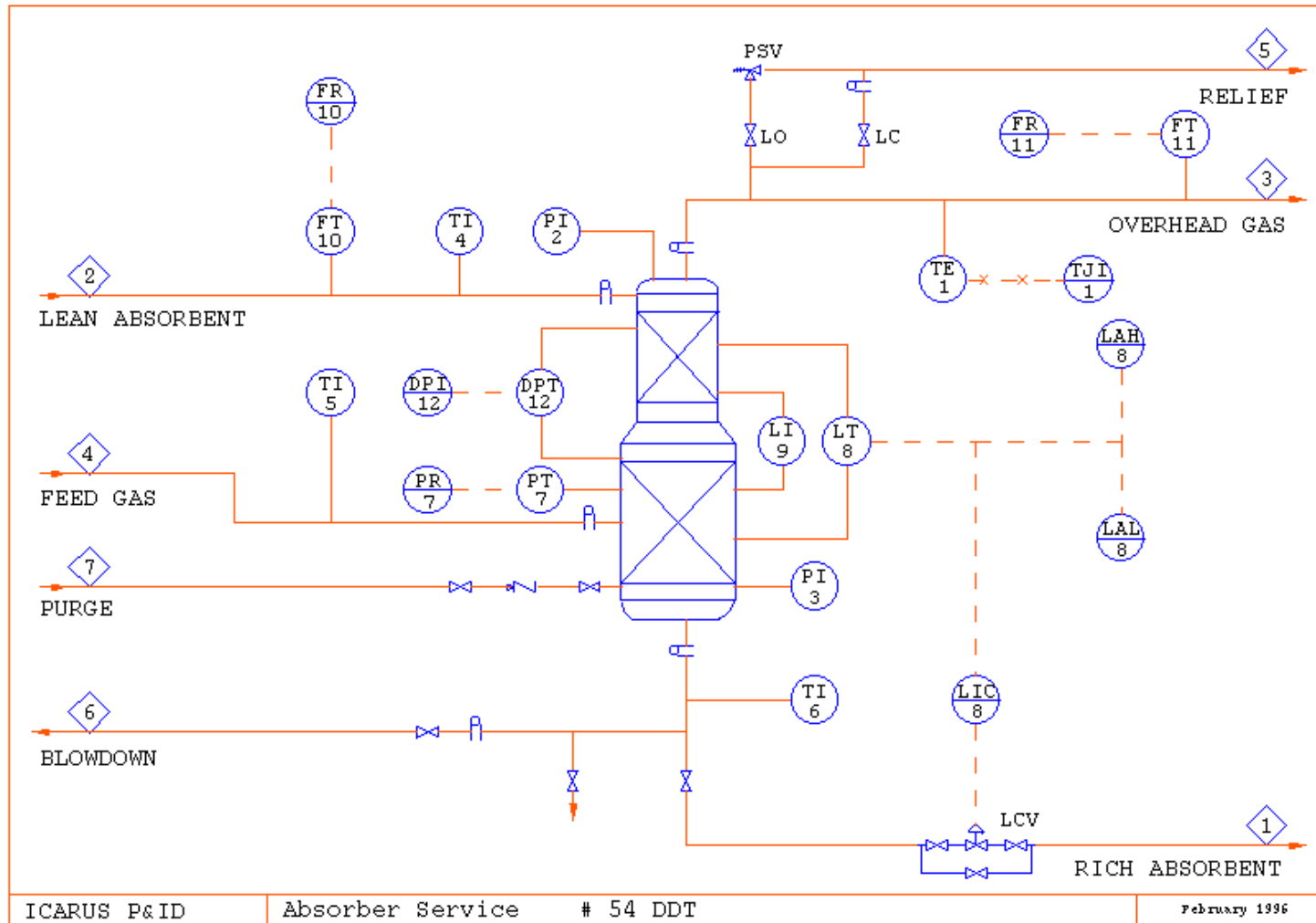
53 DDT – Extraction Service



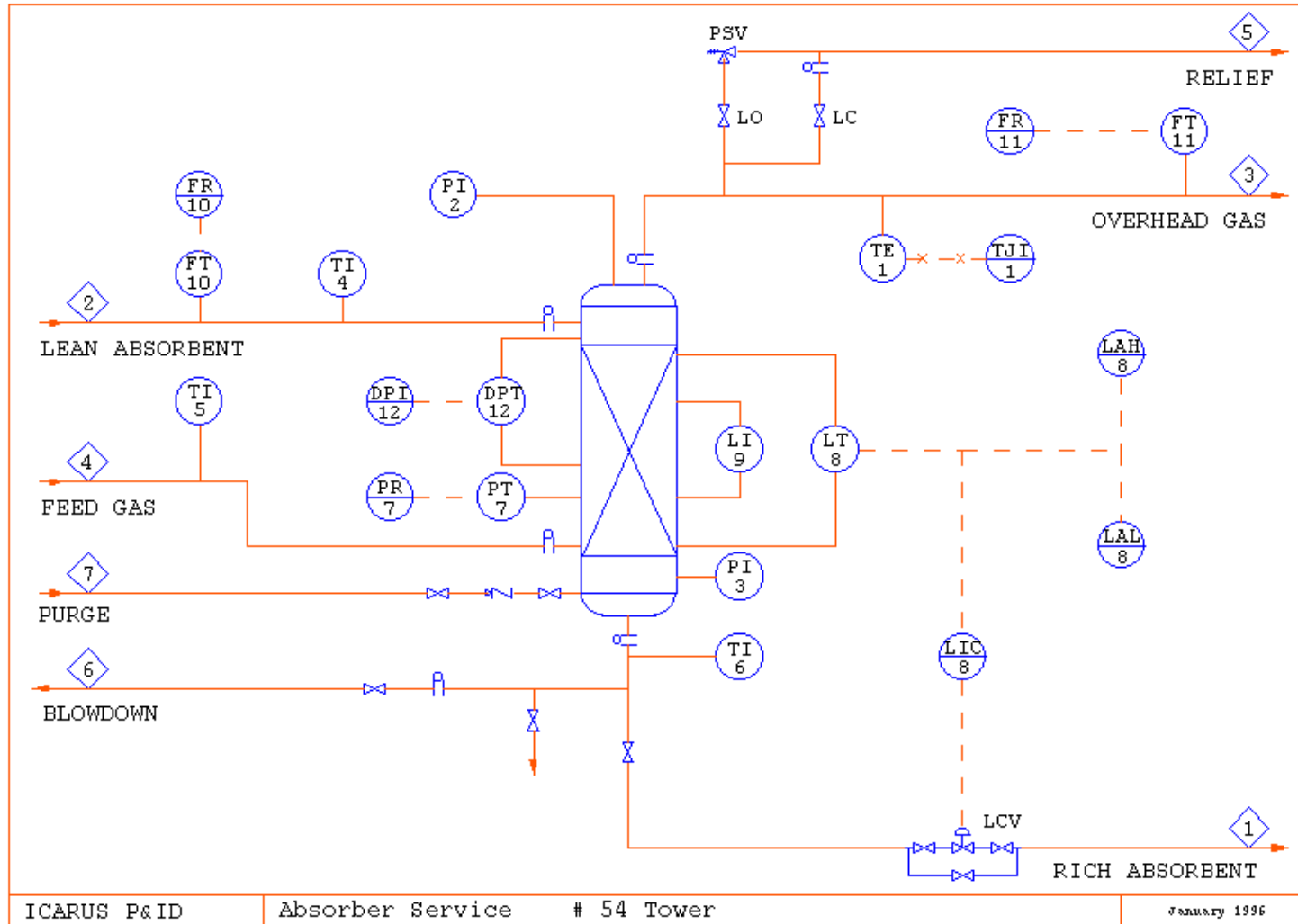
53 Tower – Extraction Service



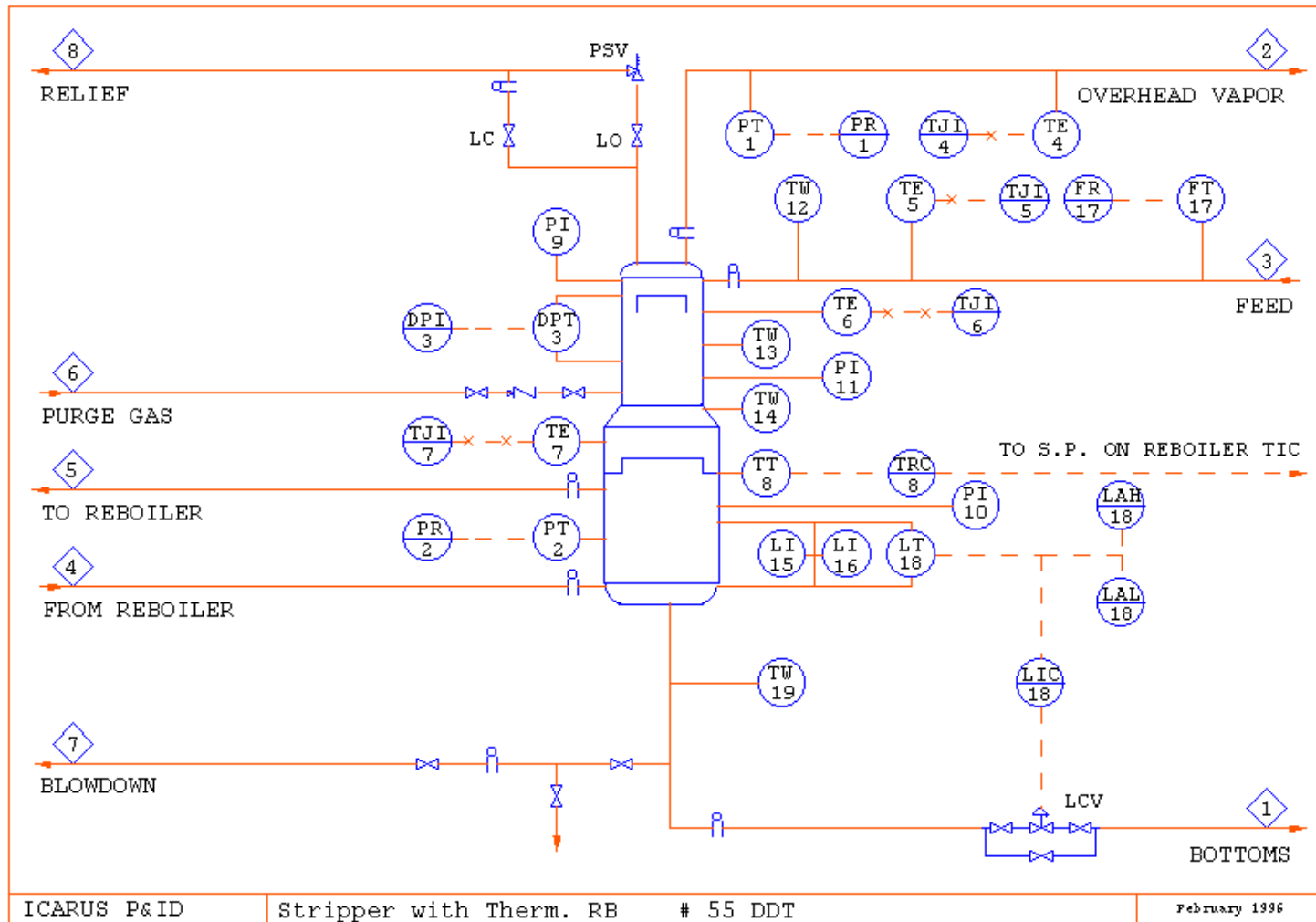
54 DDT – Absorber Service



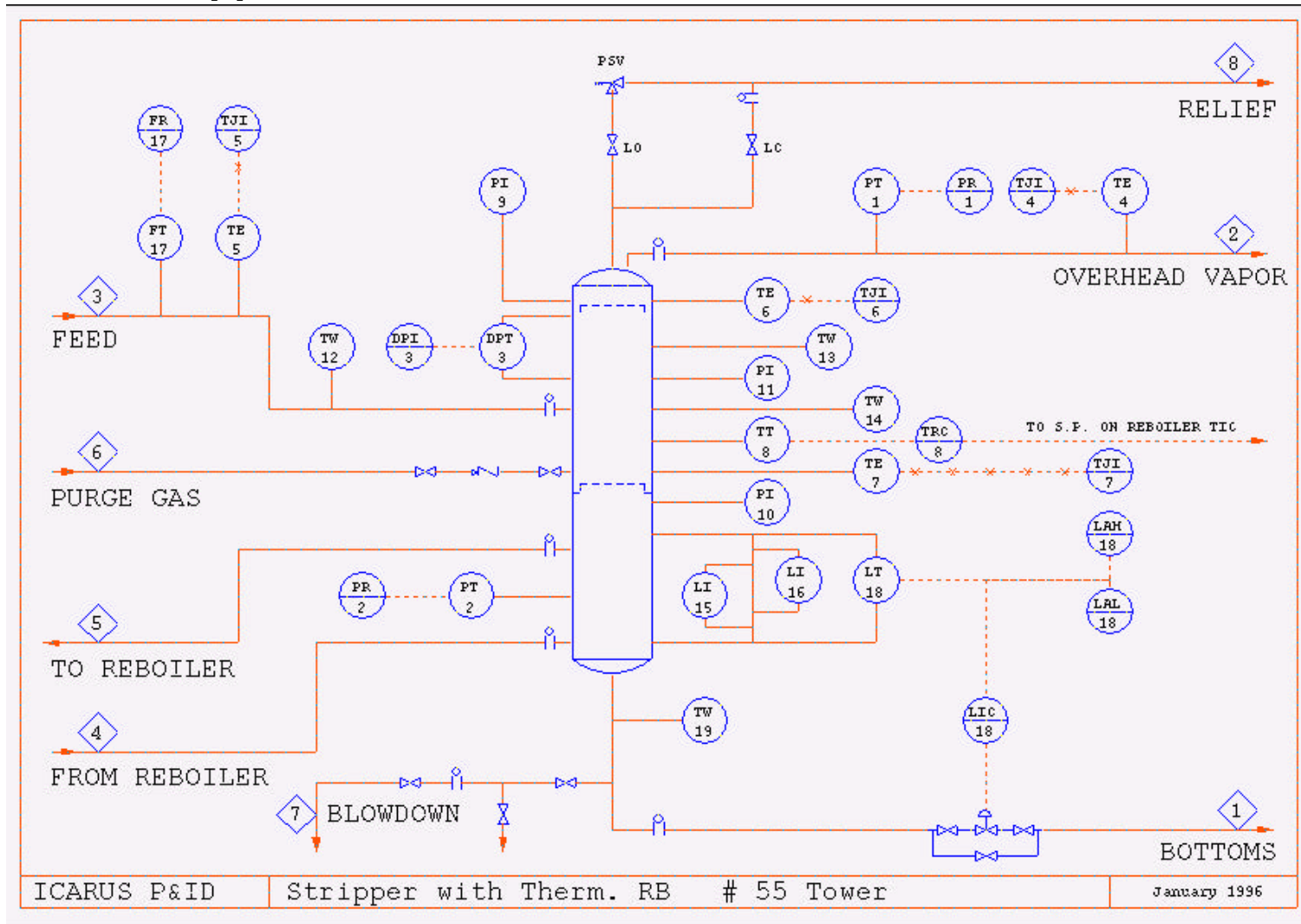
54 Tower – Absorber Service



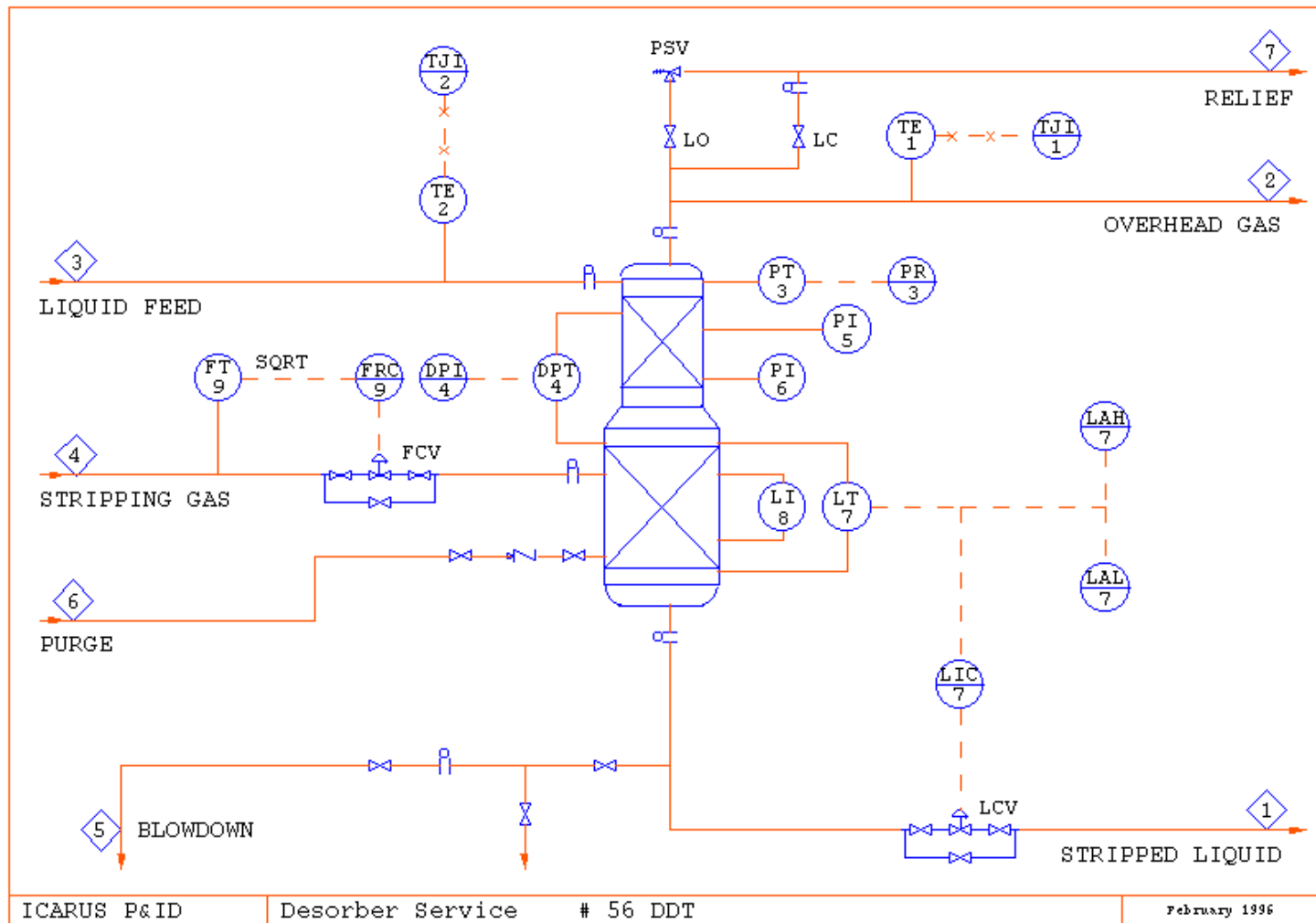
55 DDT – Stripper with Therm. RB



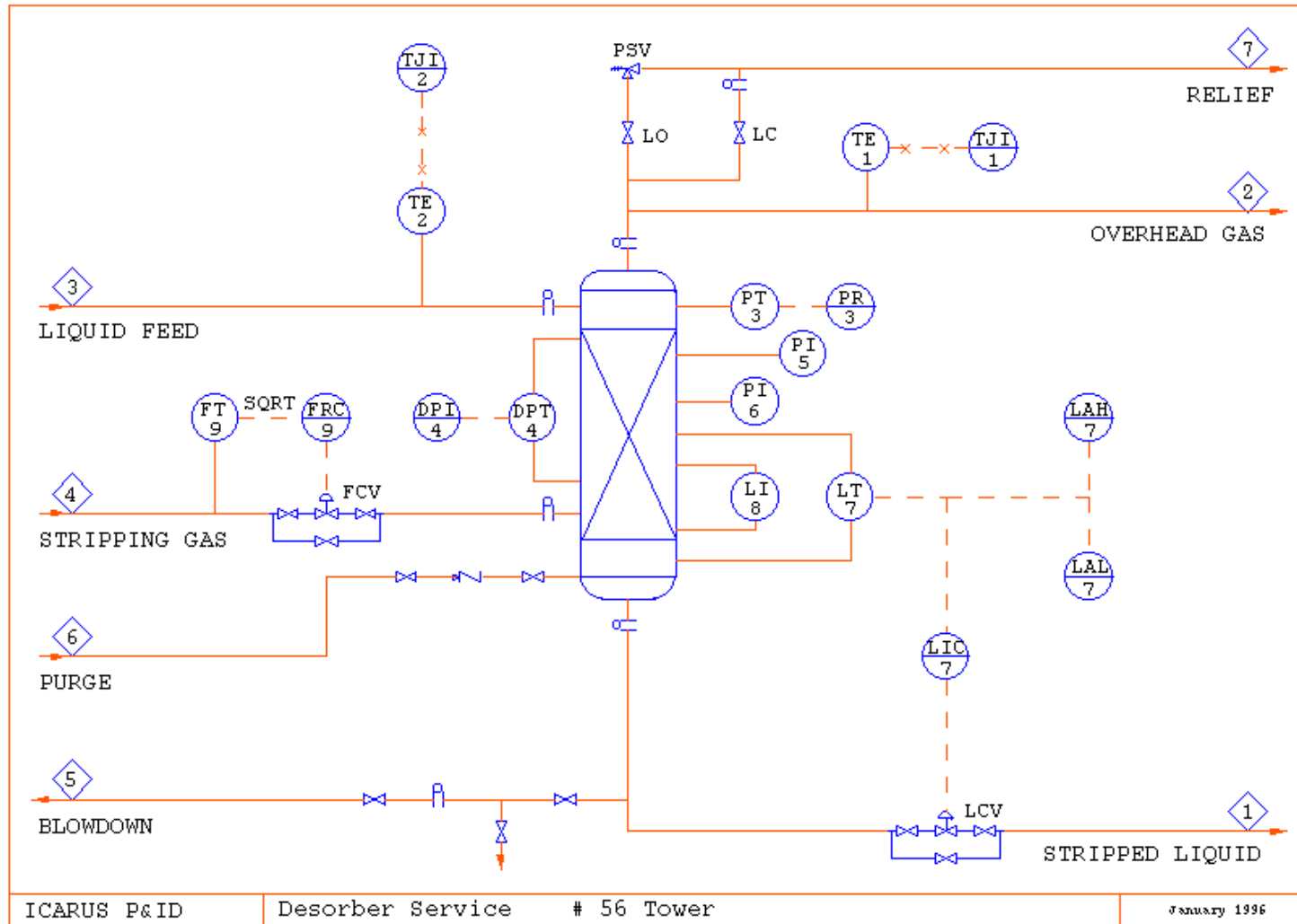
55 Tower – Stripper with Therm. RB



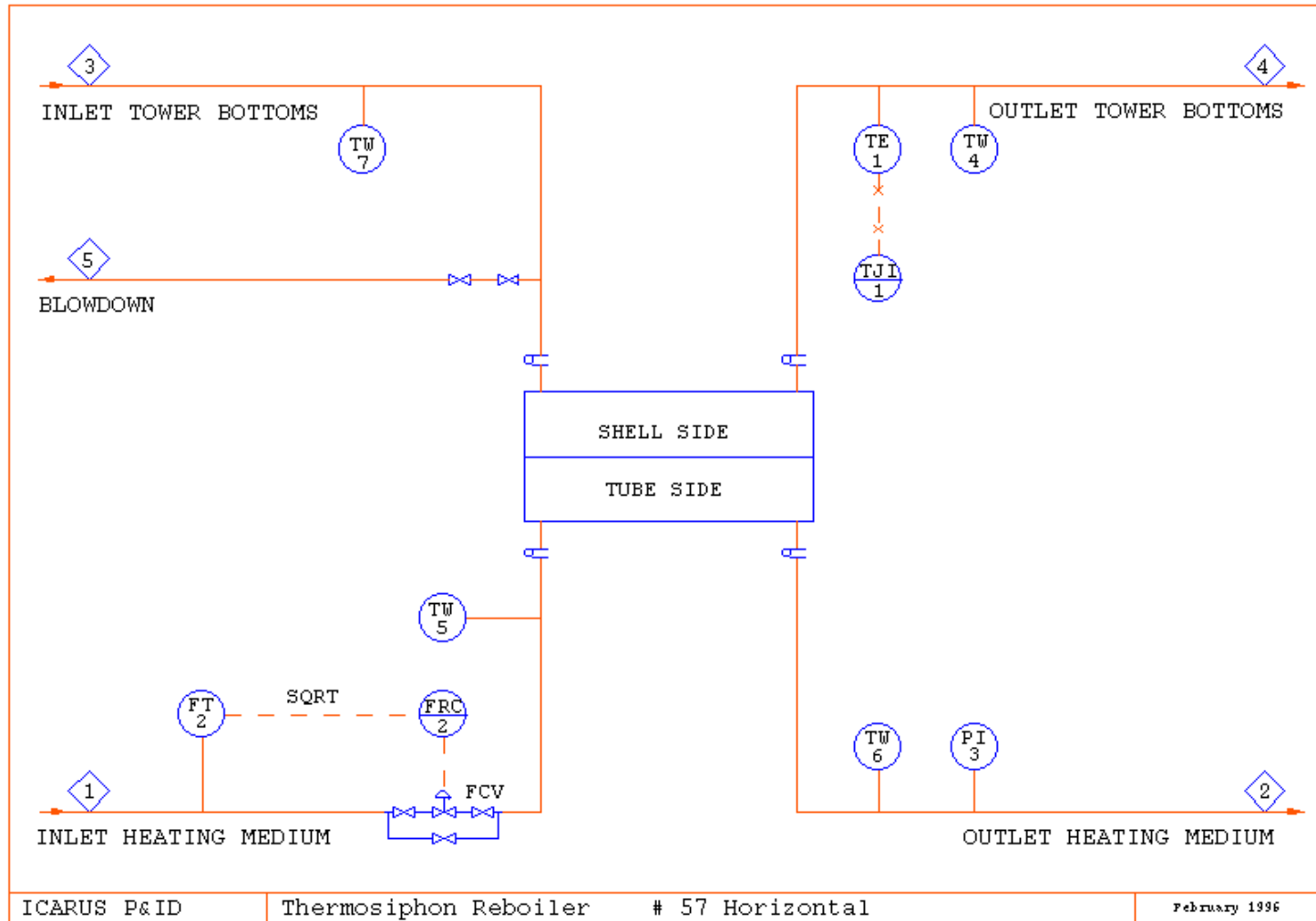
56 DDT – Desorber Service



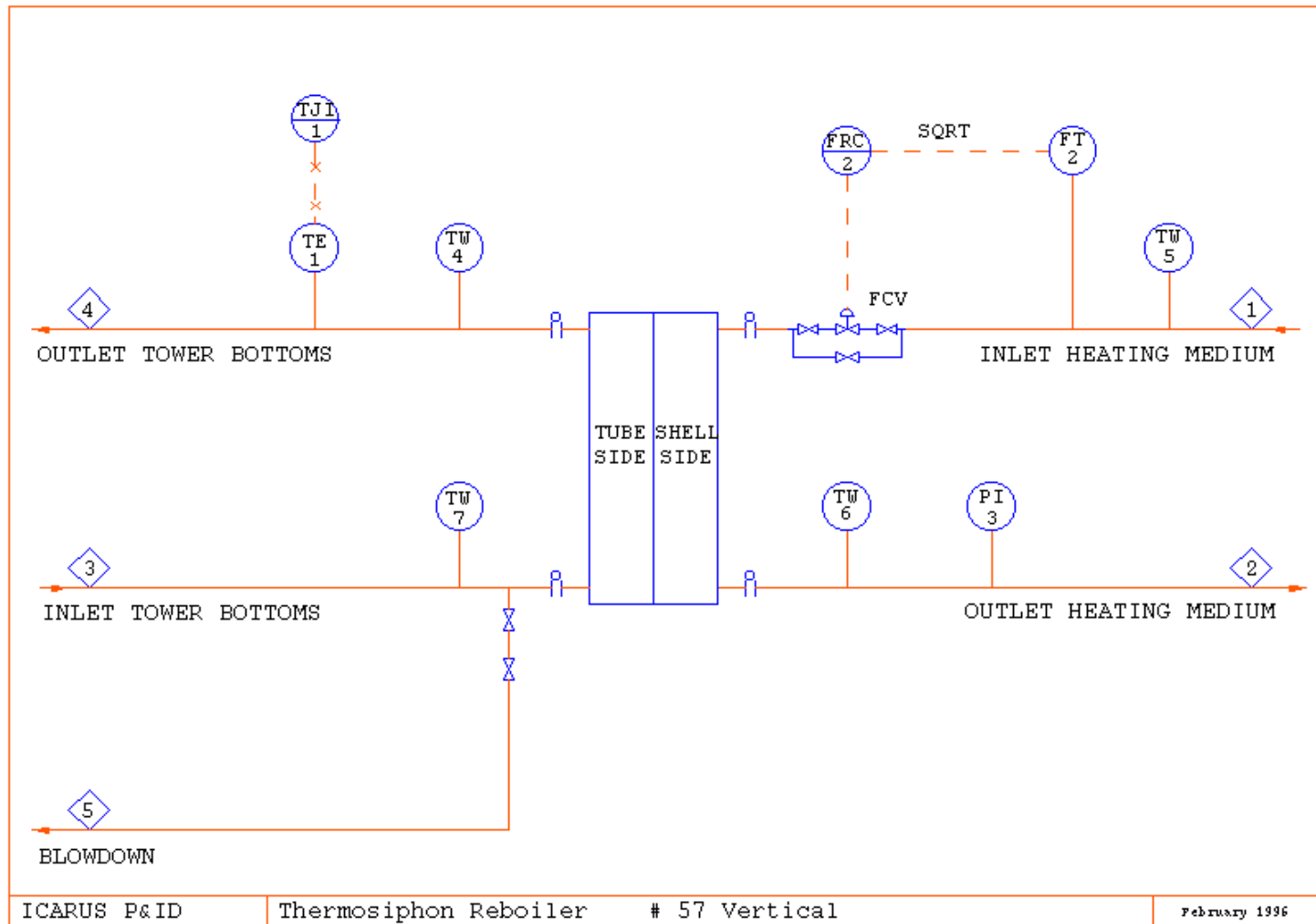
56 Tower – Desorber Service



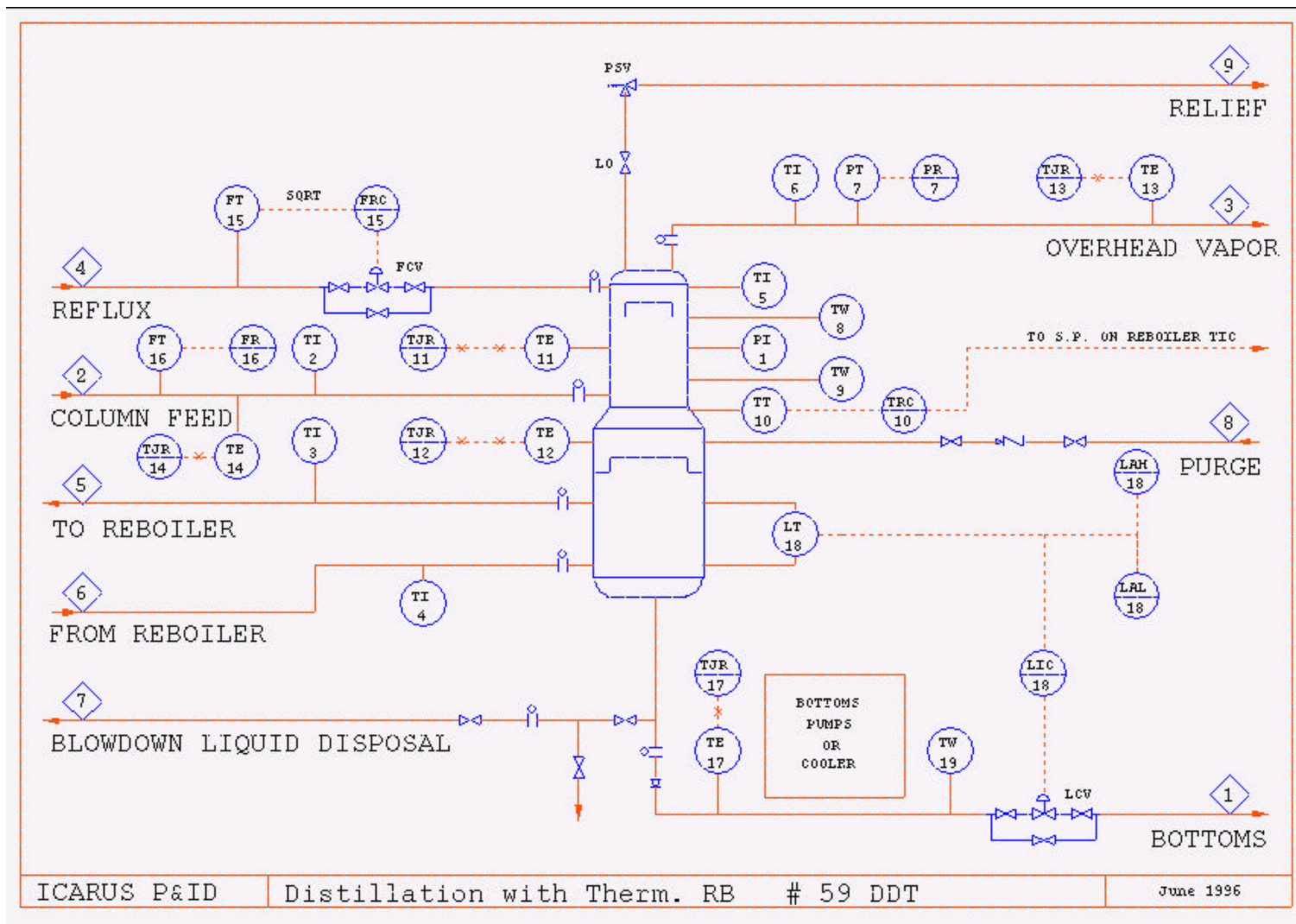
57 Horizontal Thermosiphon Reboiler



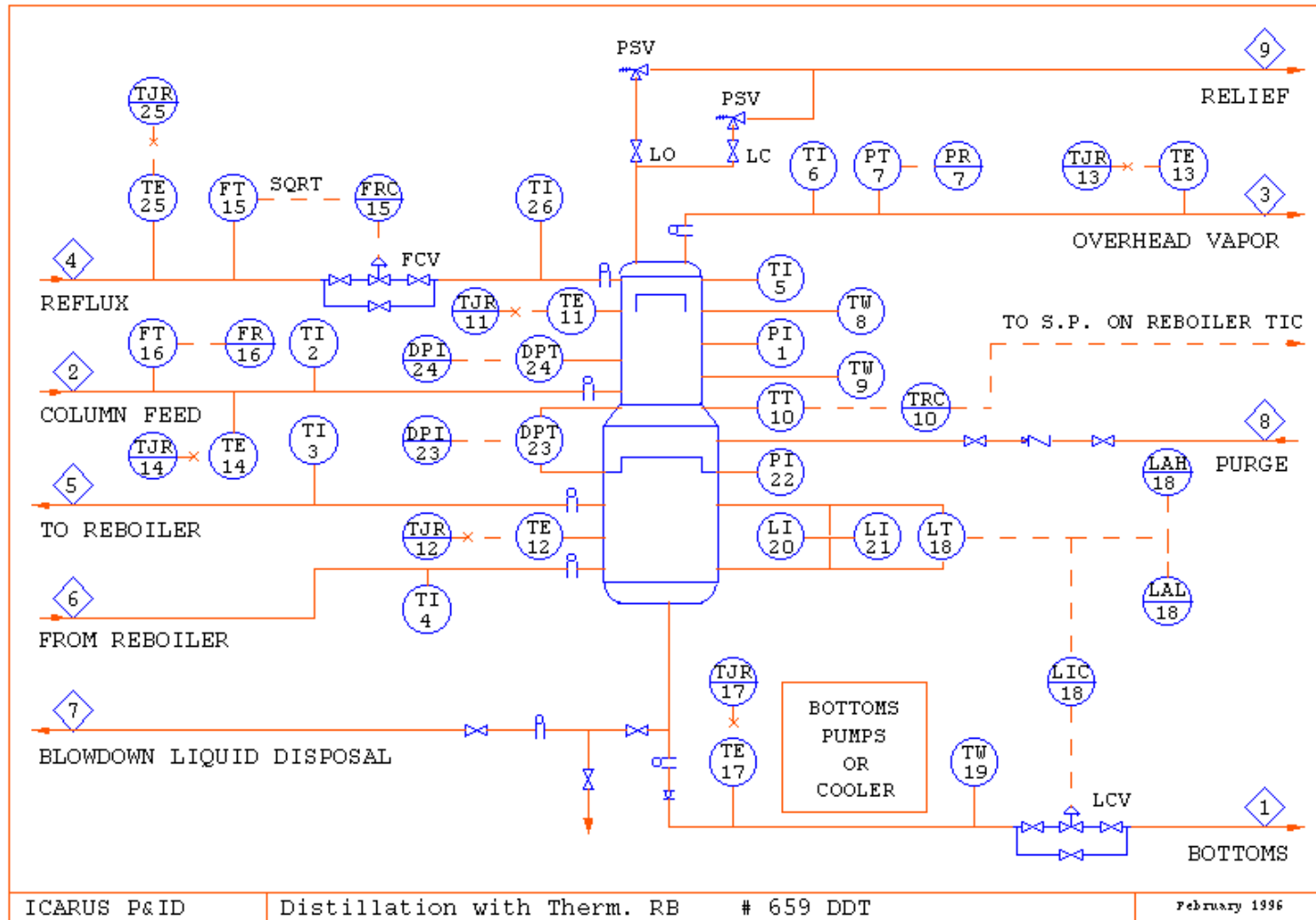
57 Vertical Thermosiphon Reboiler



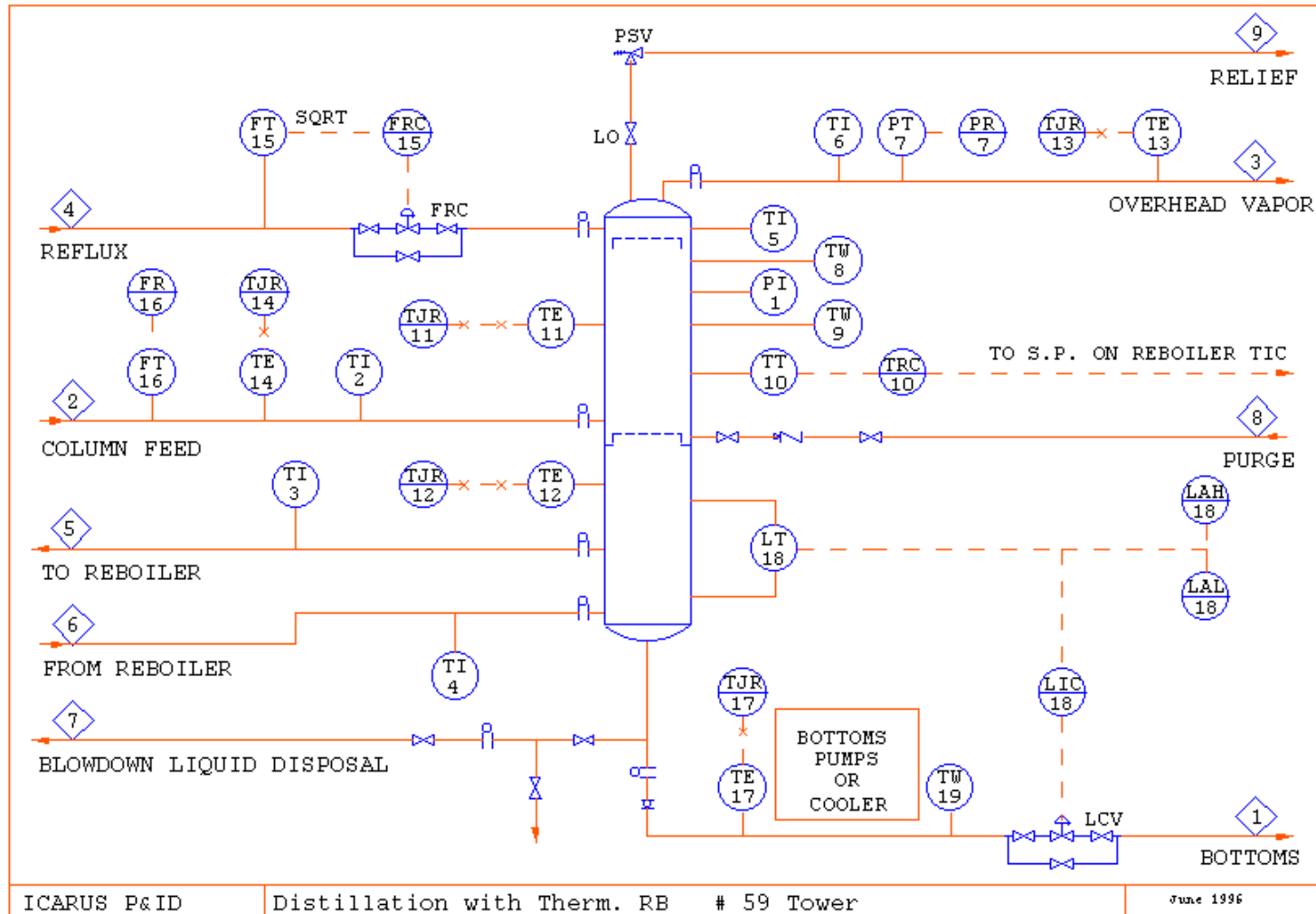
59 DDT – Distillation with Therm. RB



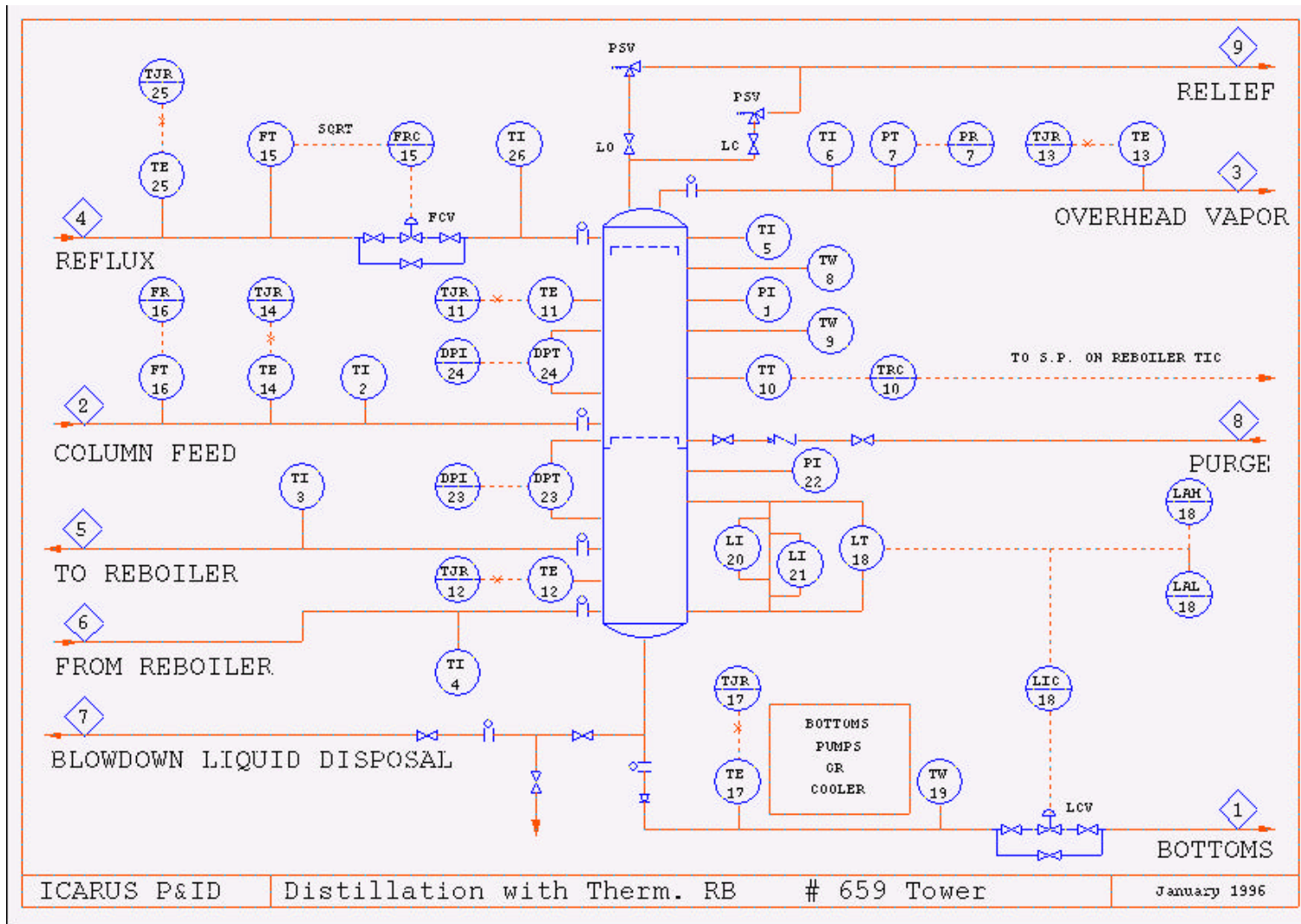
659 DDT – Distillation with Therm. RB



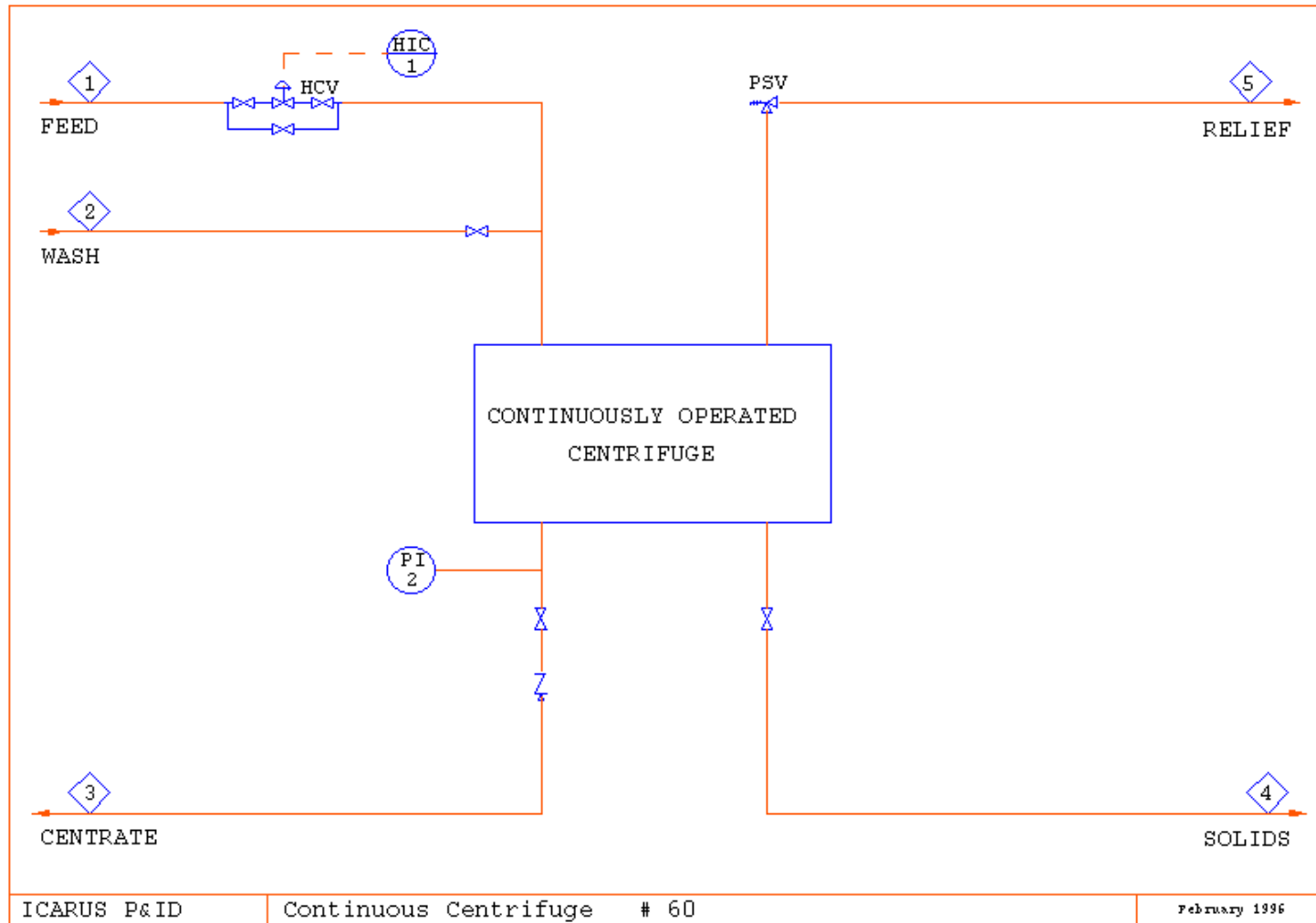
59 Tower – Distillation with Therm. RB



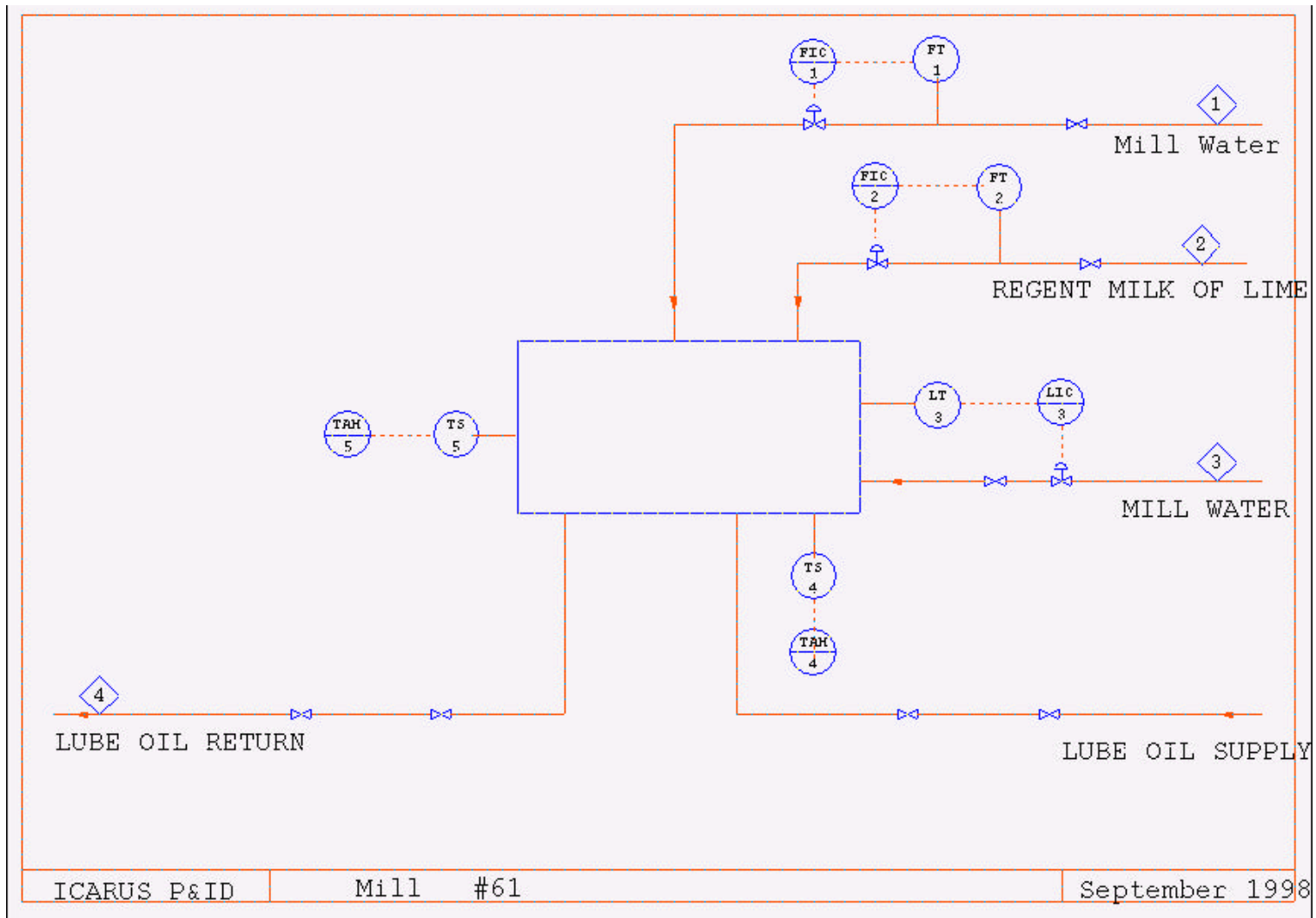
659 Tower – Distillation with Therm. RB



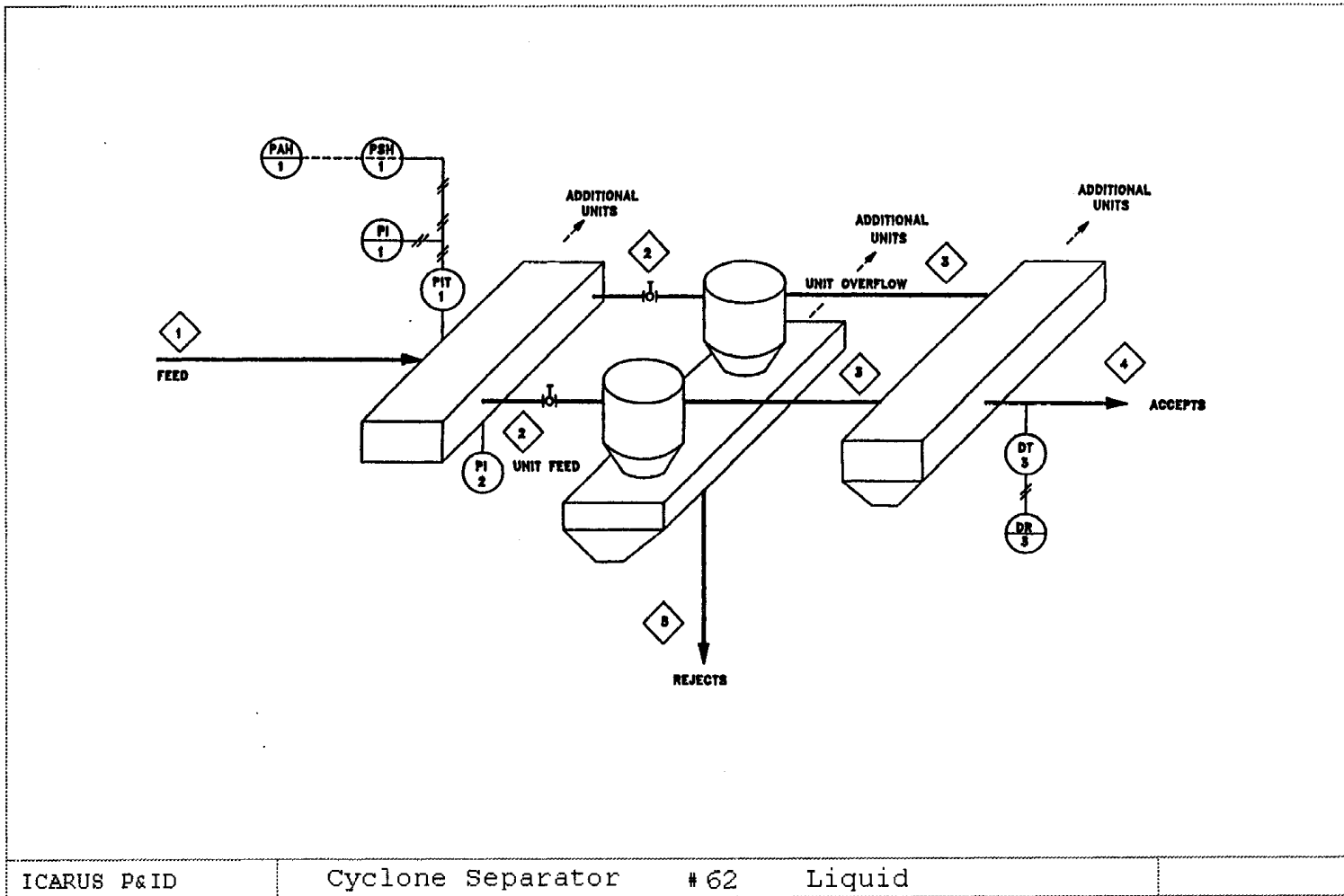
60 Continuous Centrifuge



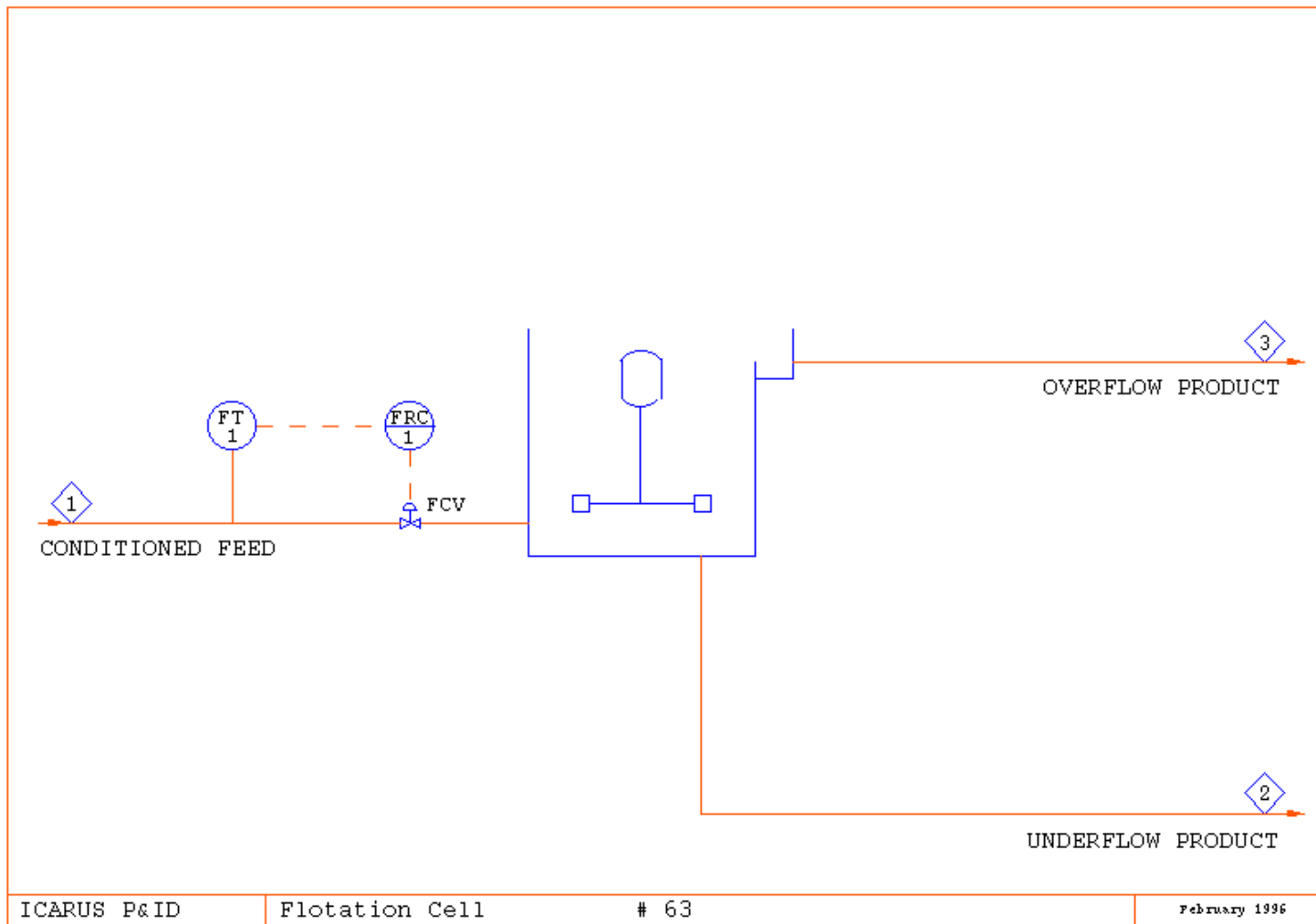
61 Mill



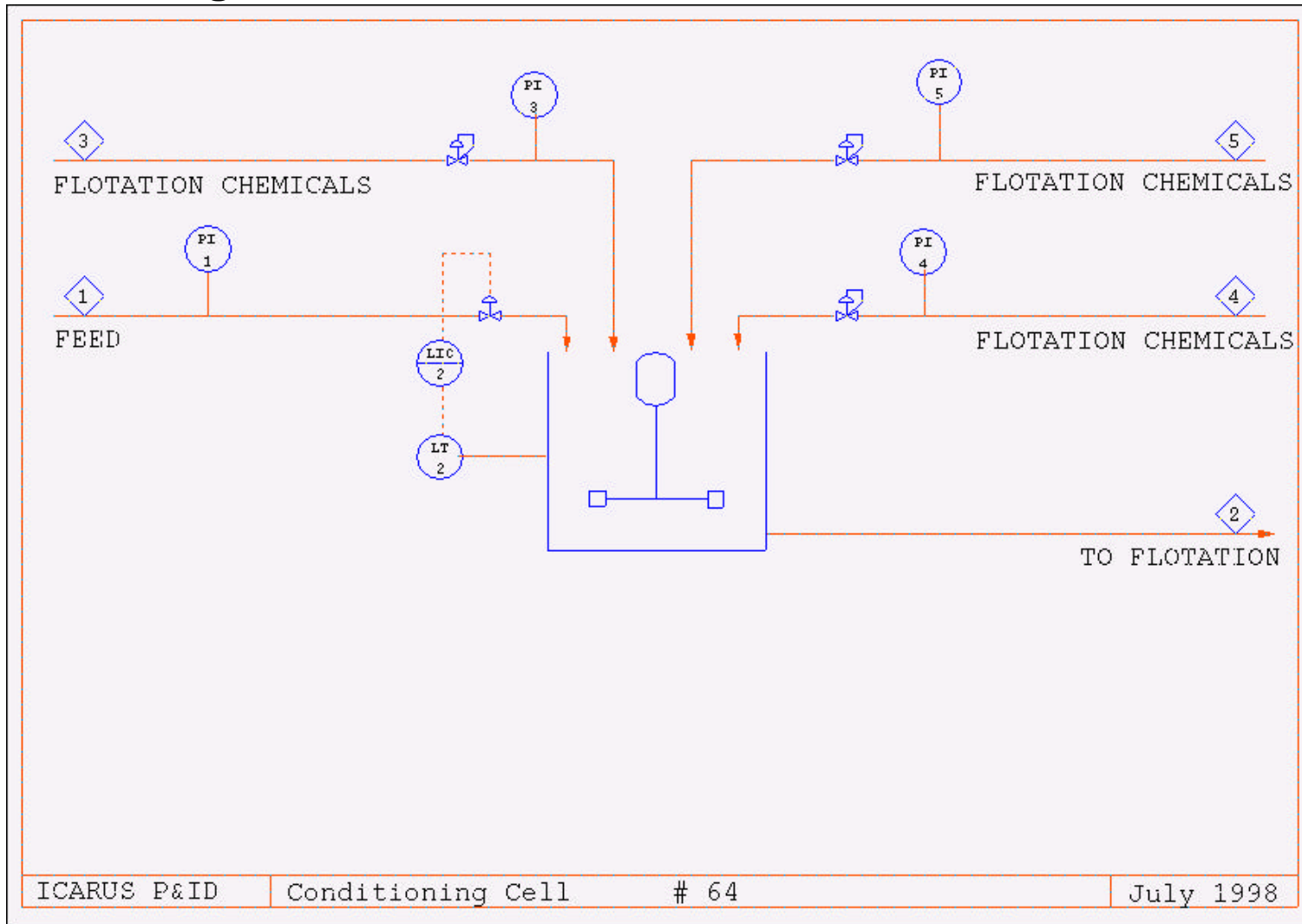
62 Liquid Cyclone Separator



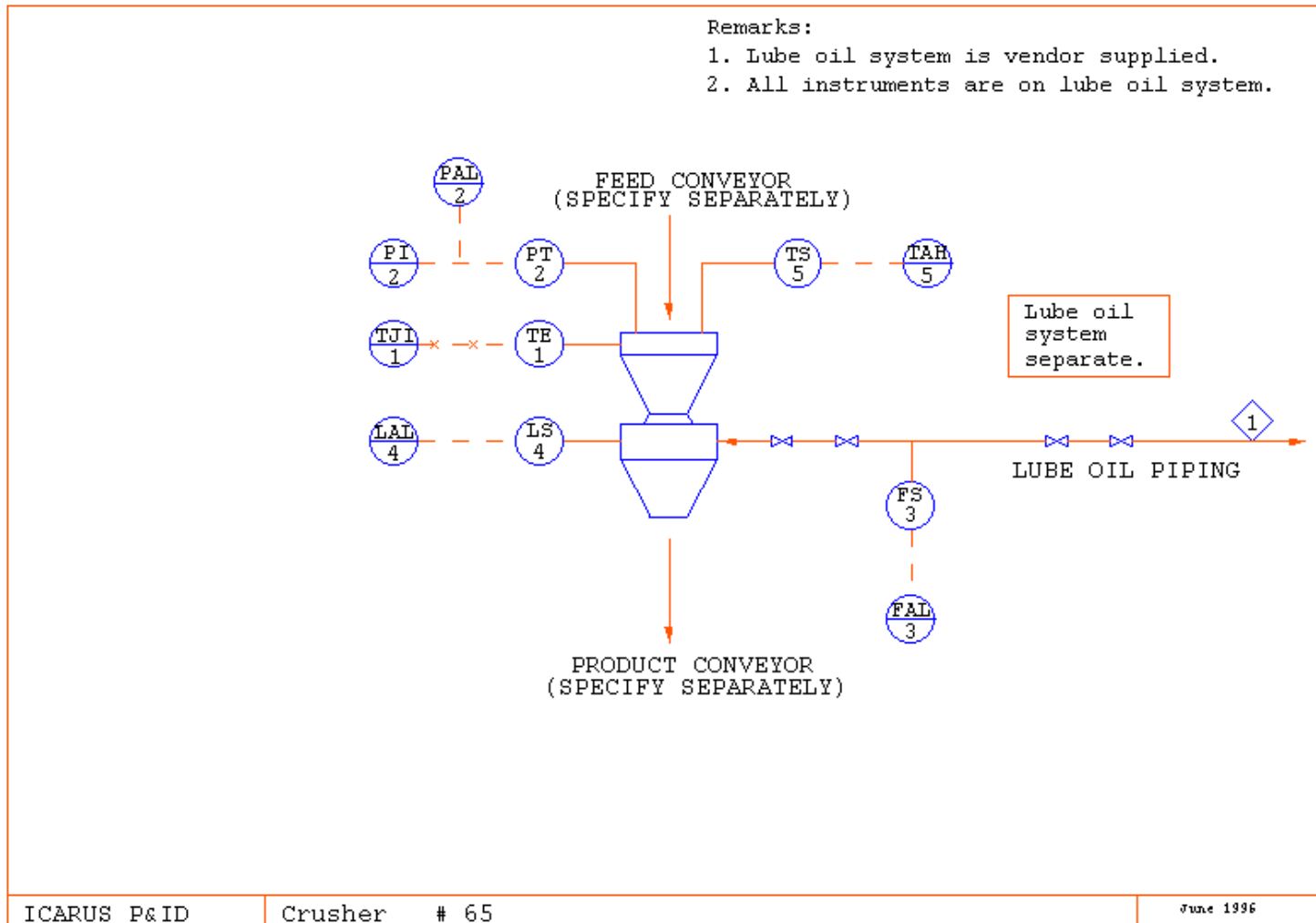
63 Flotation Cell



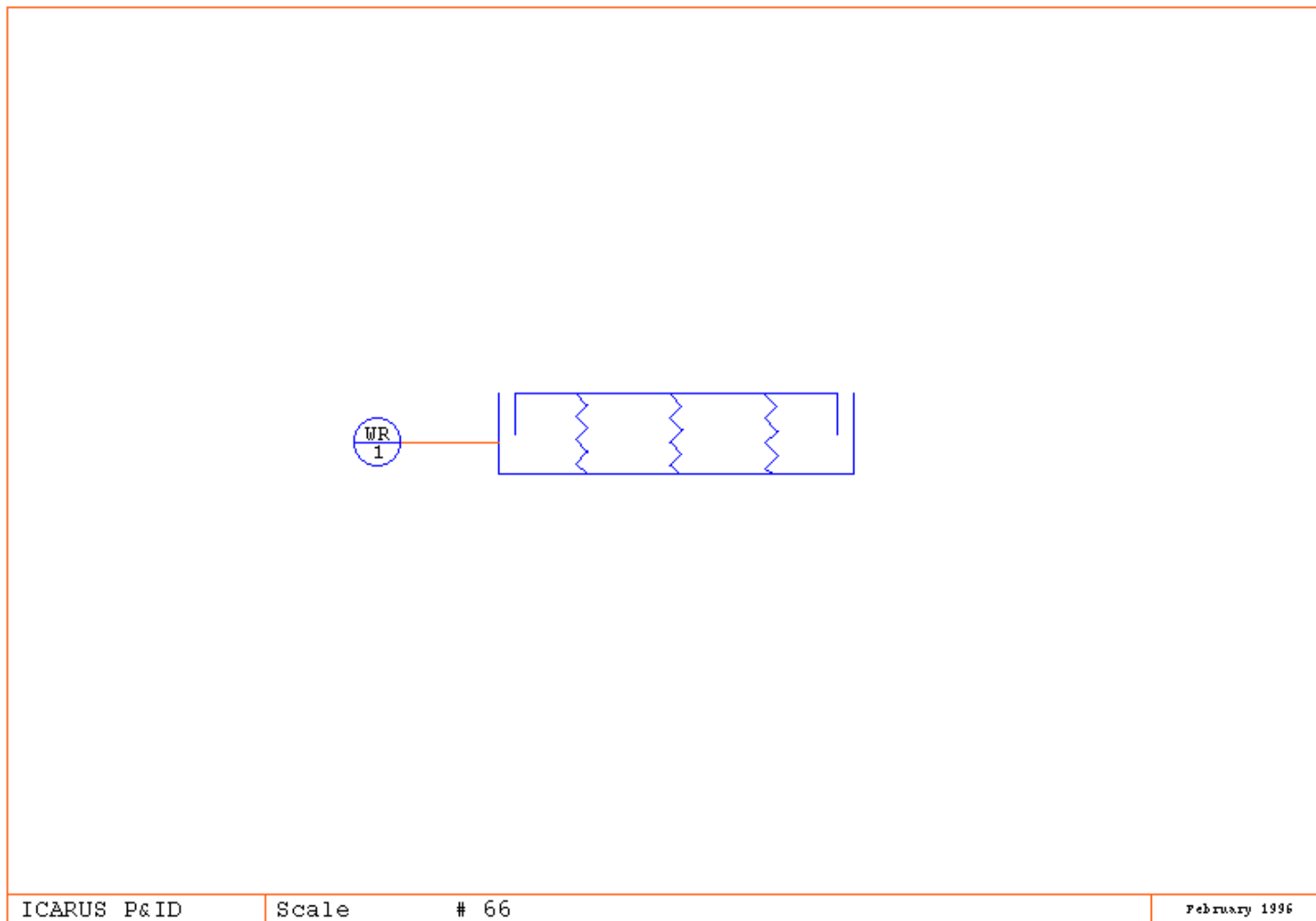
64 Conditioning Cell



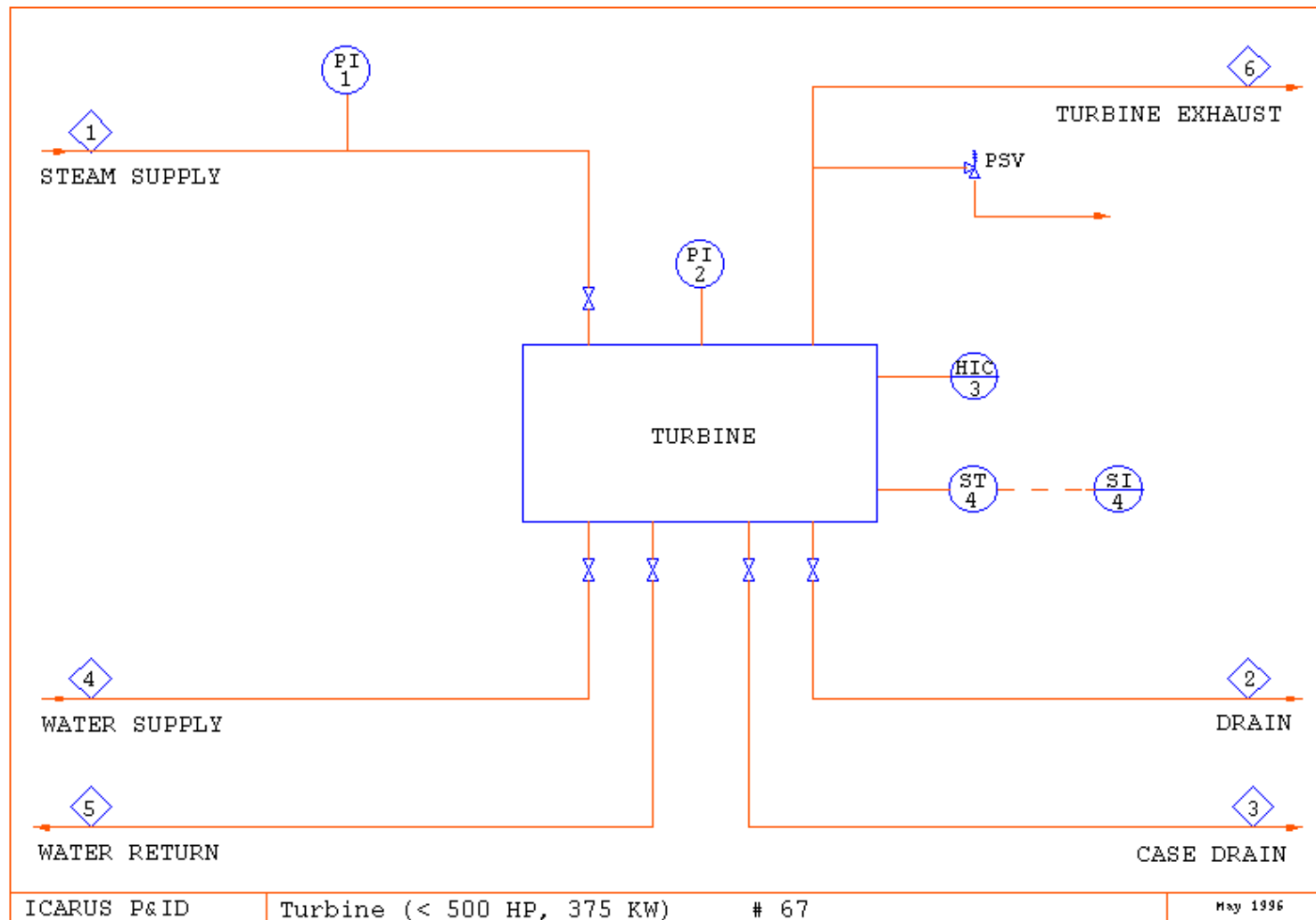
65 Crusher



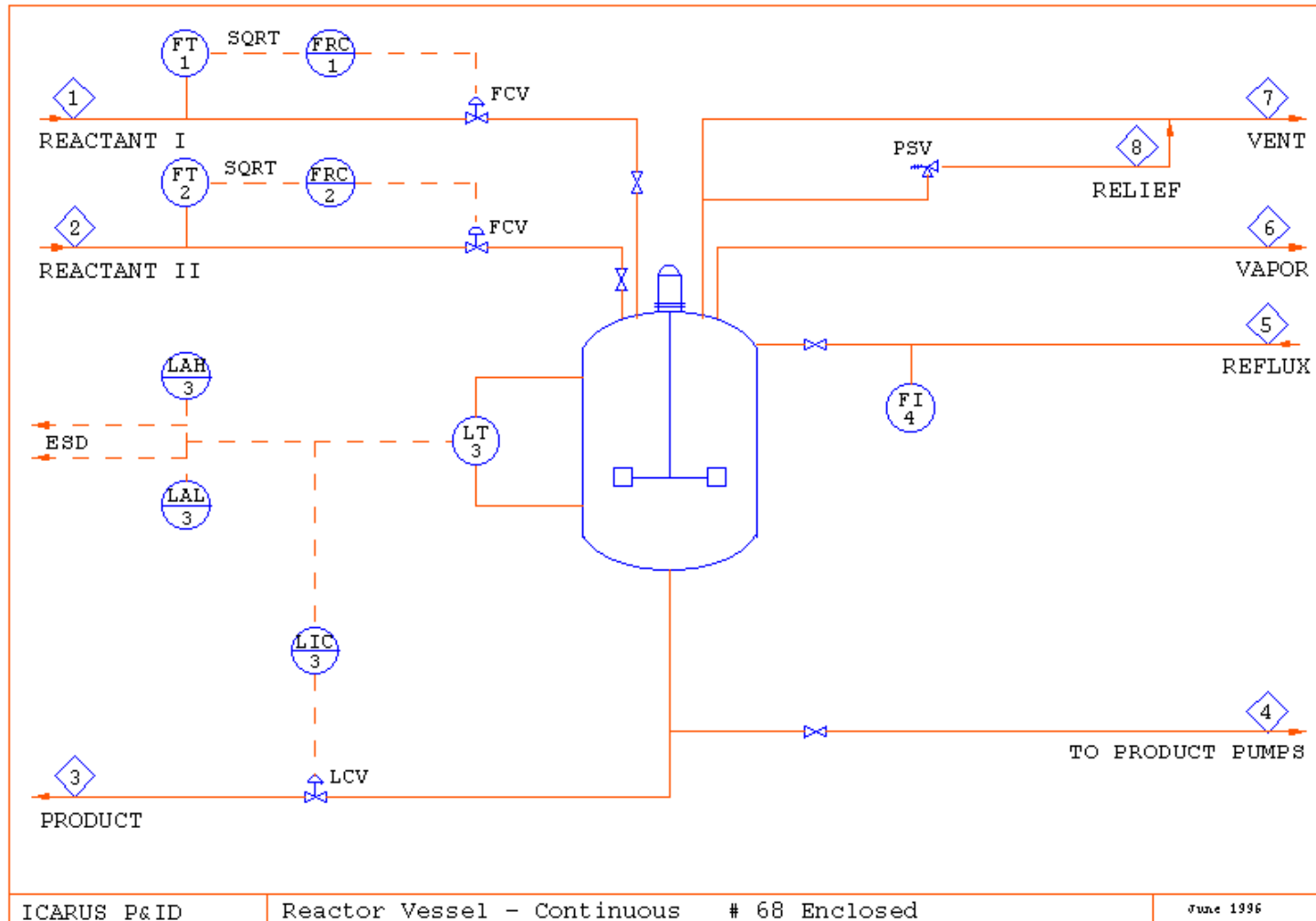
66 Scale



67 Turbine (<500 HP, 375 KW)

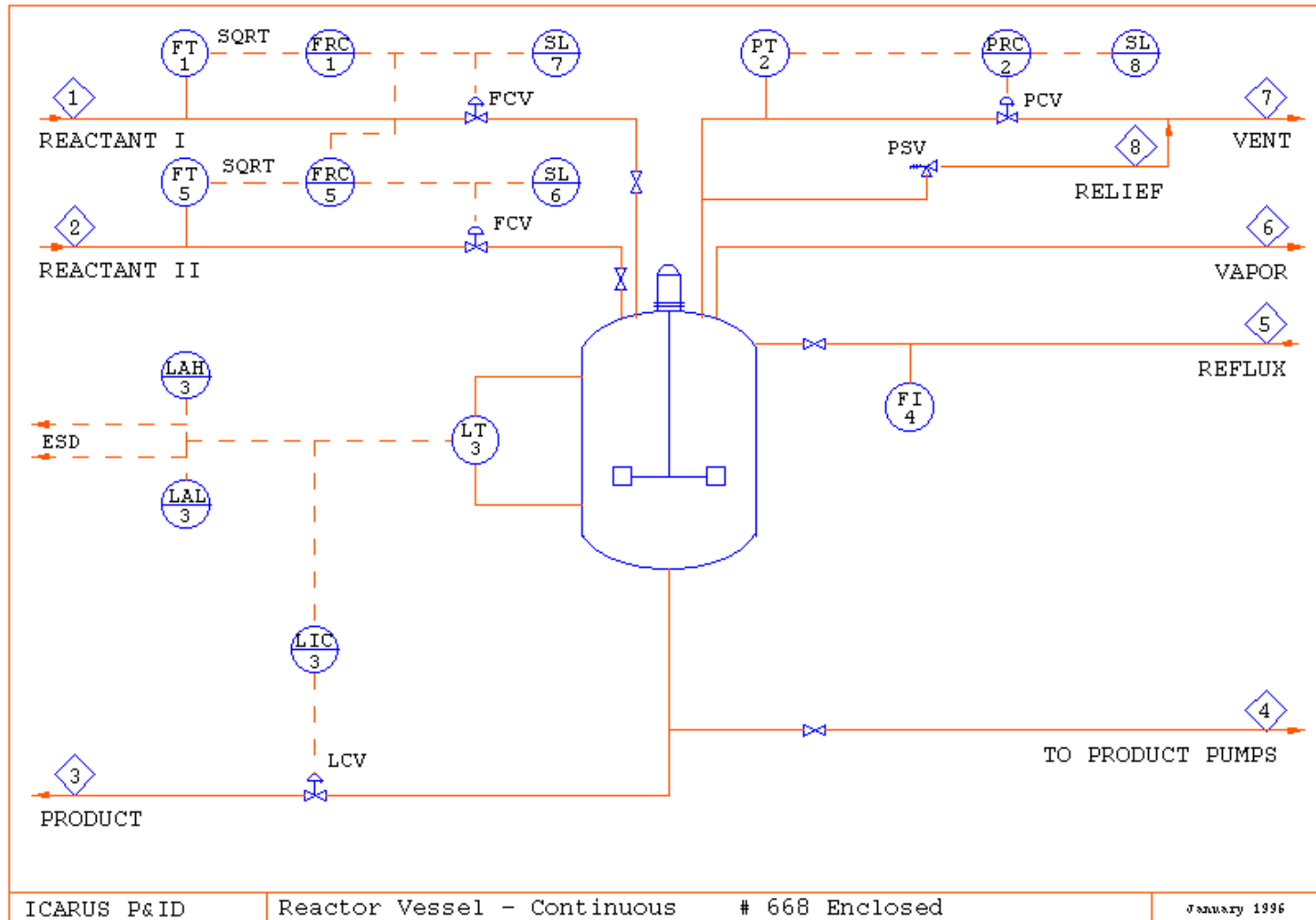


68 Enclosed Reactor Vessel – Continuous



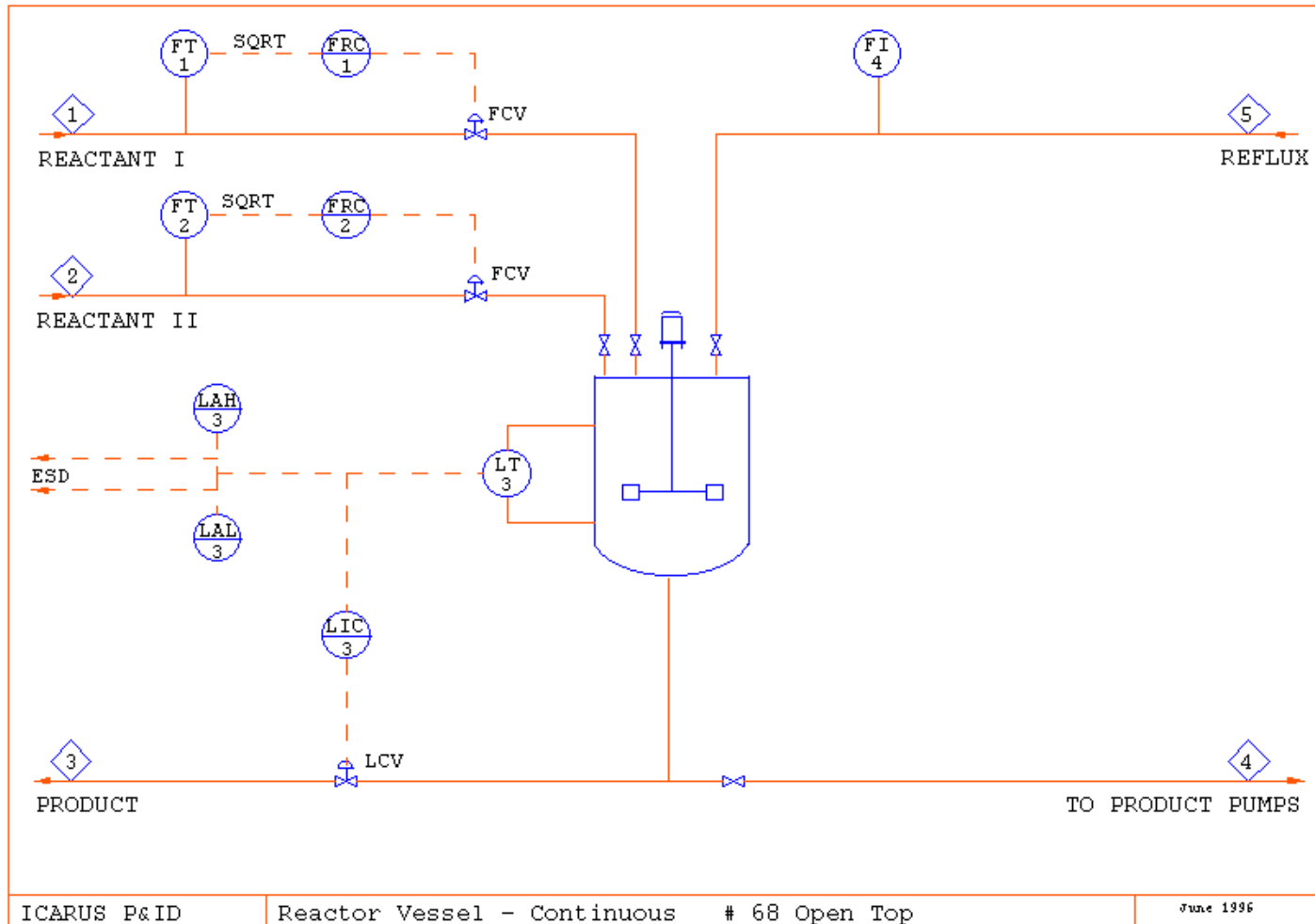
Jacket: See Drawing 23 and 623

668 Enclosed Reactor Vessel – Continuous



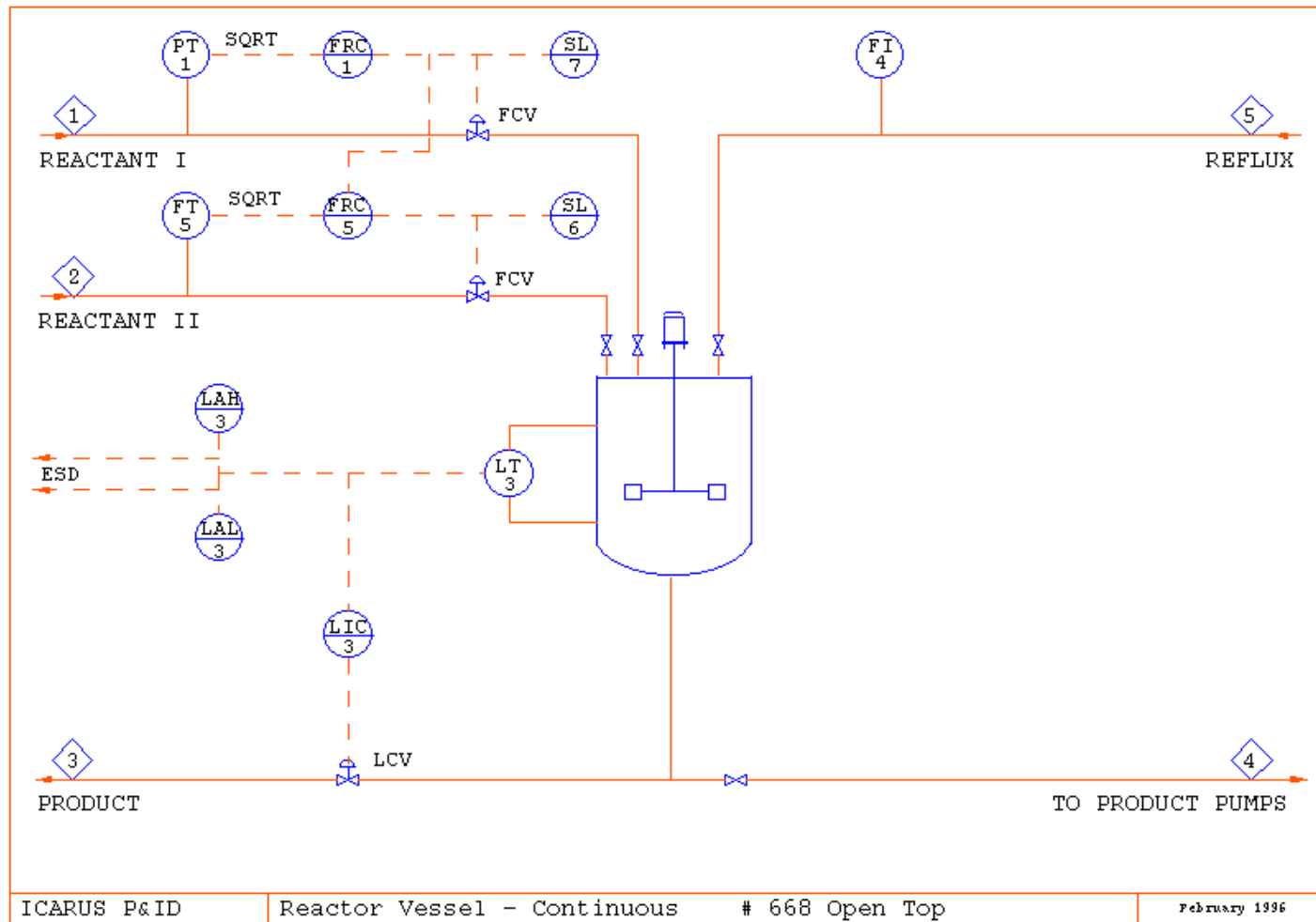
Jacket: See Drawing 23 and 623

68 Open Top Reactor Vessel – Continuous



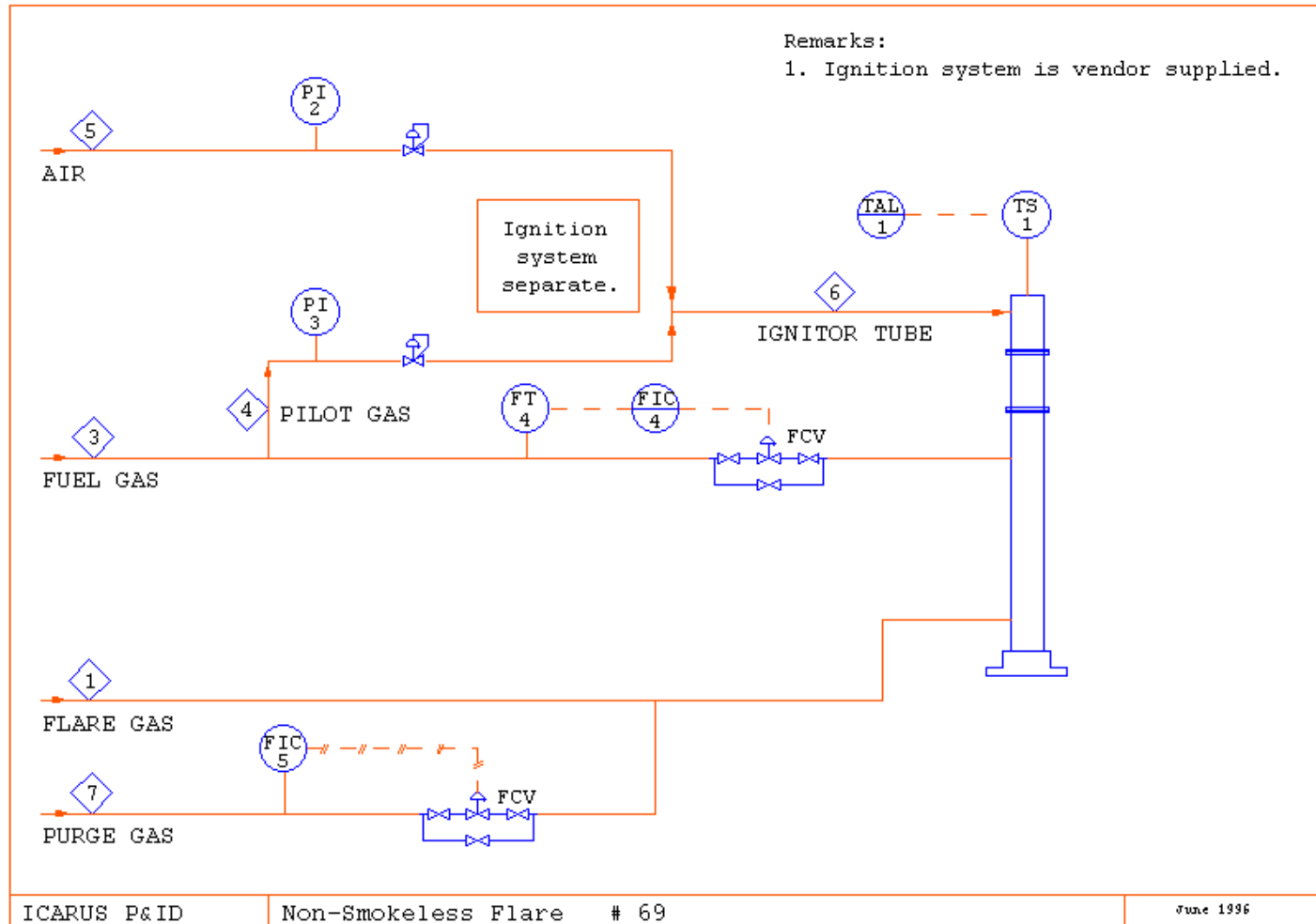
Jacket: See Drawing 23 and 623

668 Open Top Reactor Vessel – Continuous

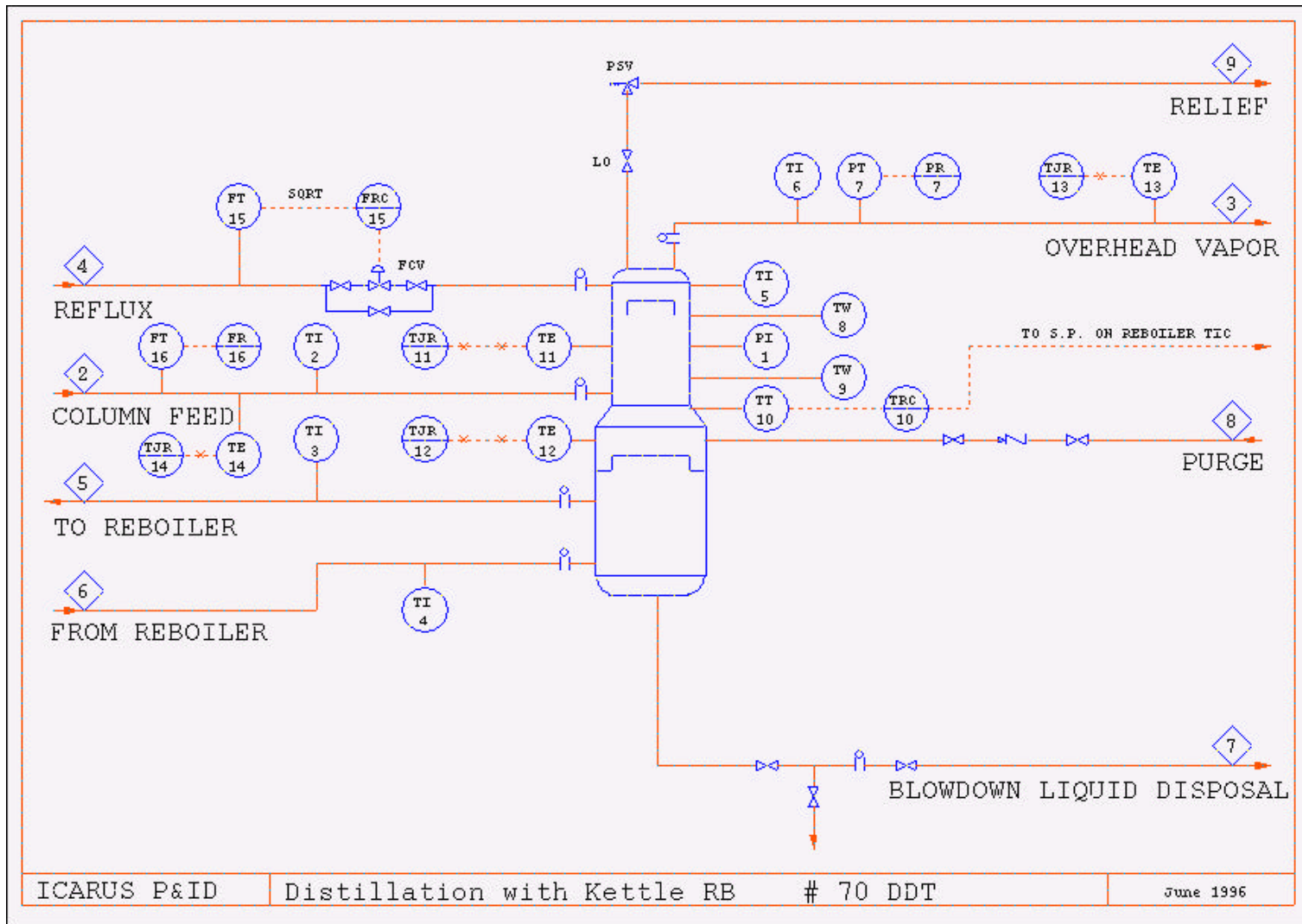


Jacket: See Drawing 23 and 623

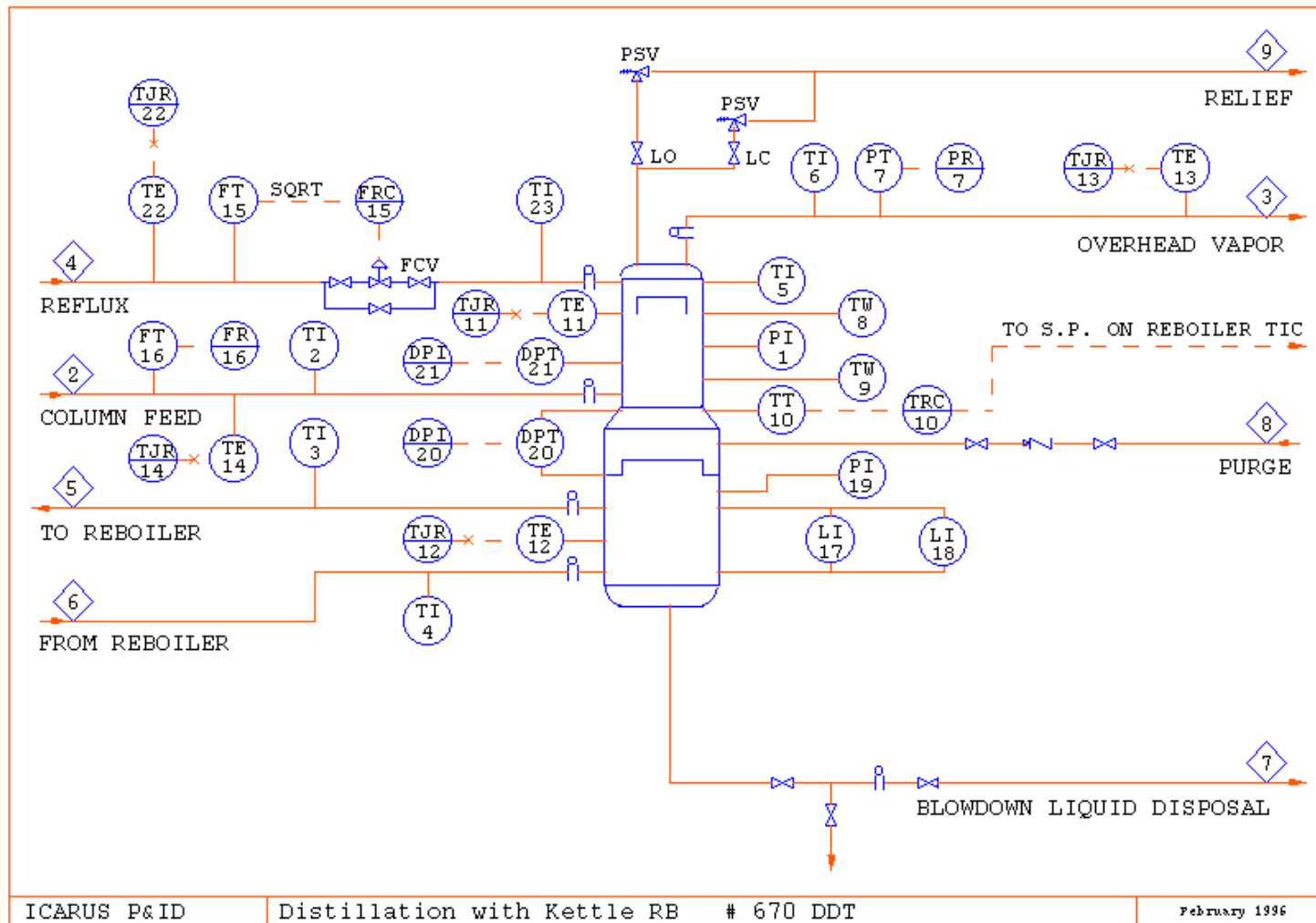
69 Non-Smokeless Flare



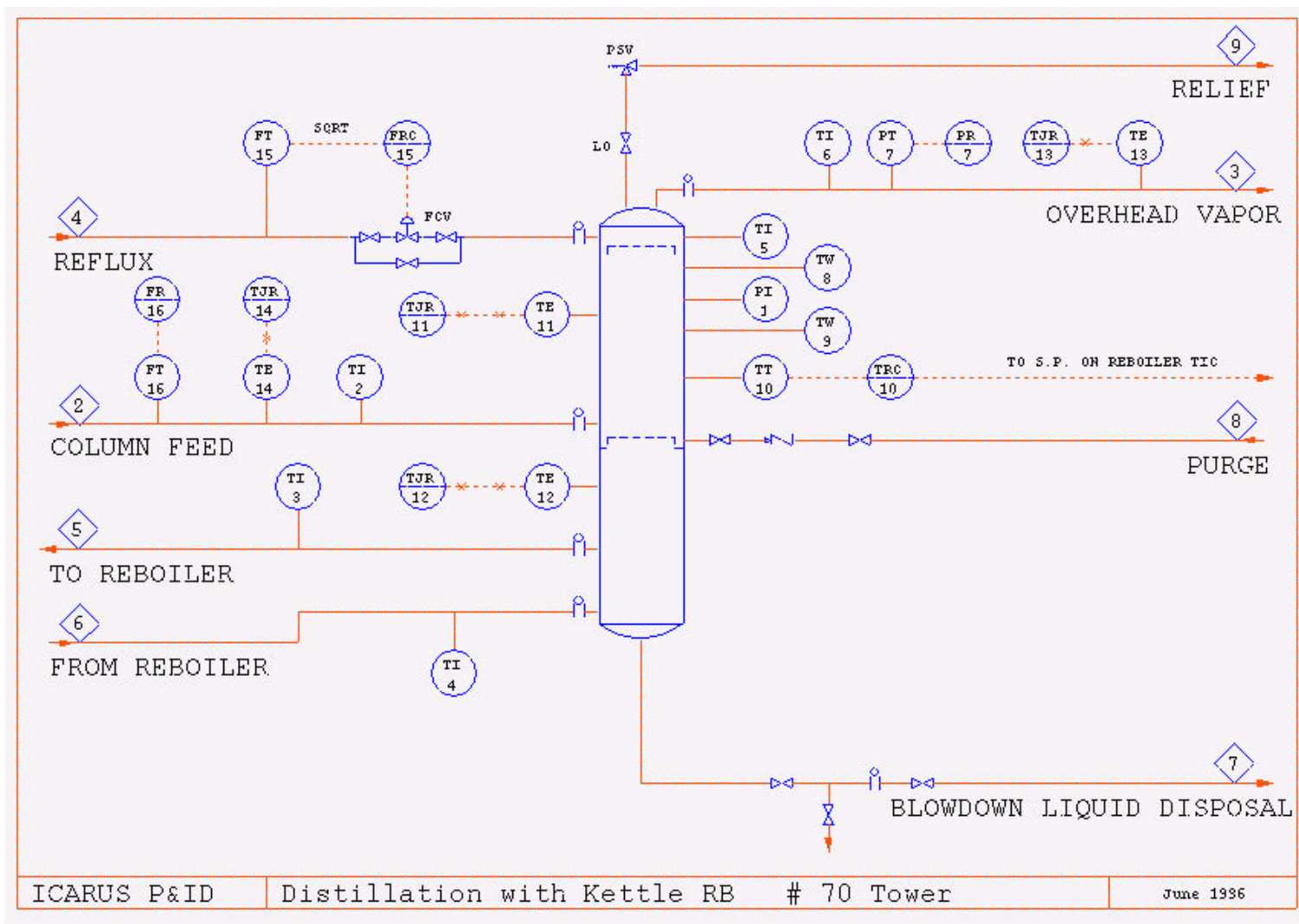
70 DDT – Distillation with Kettle RB



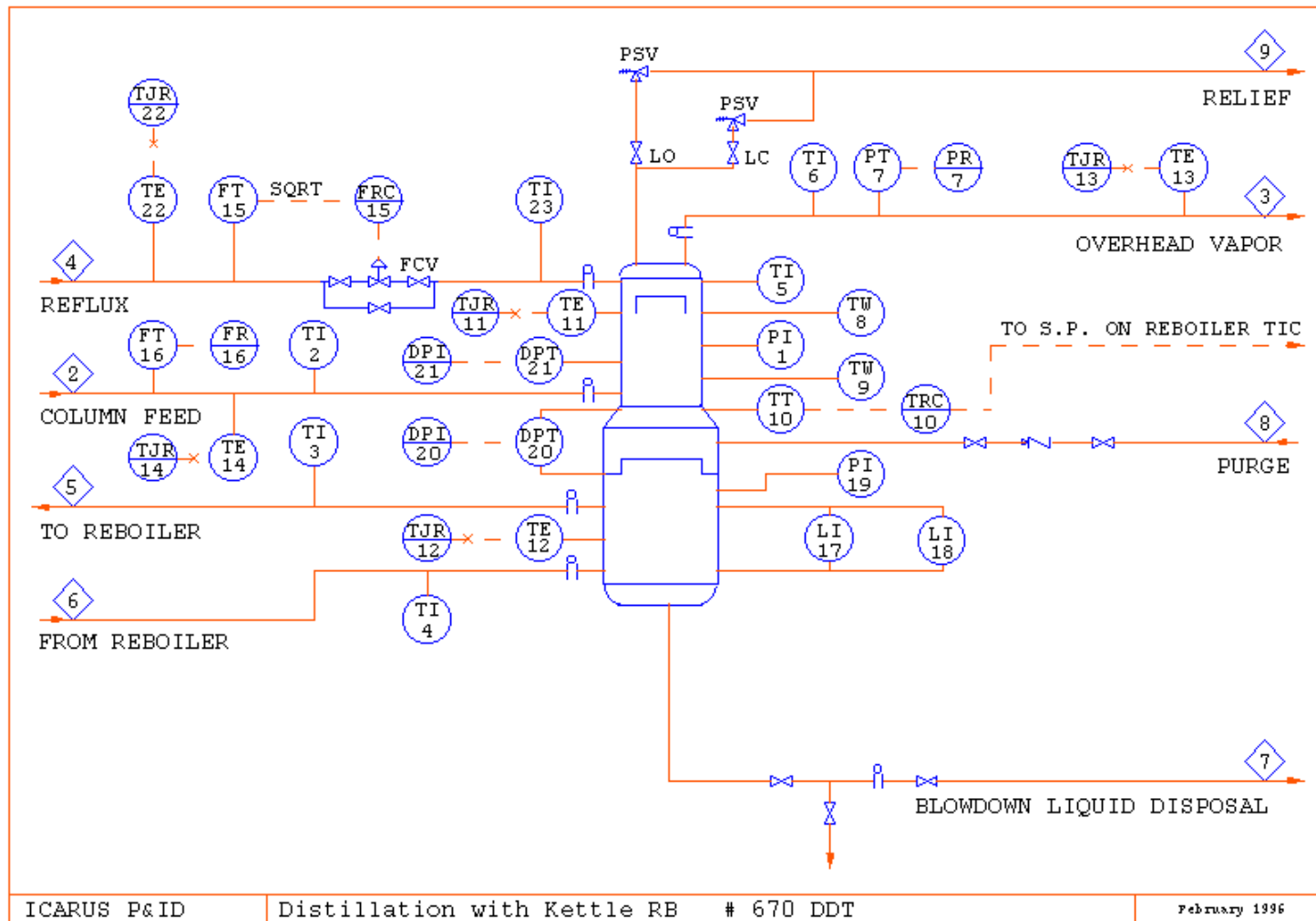
670 DDT – Distillation with Kettle RB



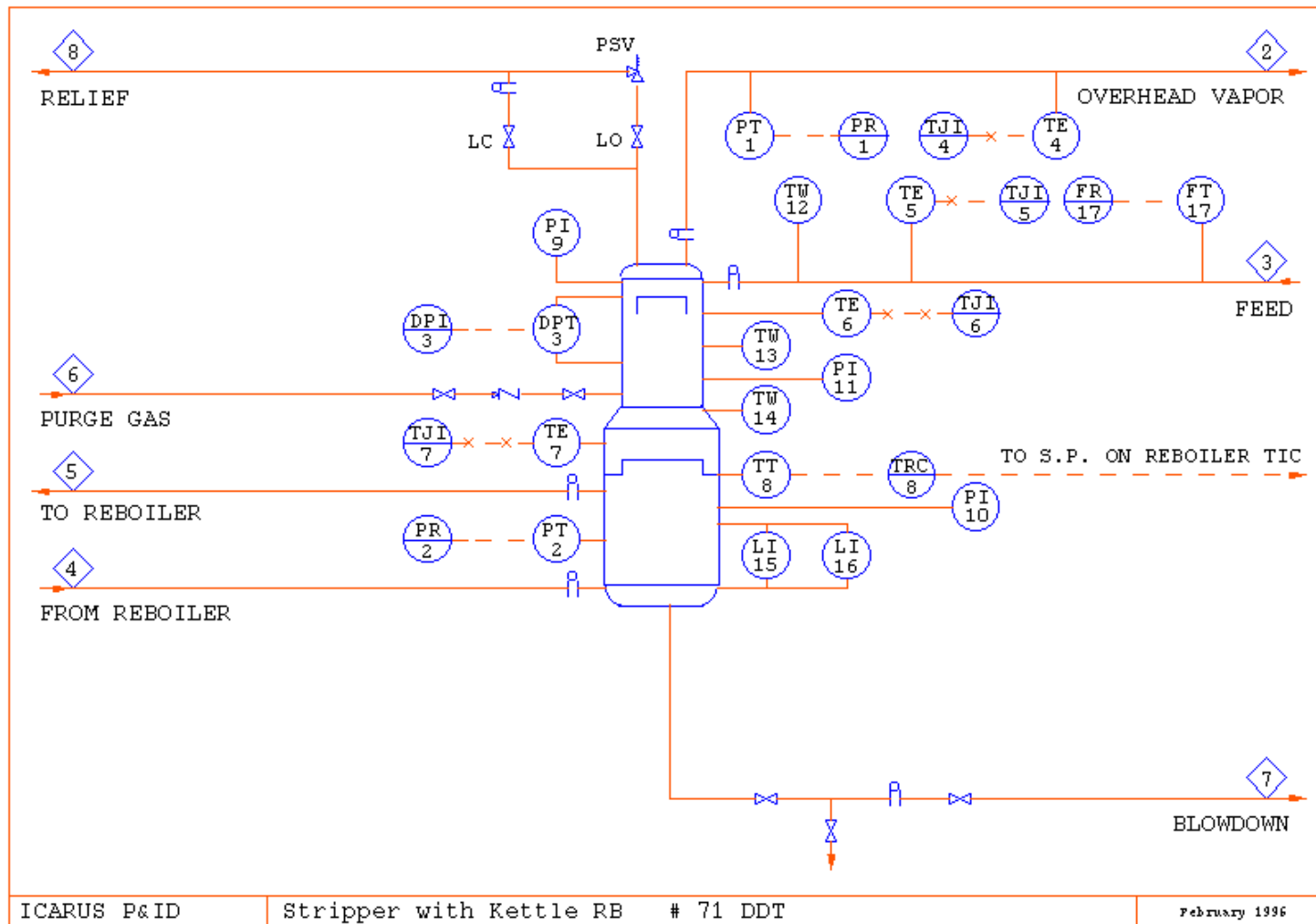
70 Tower – Distillation with Kettle RB



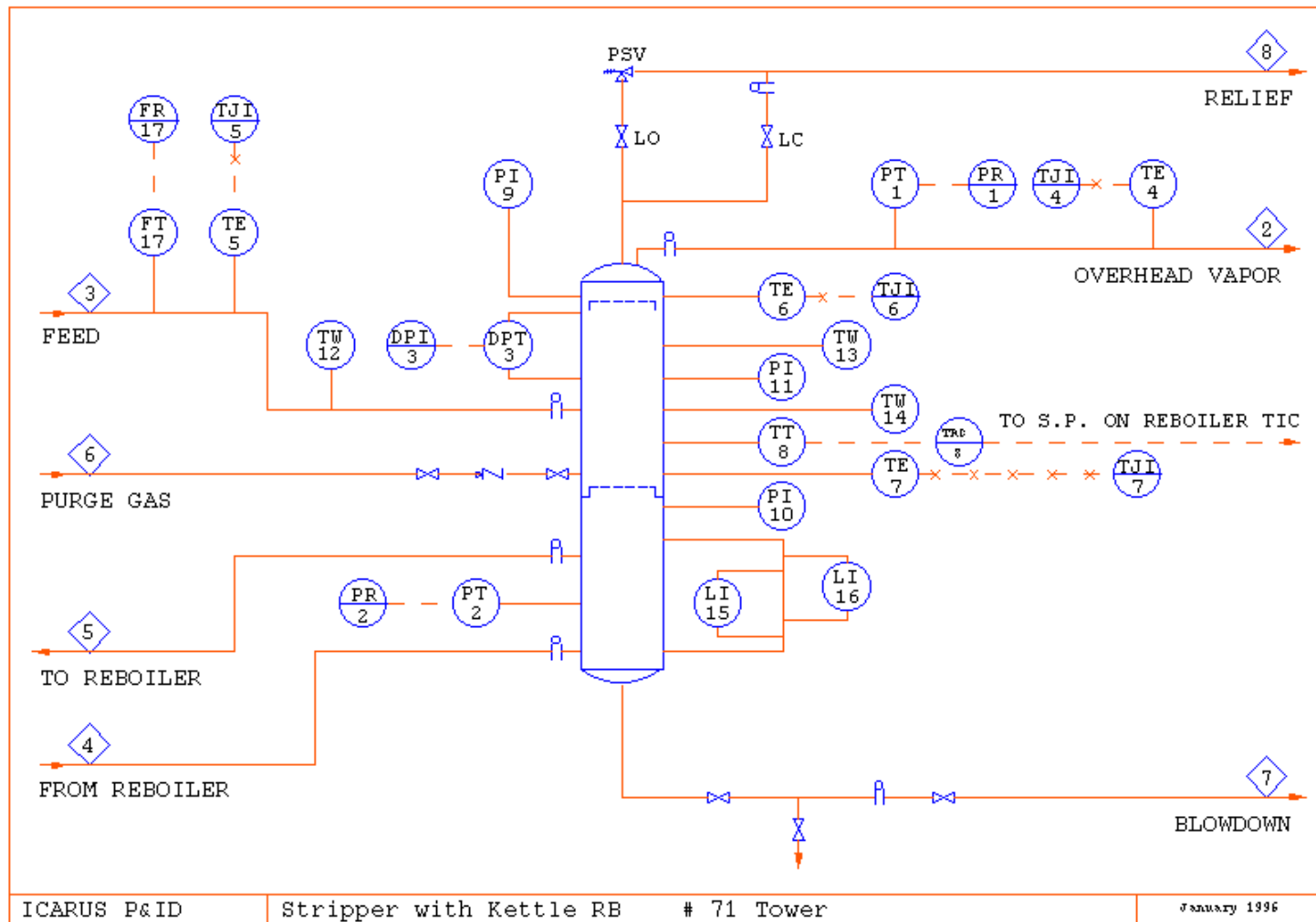
670 Tower – Distillation with Kettle RB



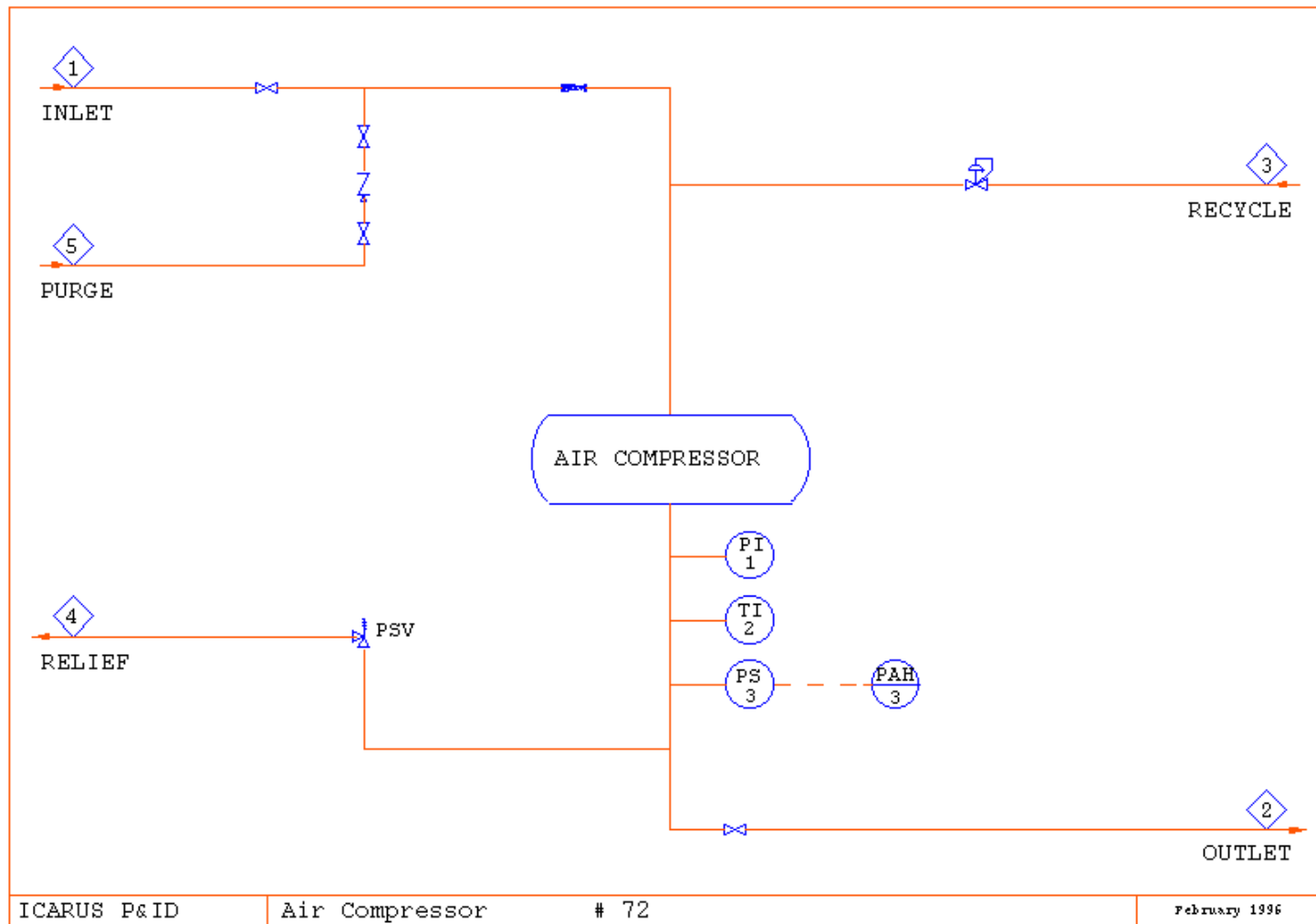
71 DDT – Stripper with Kettle RB



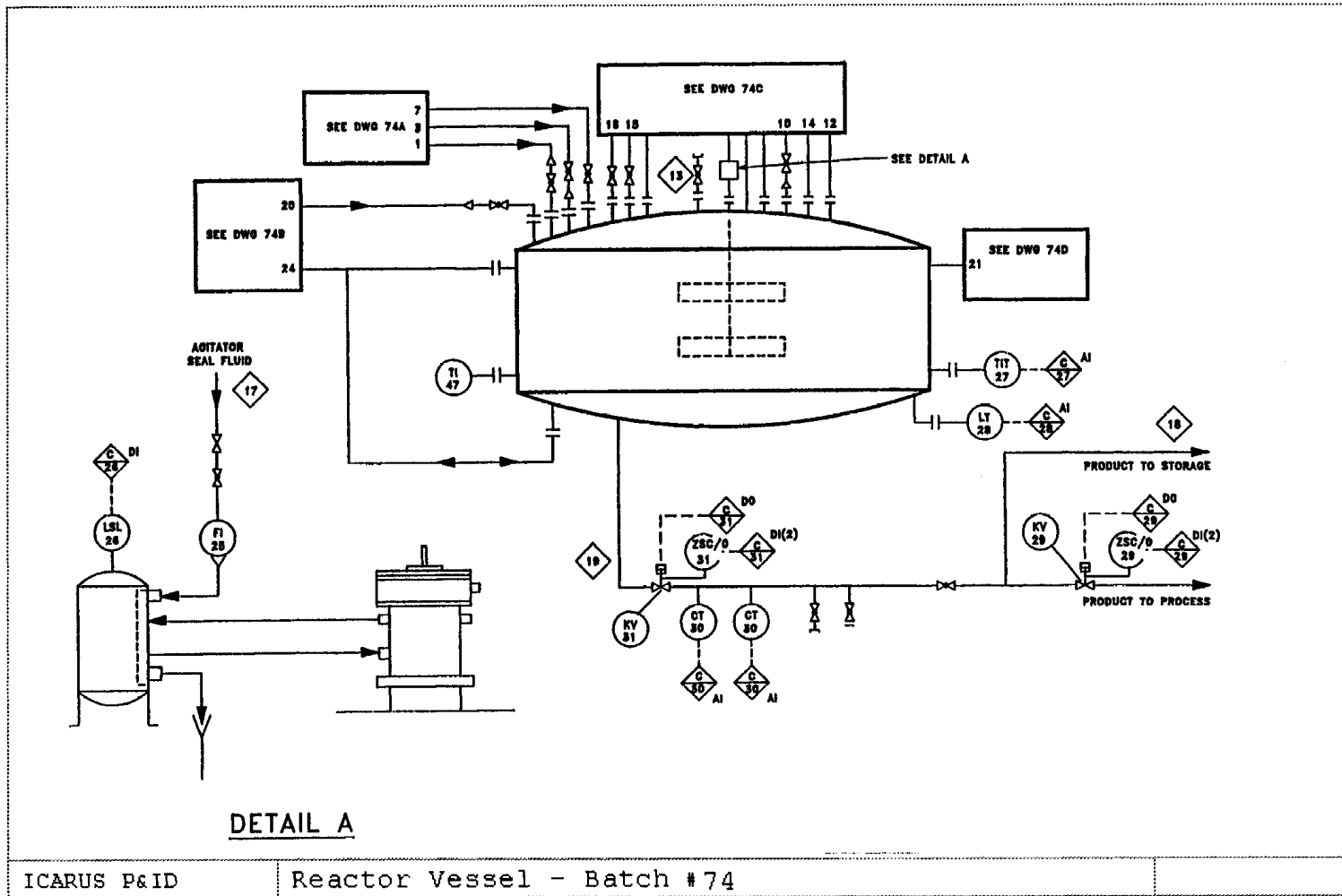
71 Tower – Stripper with Kettle RB



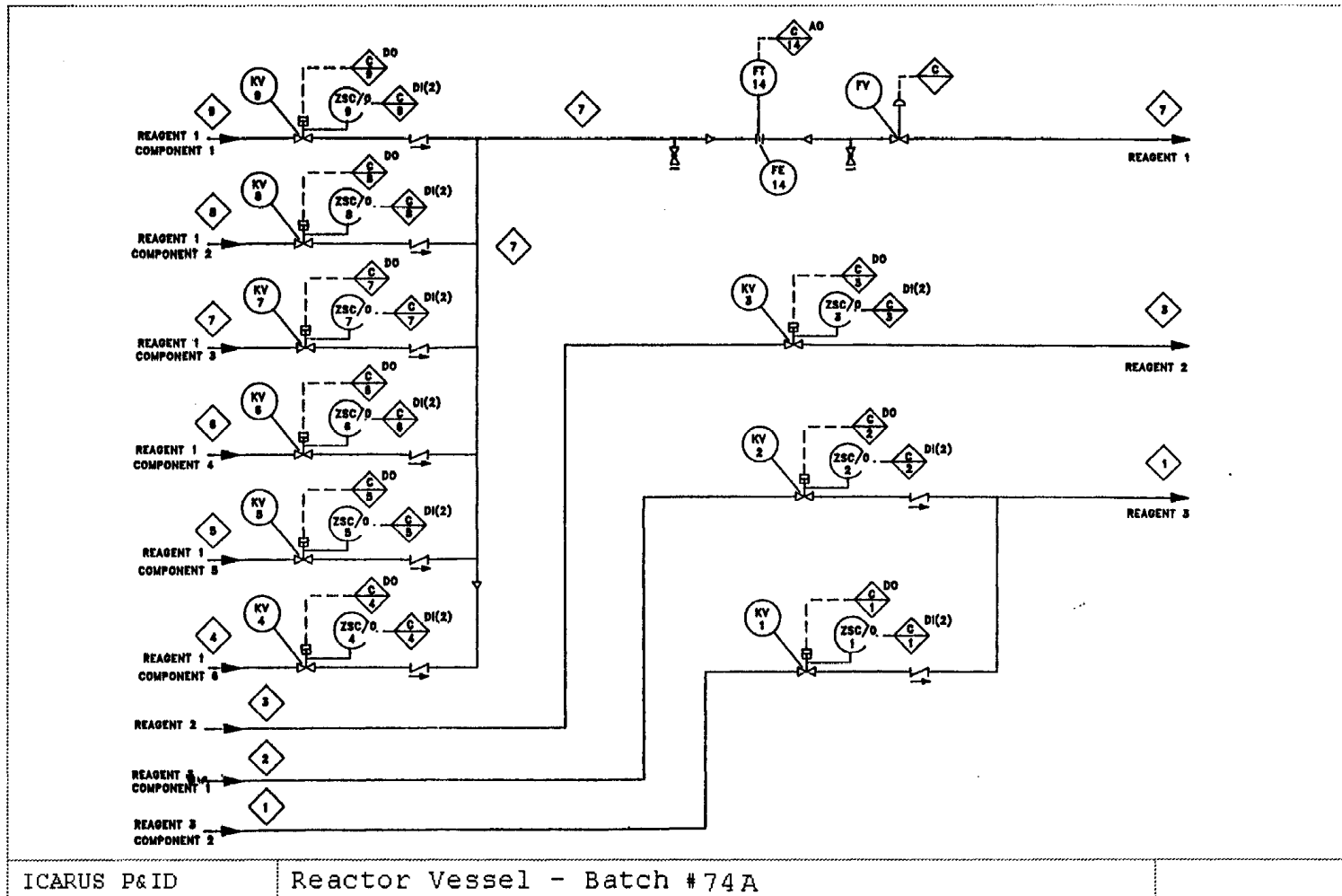
72 Air Compressor



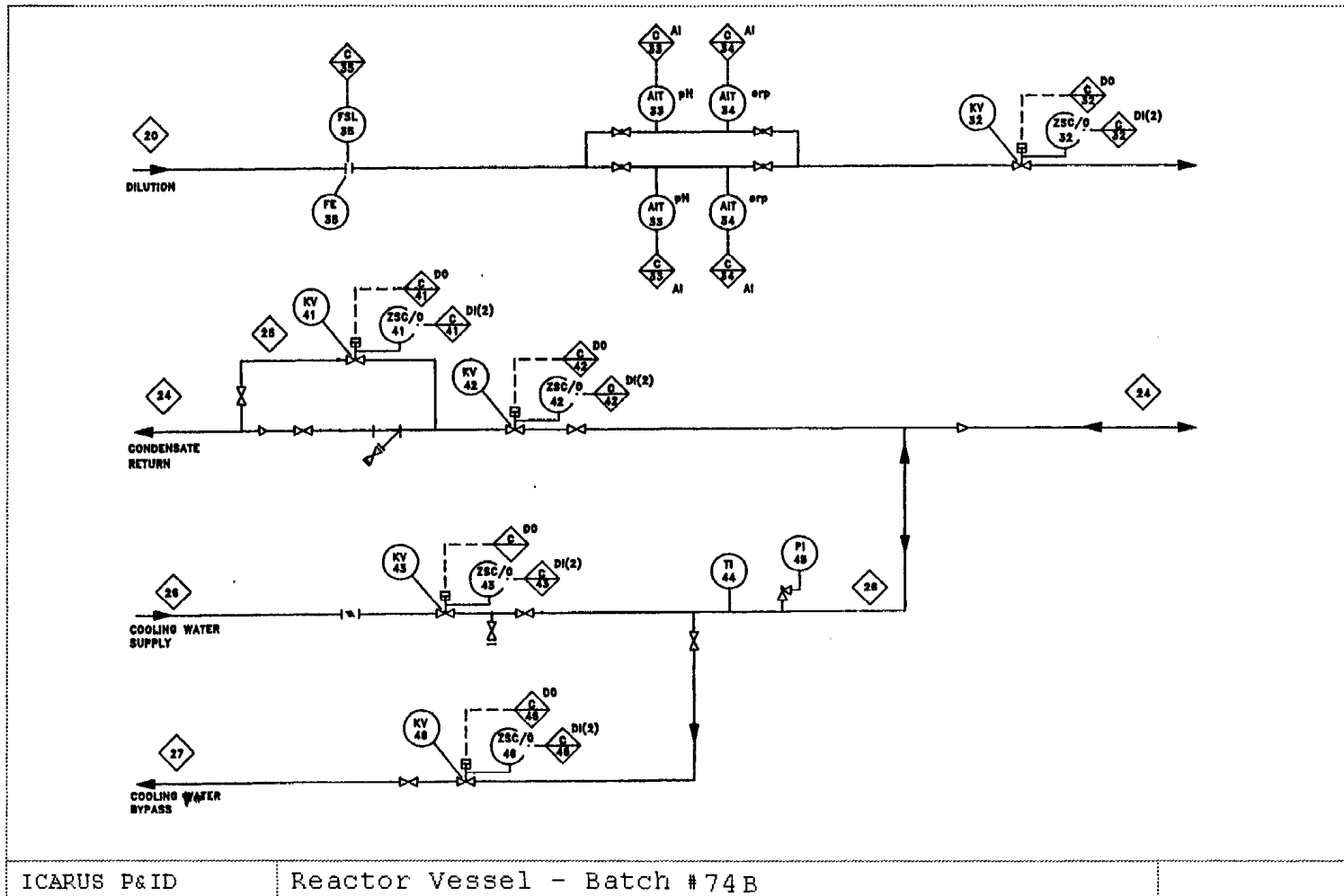
74 Reactor Vessel – Batch



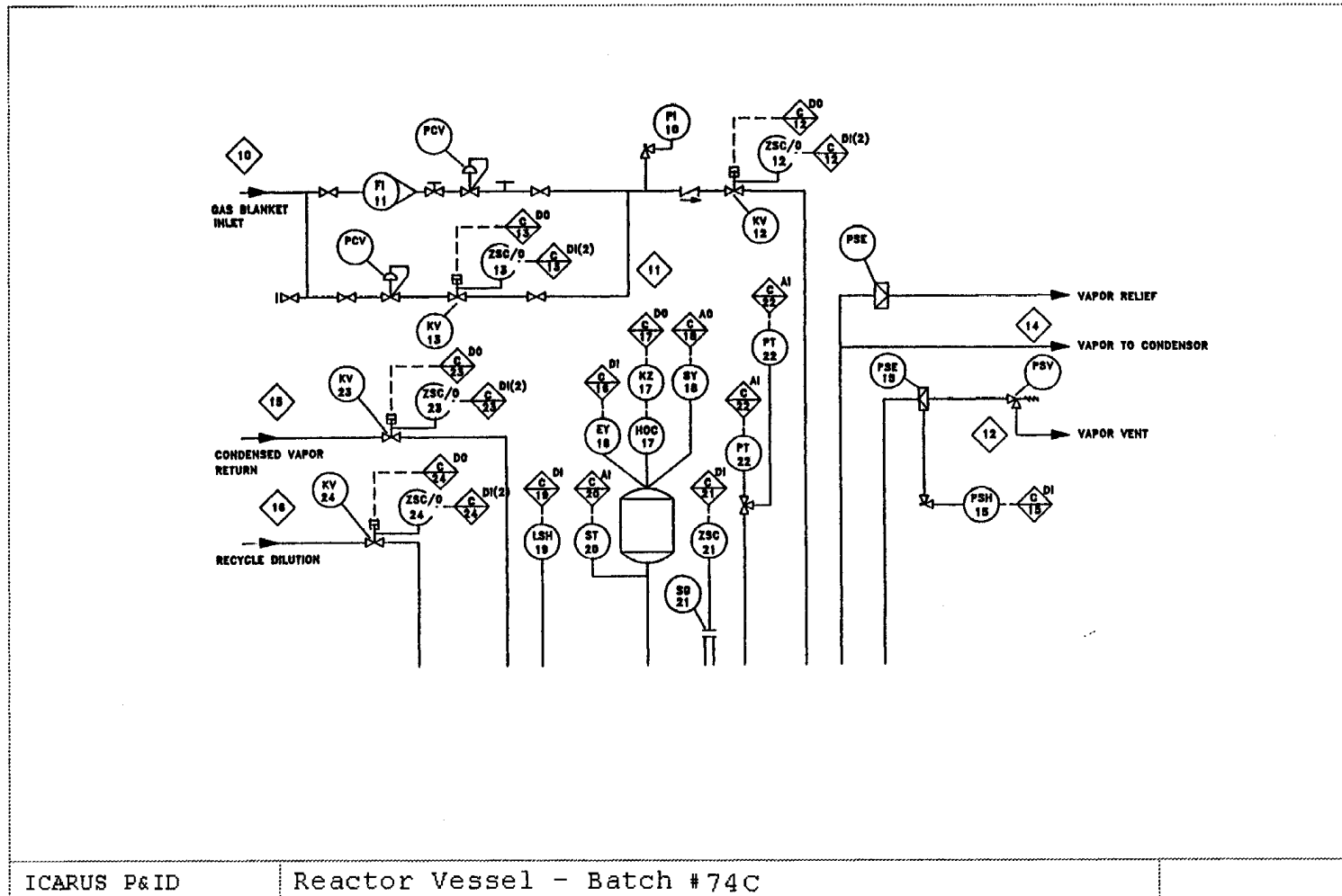
74A Reactor Vessel – Batch



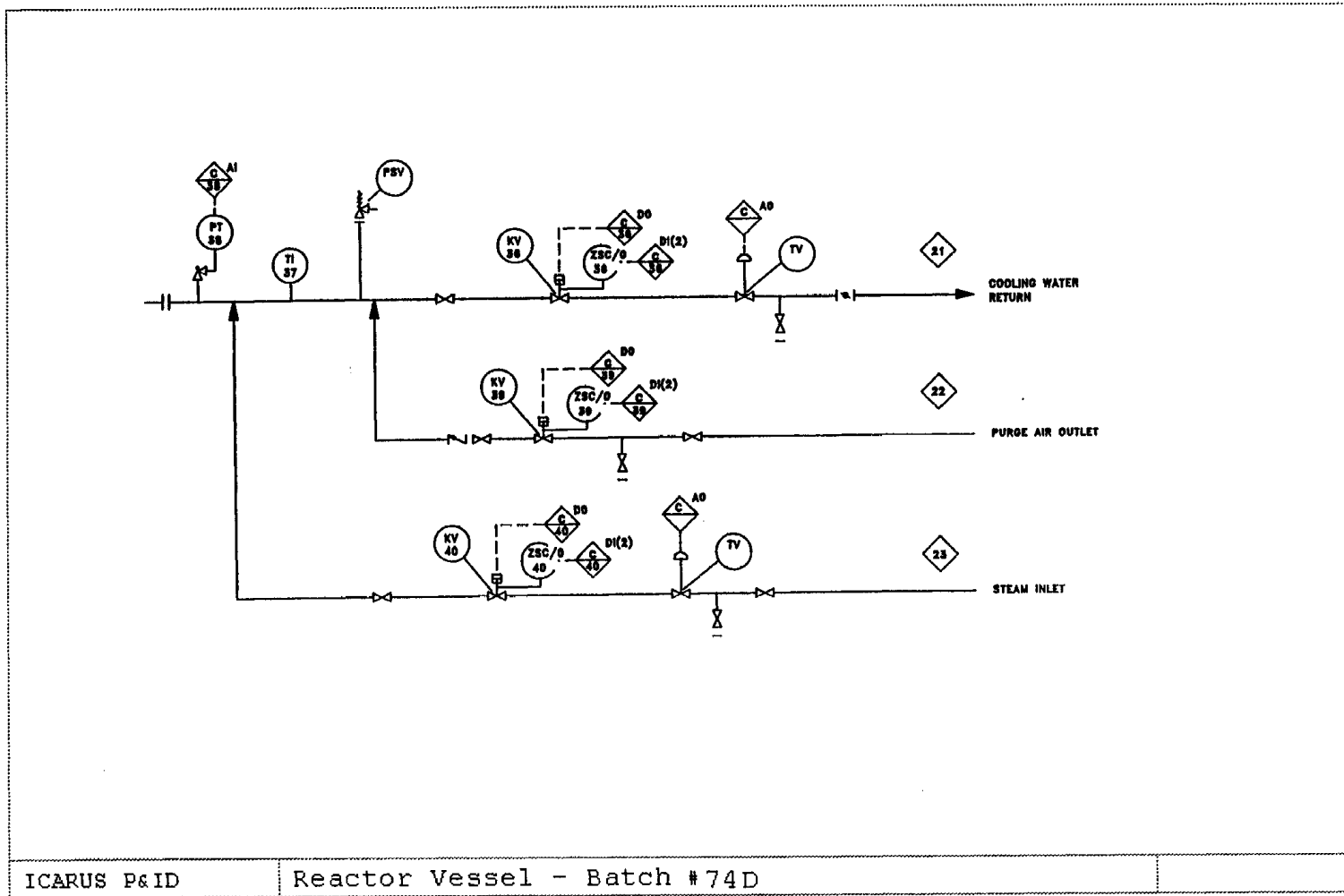
74B Reactor Vessel – Batch



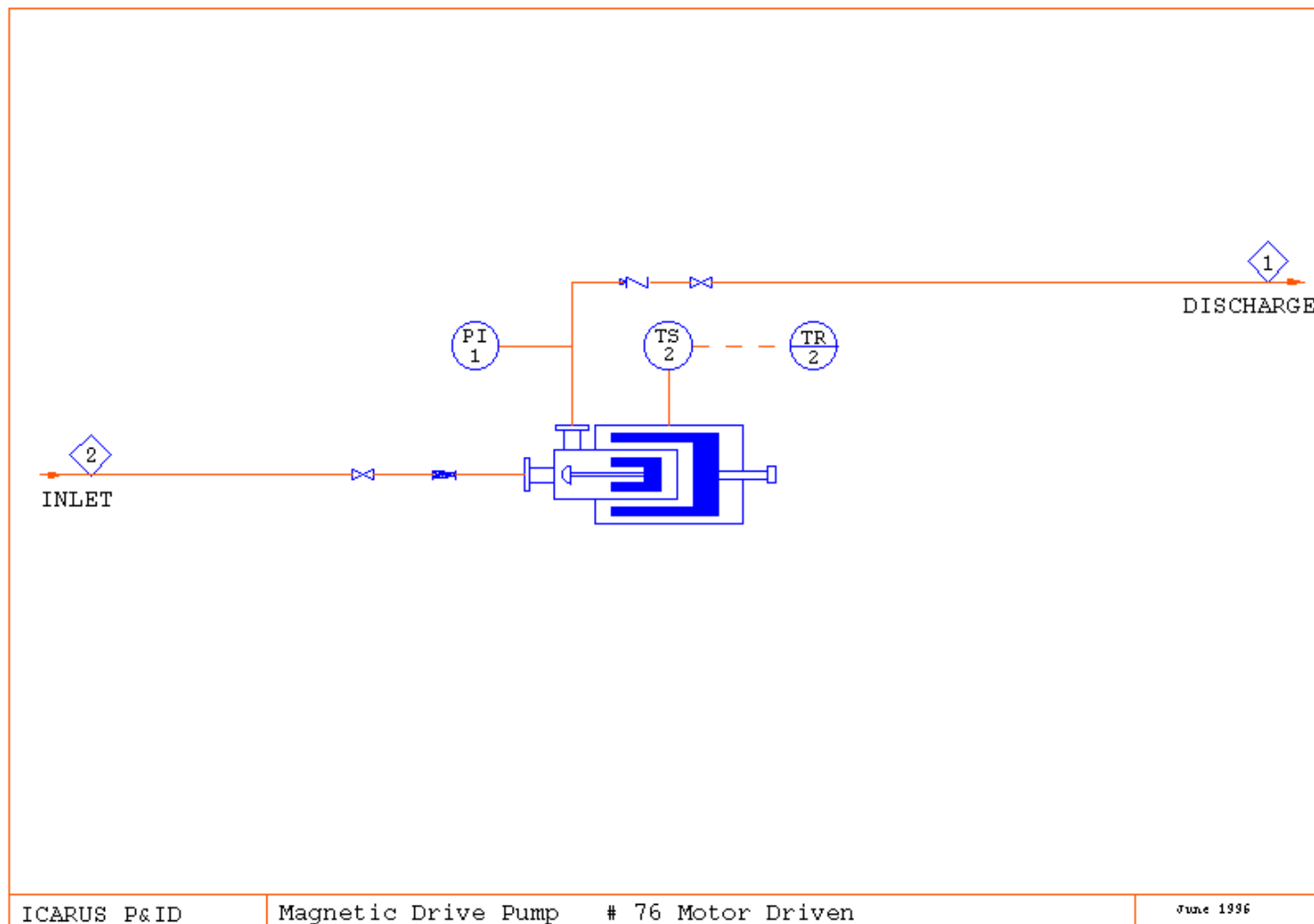
74C Reactor Vessel – Batch



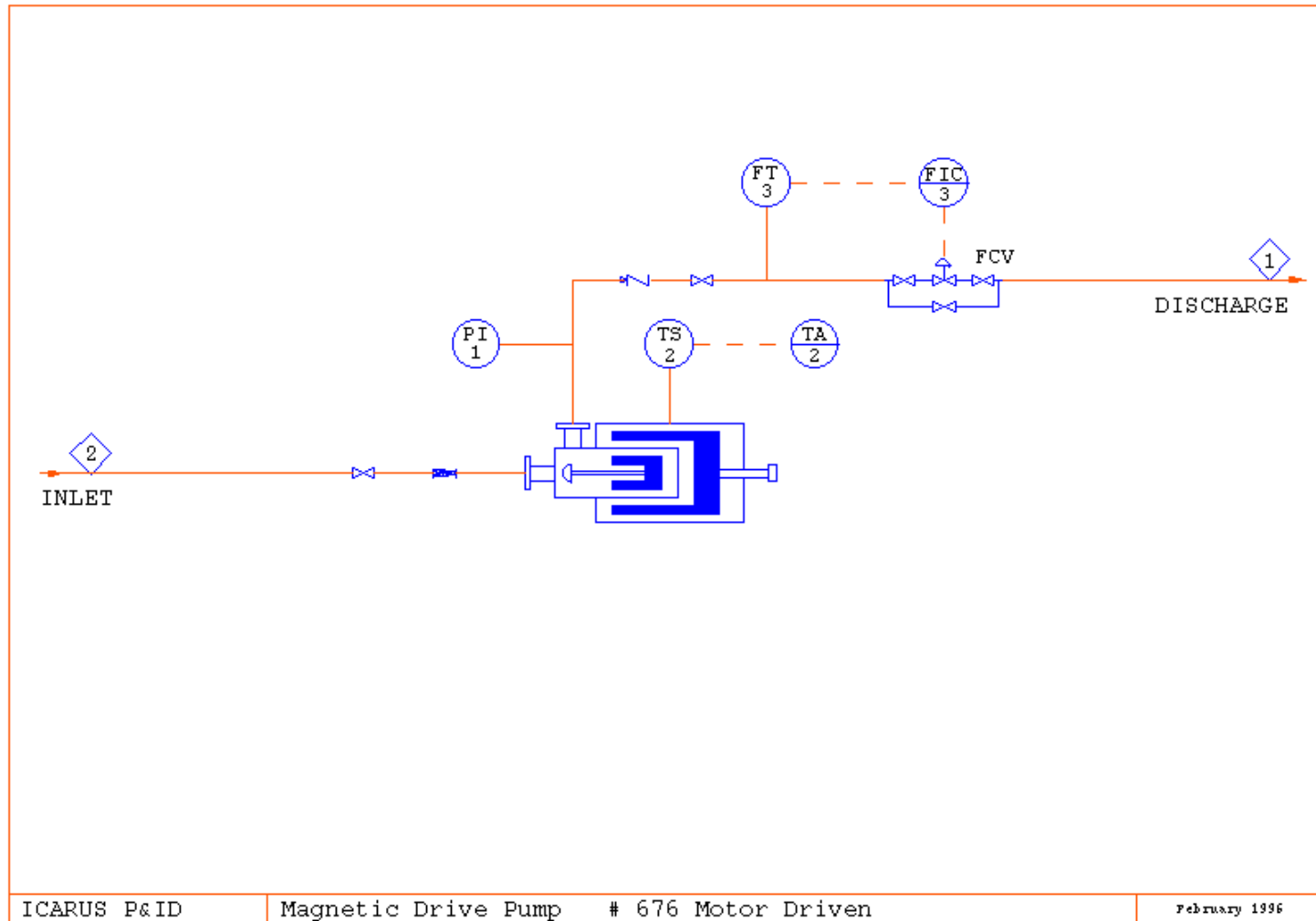
74D Reactor Vessel – Batch



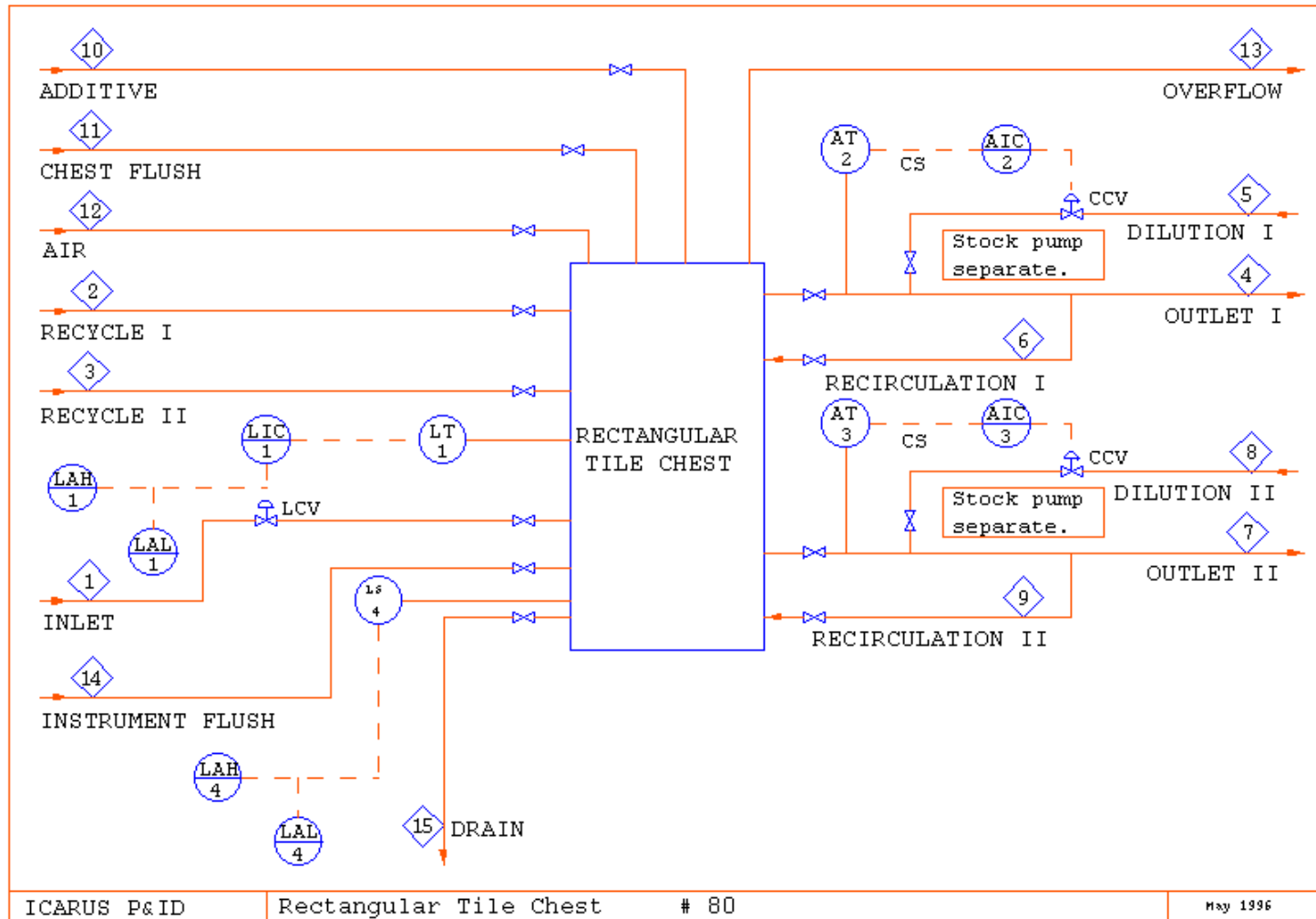
76 Motor Driven Magnetic Drive Pipe



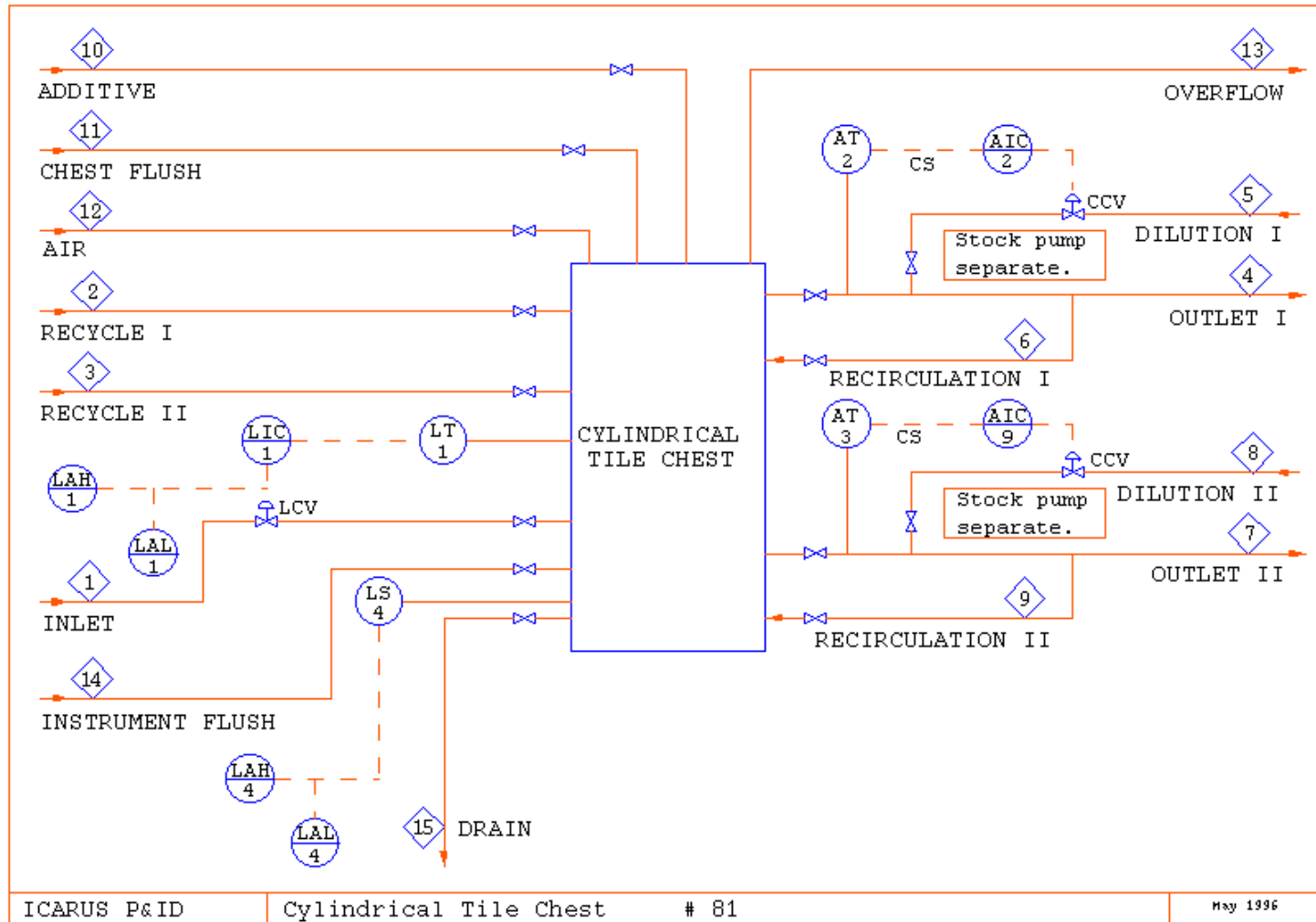
676 Motor Driven Magnetic Drive Pump



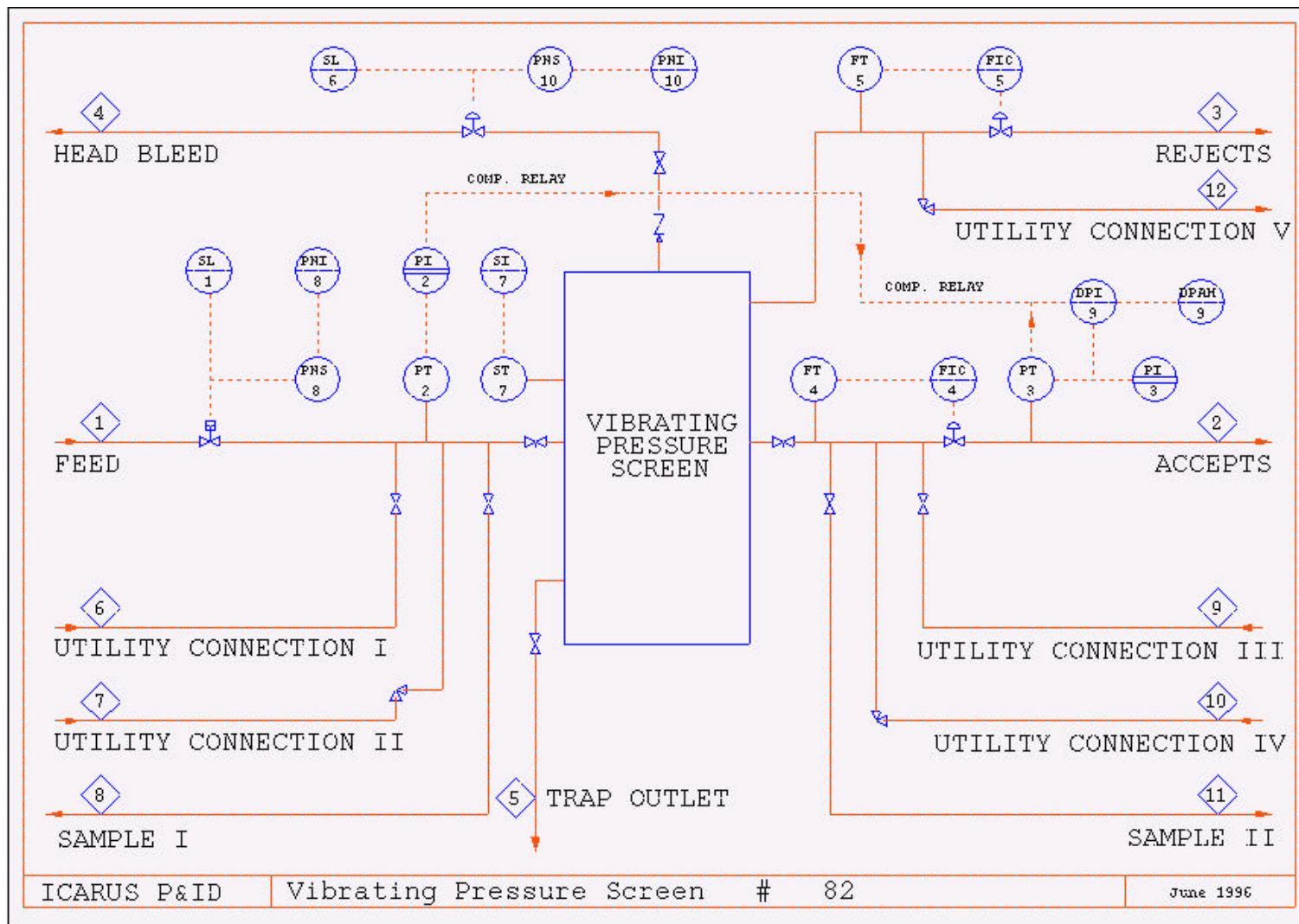
80 Rectangular Tile Chest



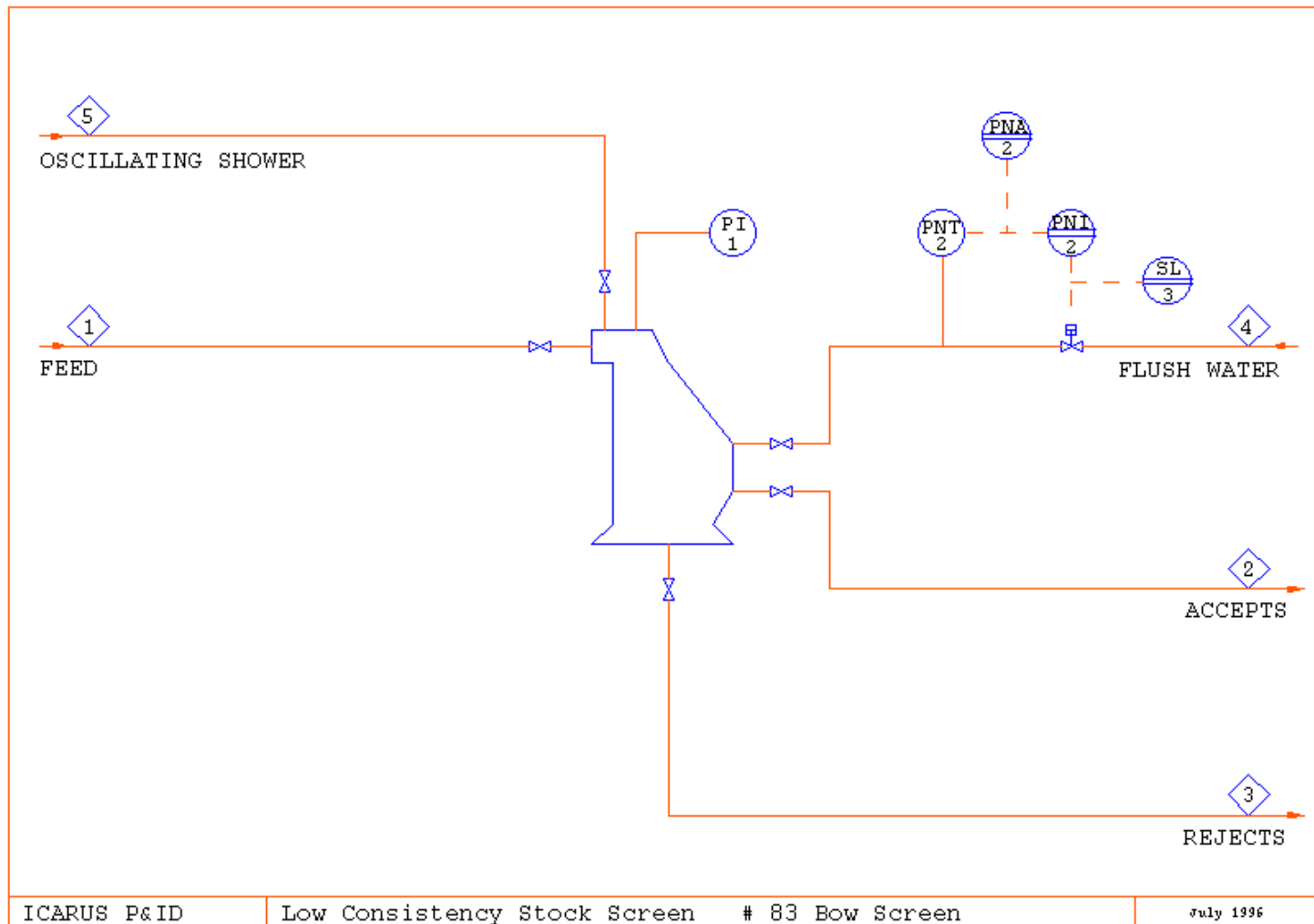
81 Cylindrical Tile Chest



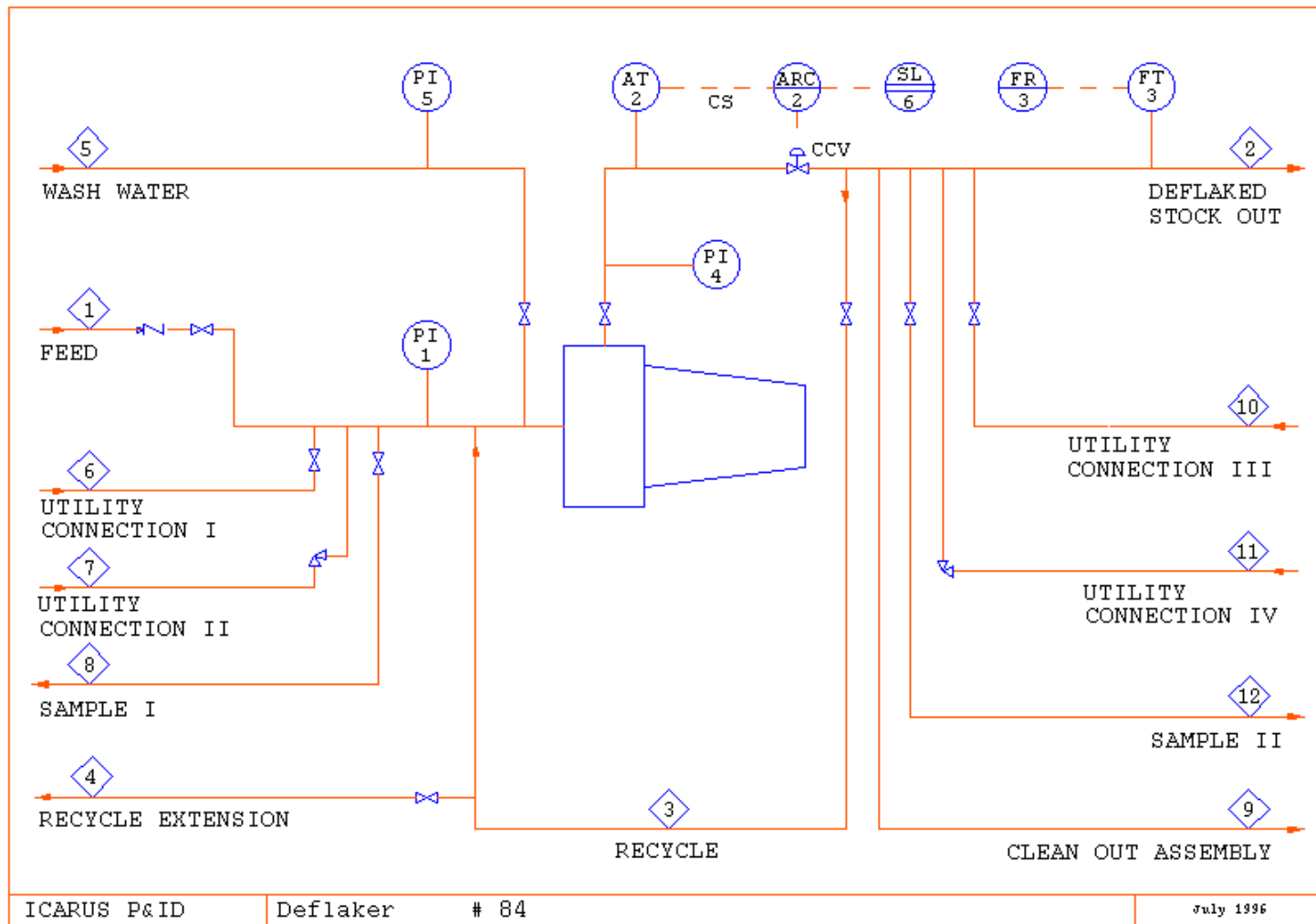
82 Vibrating Pressure Screen



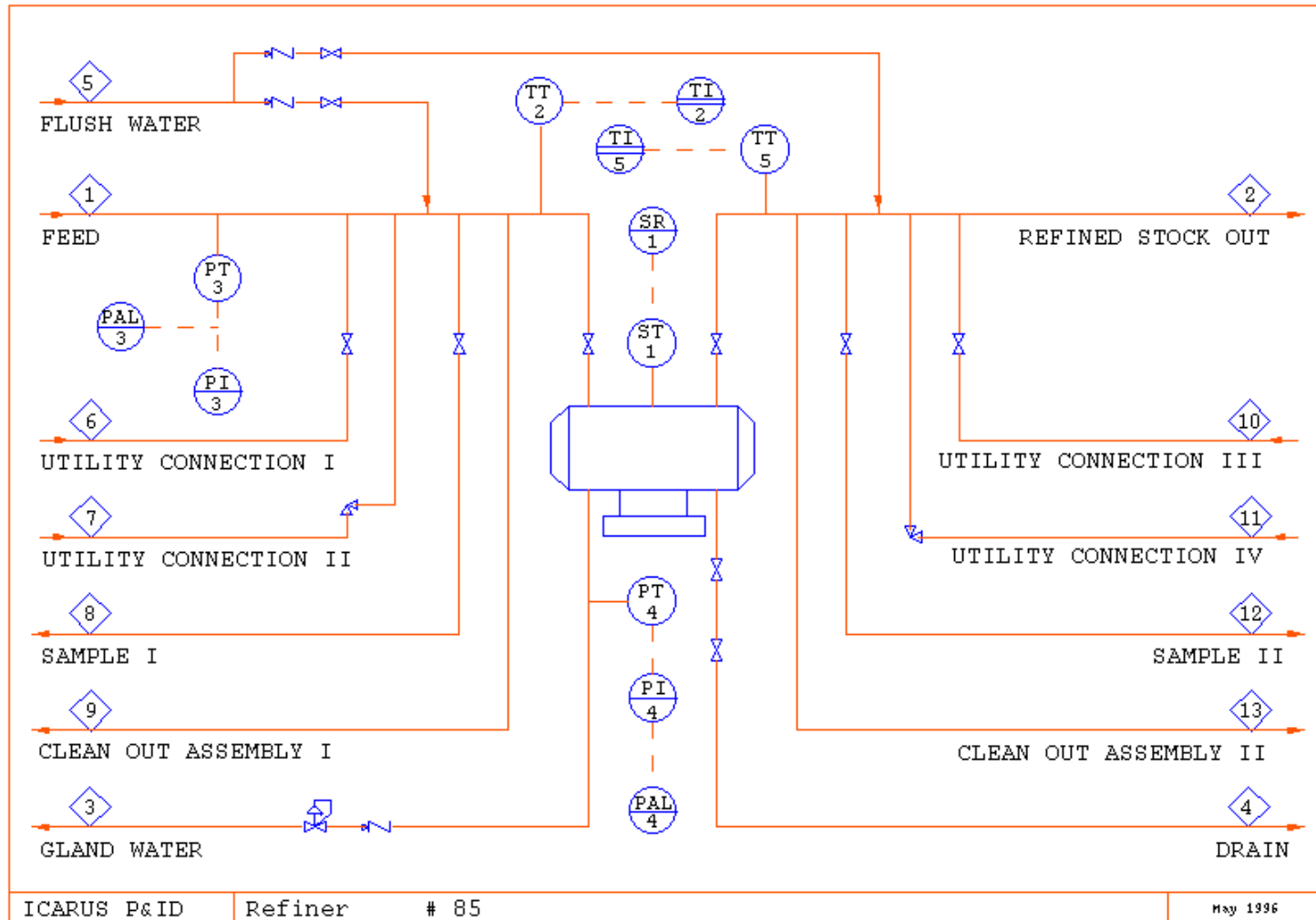
83 Bow Screen – Low Consistency Stock Screen



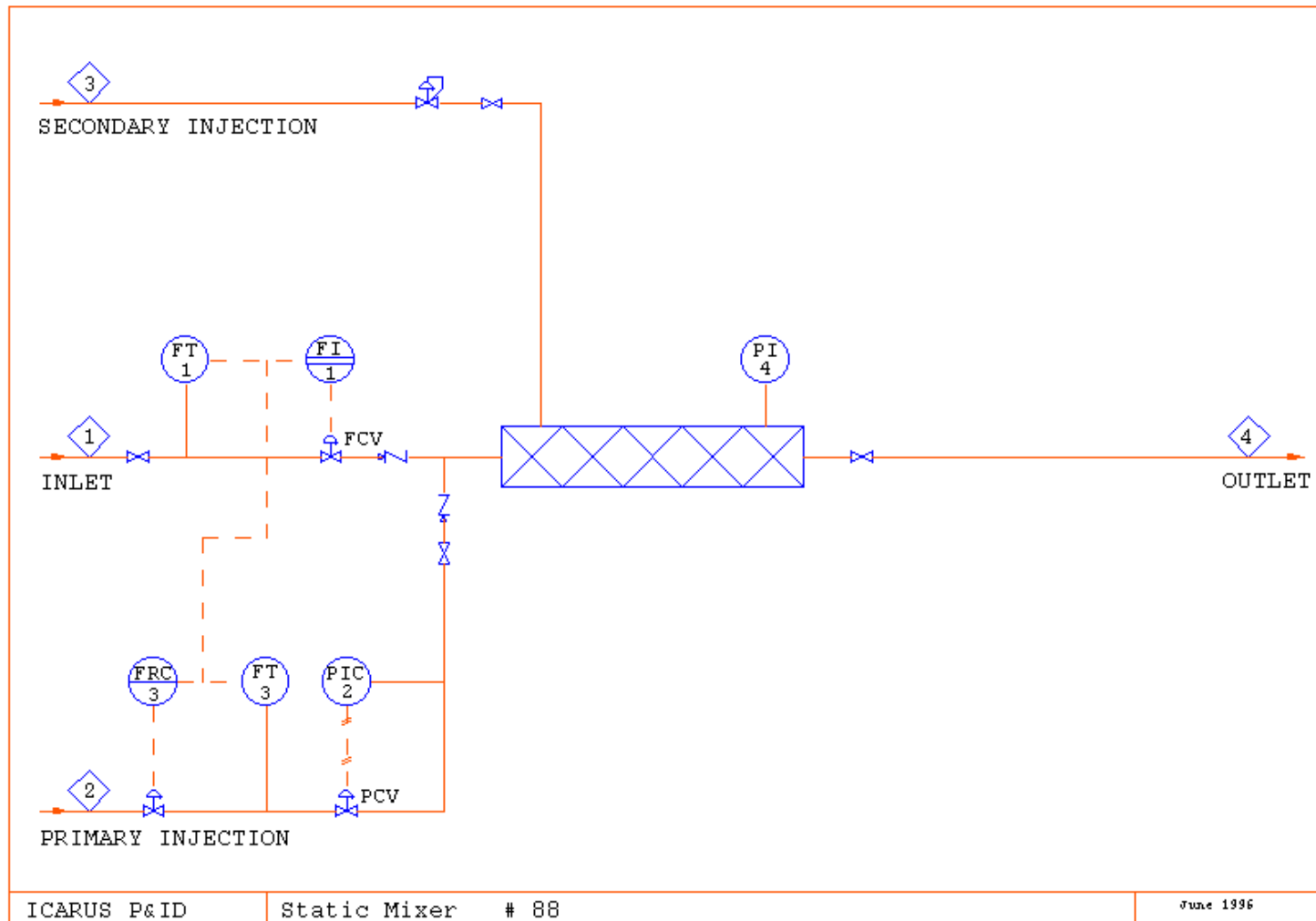
84 Deflaker



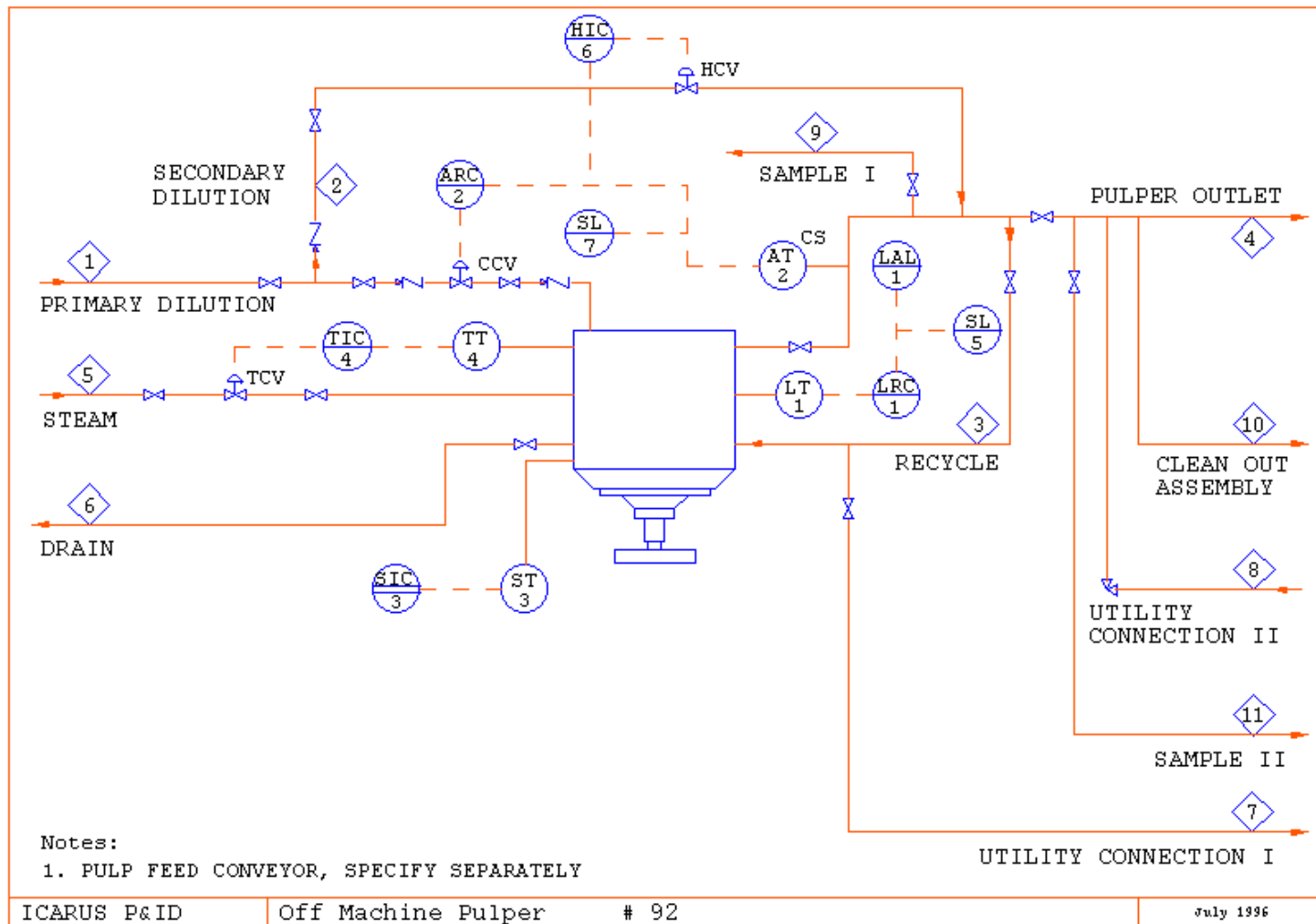
85 Refiner



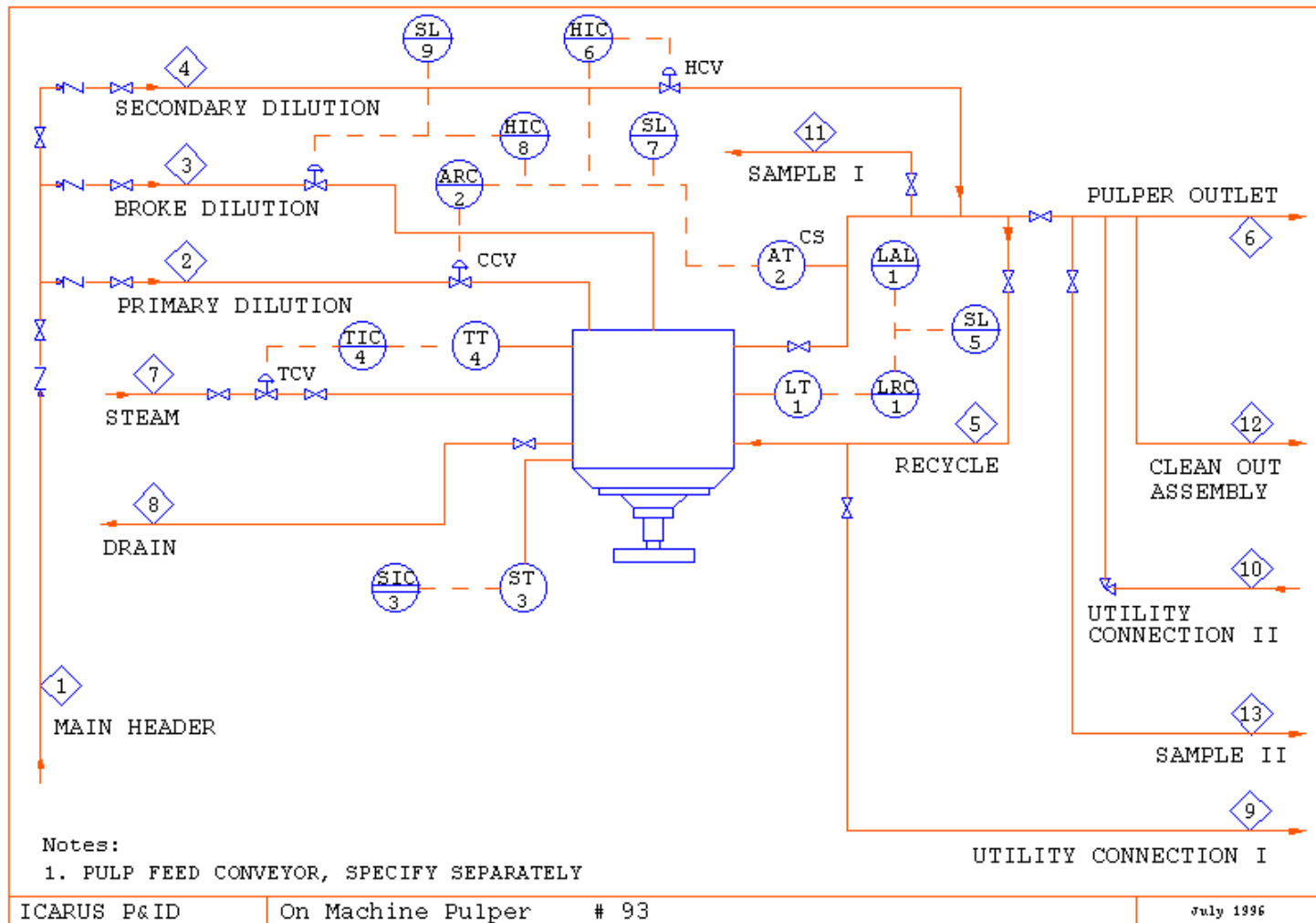
88 Static Mixer



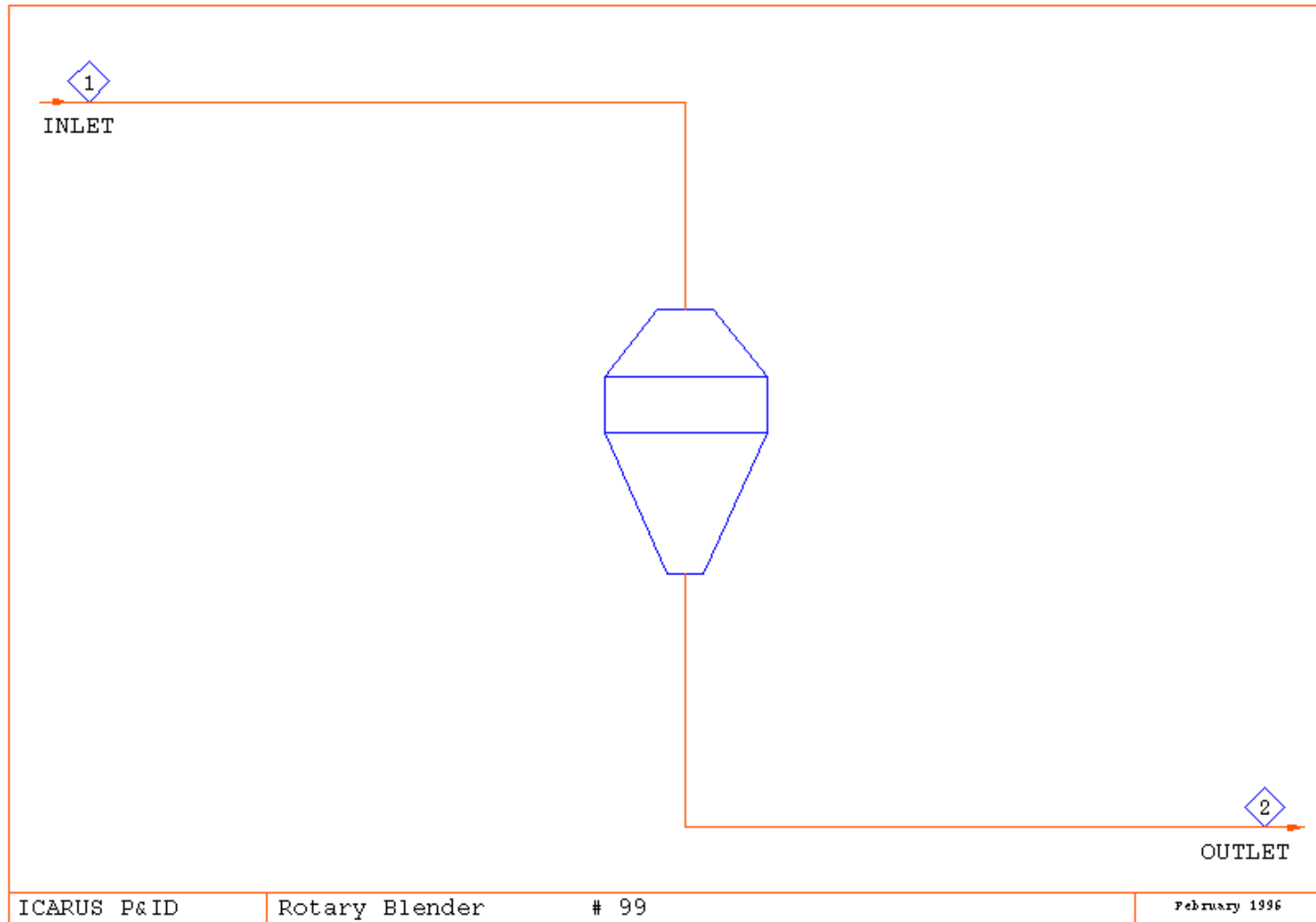
92 Off Machine Pulper



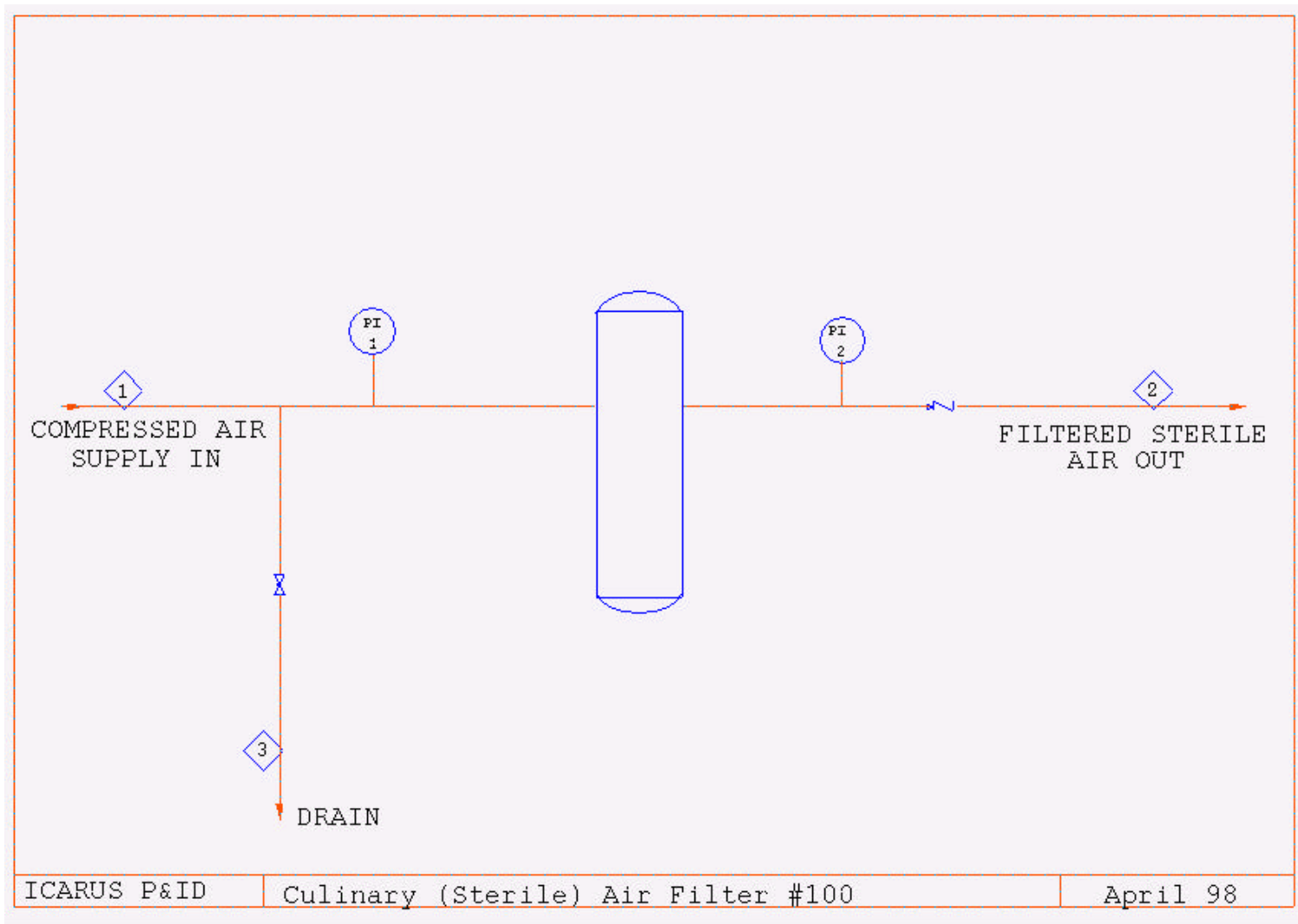
93 On Machine Pulper



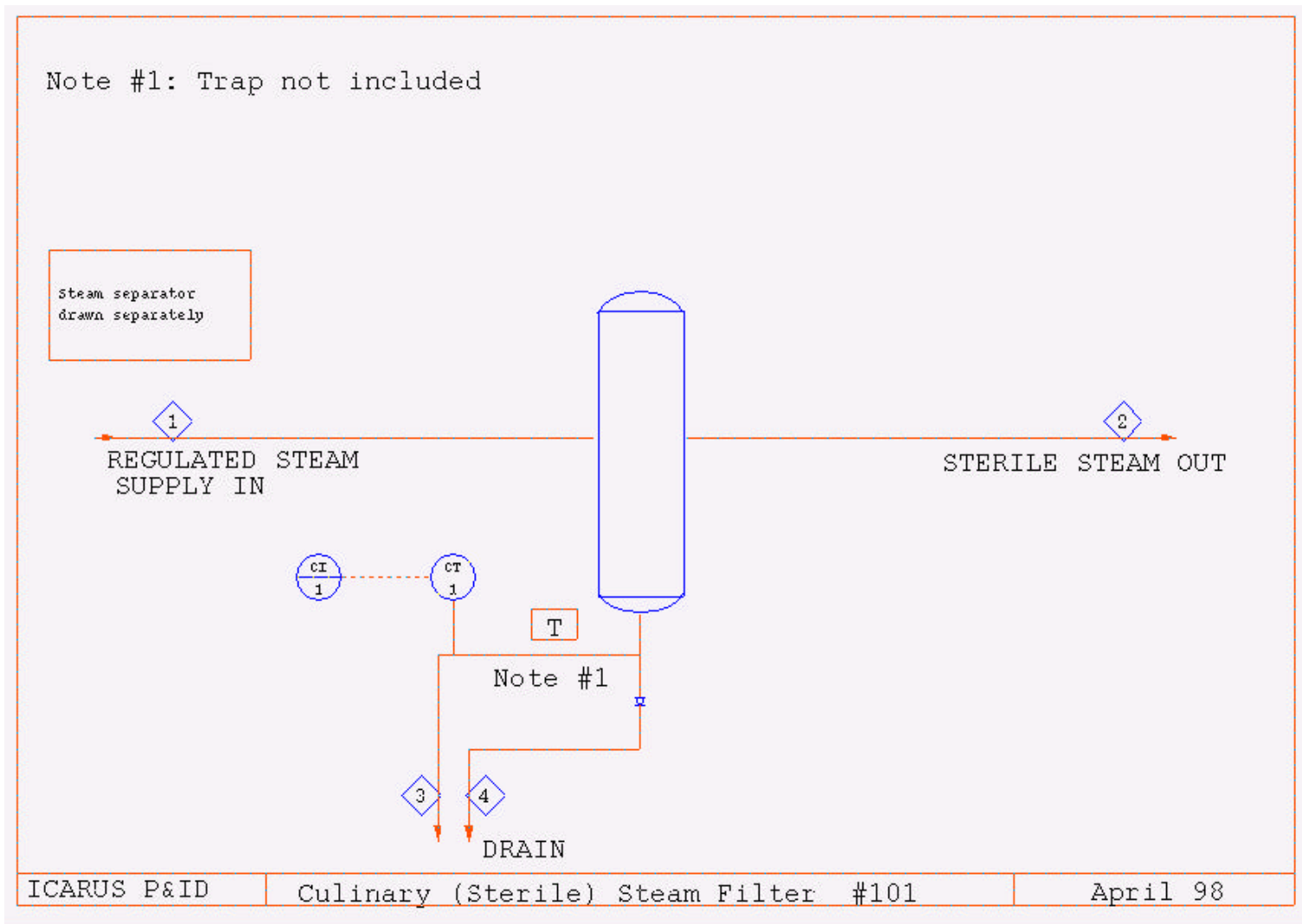
99 Rotary Blender



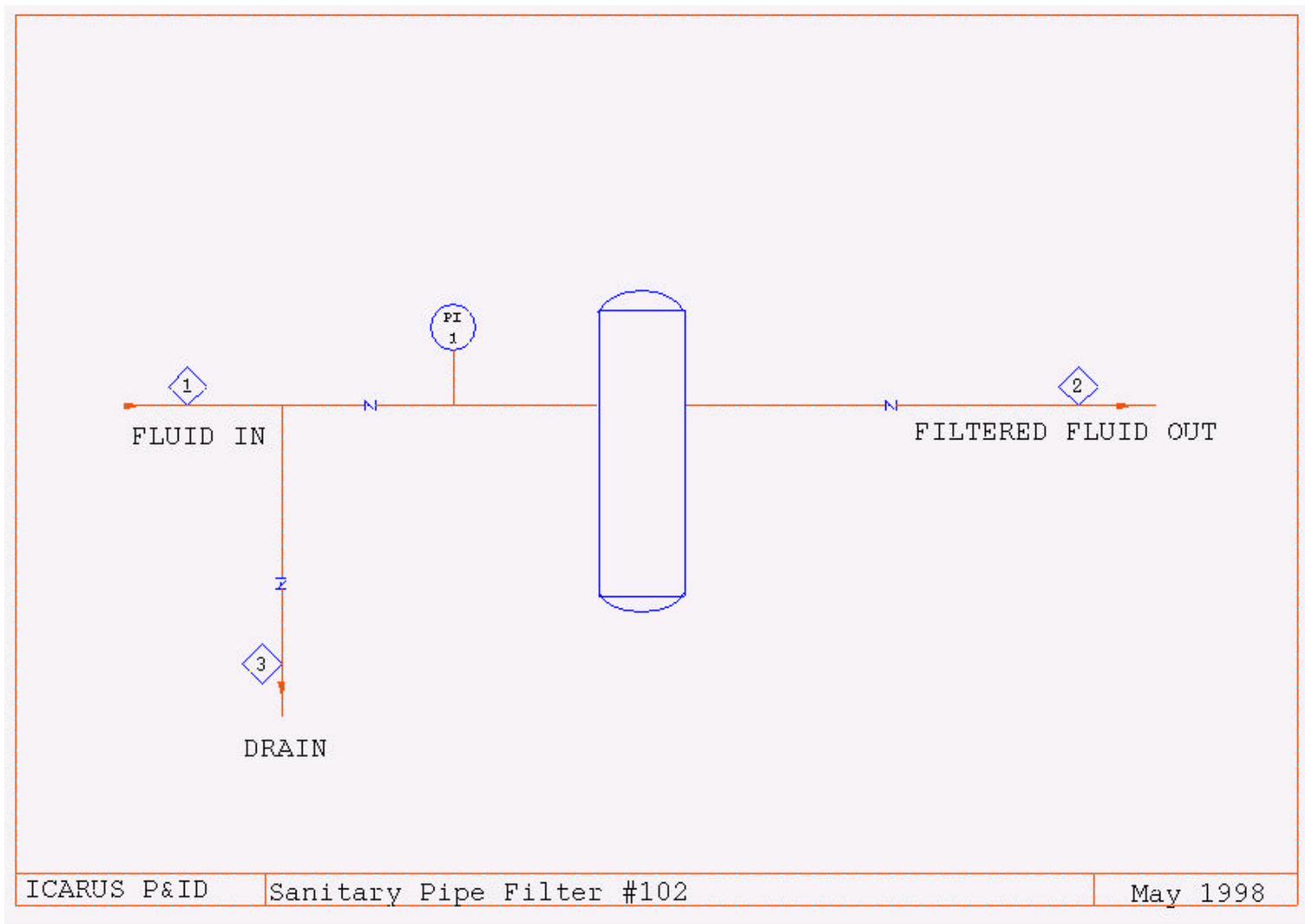
100 Culinary Air Filter



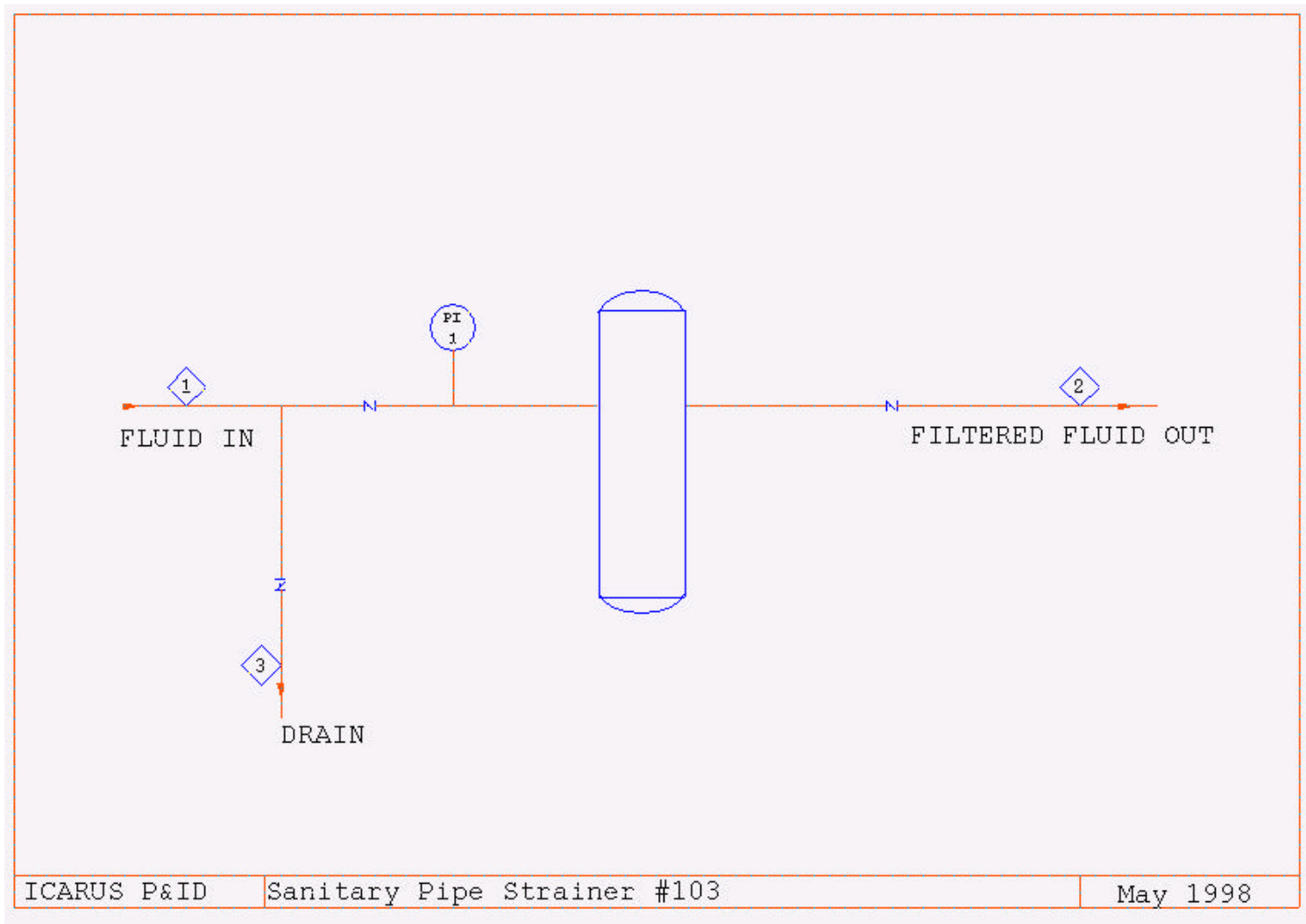
101 Culinary (Sterile) Steam Filter F-6



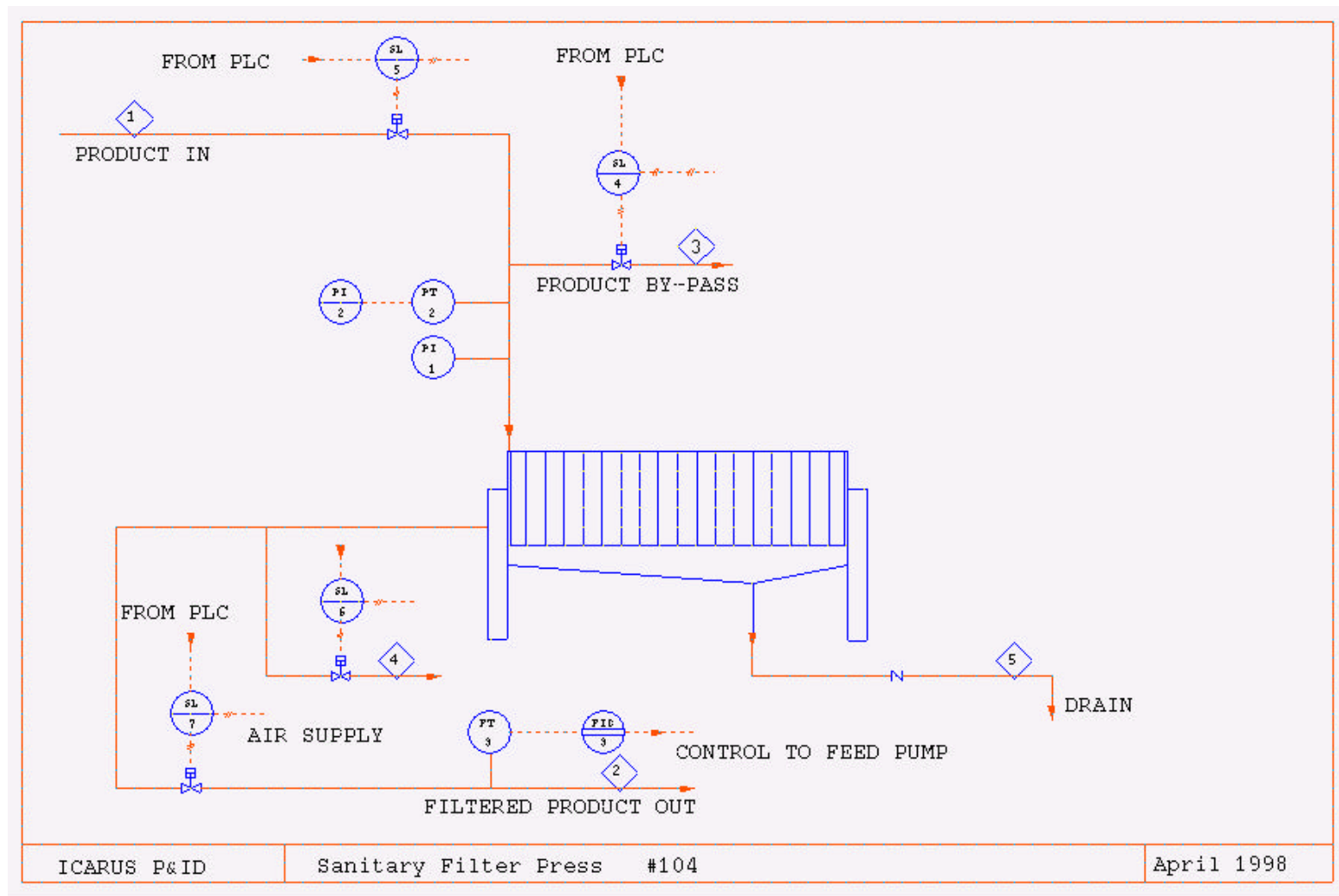
102 Sanitary Pipe Filter



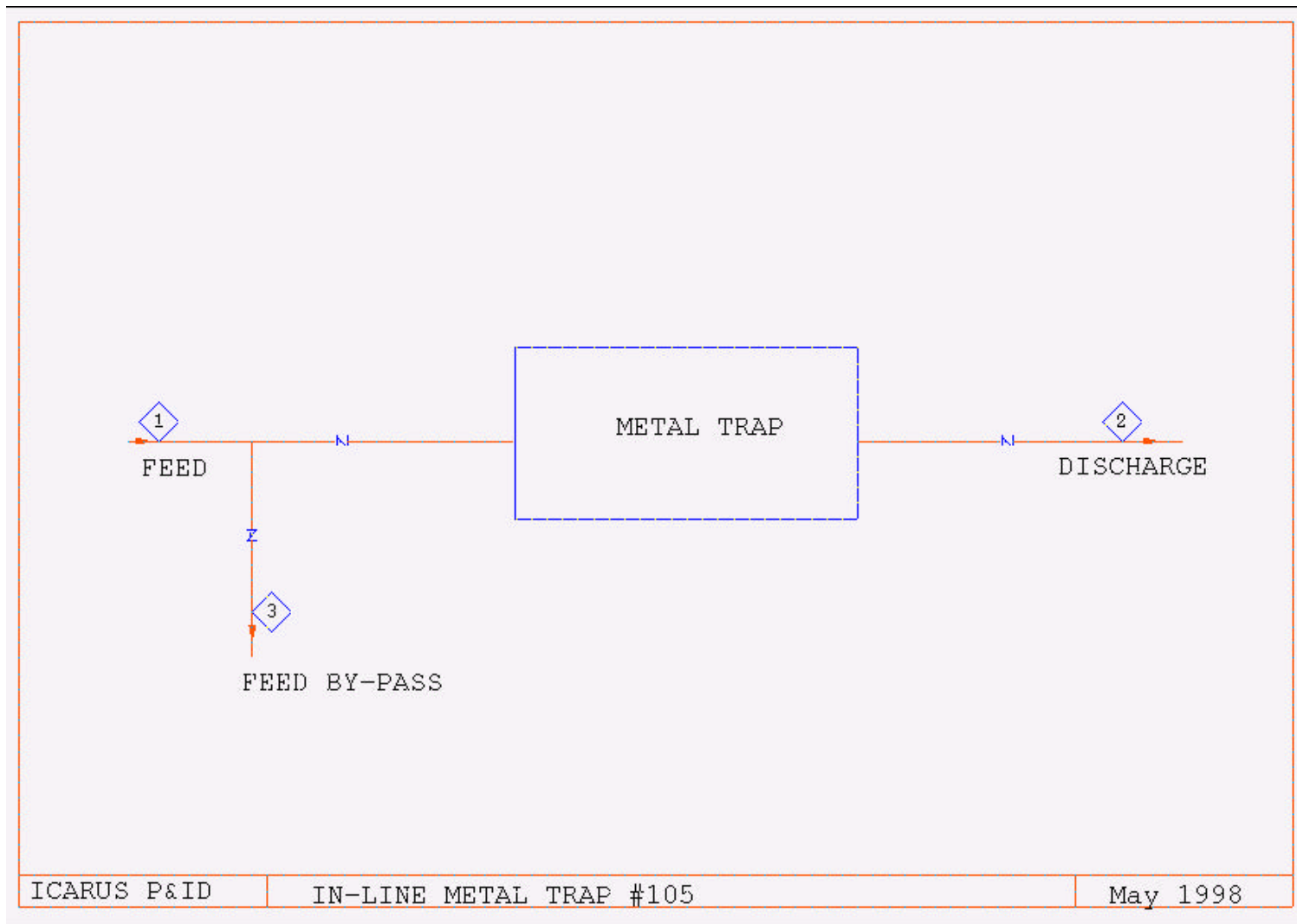
103 Sanitary Pipe Strainer



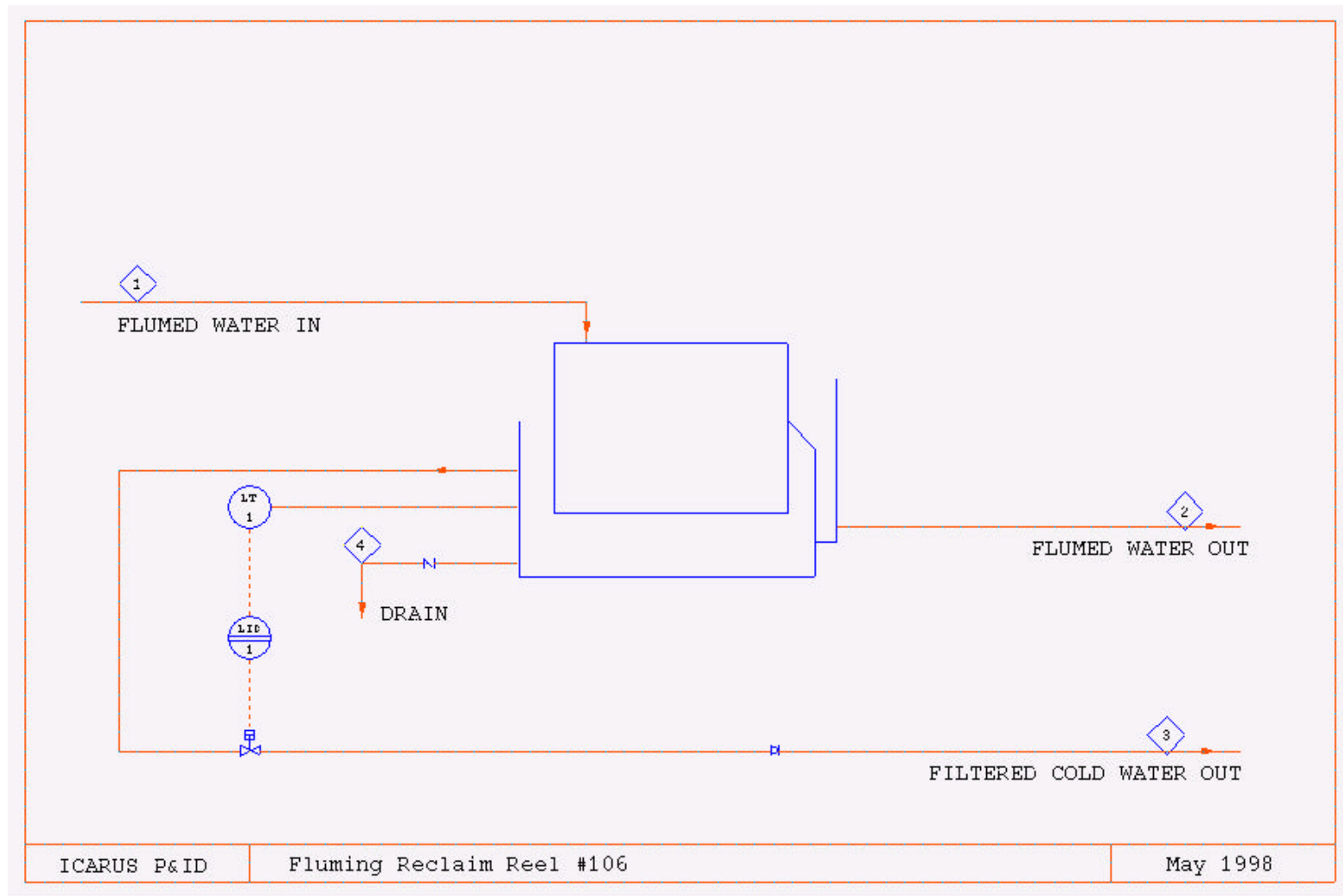
104 Sanitary Filter Press



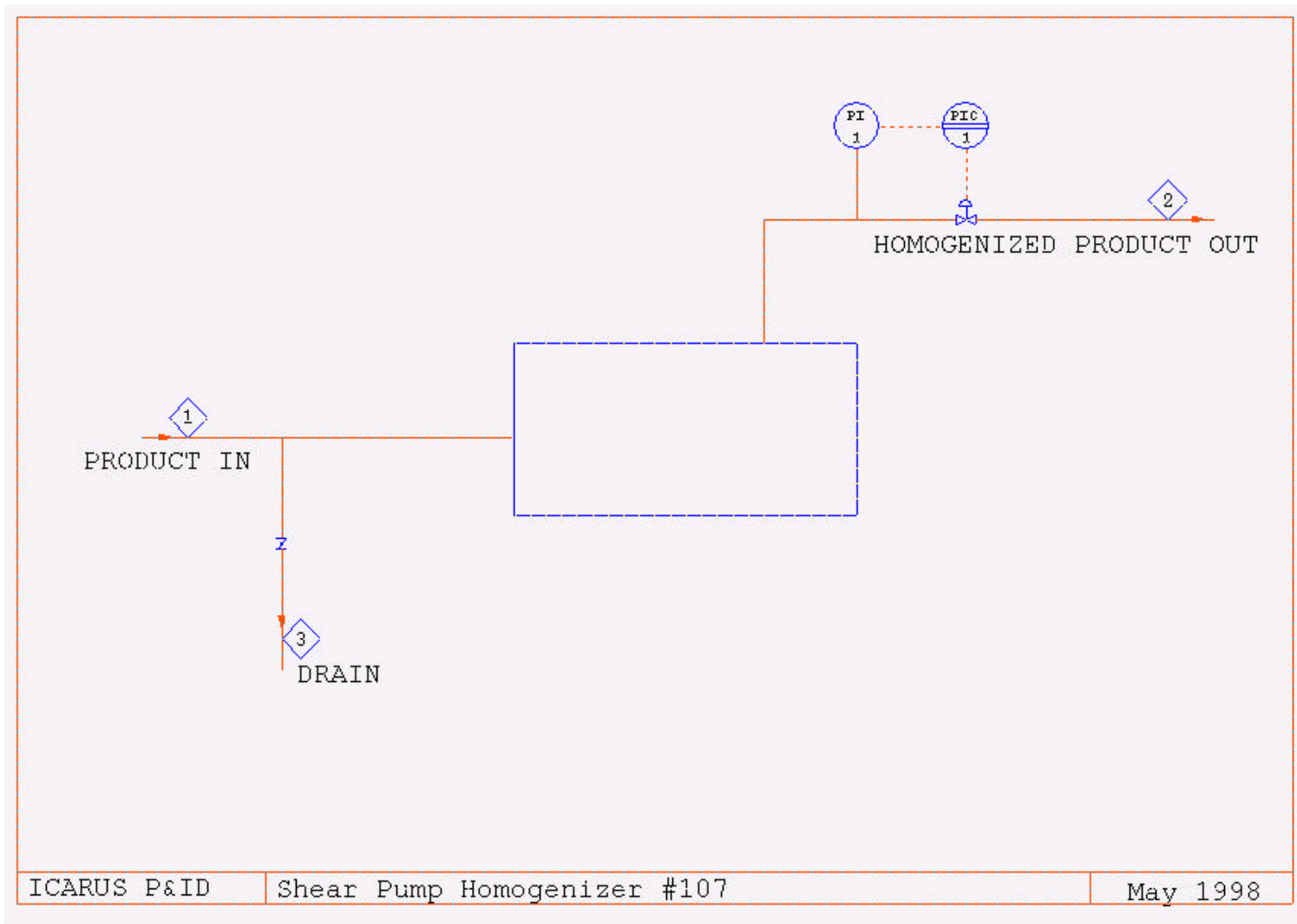
105 In-Line Metal Trap



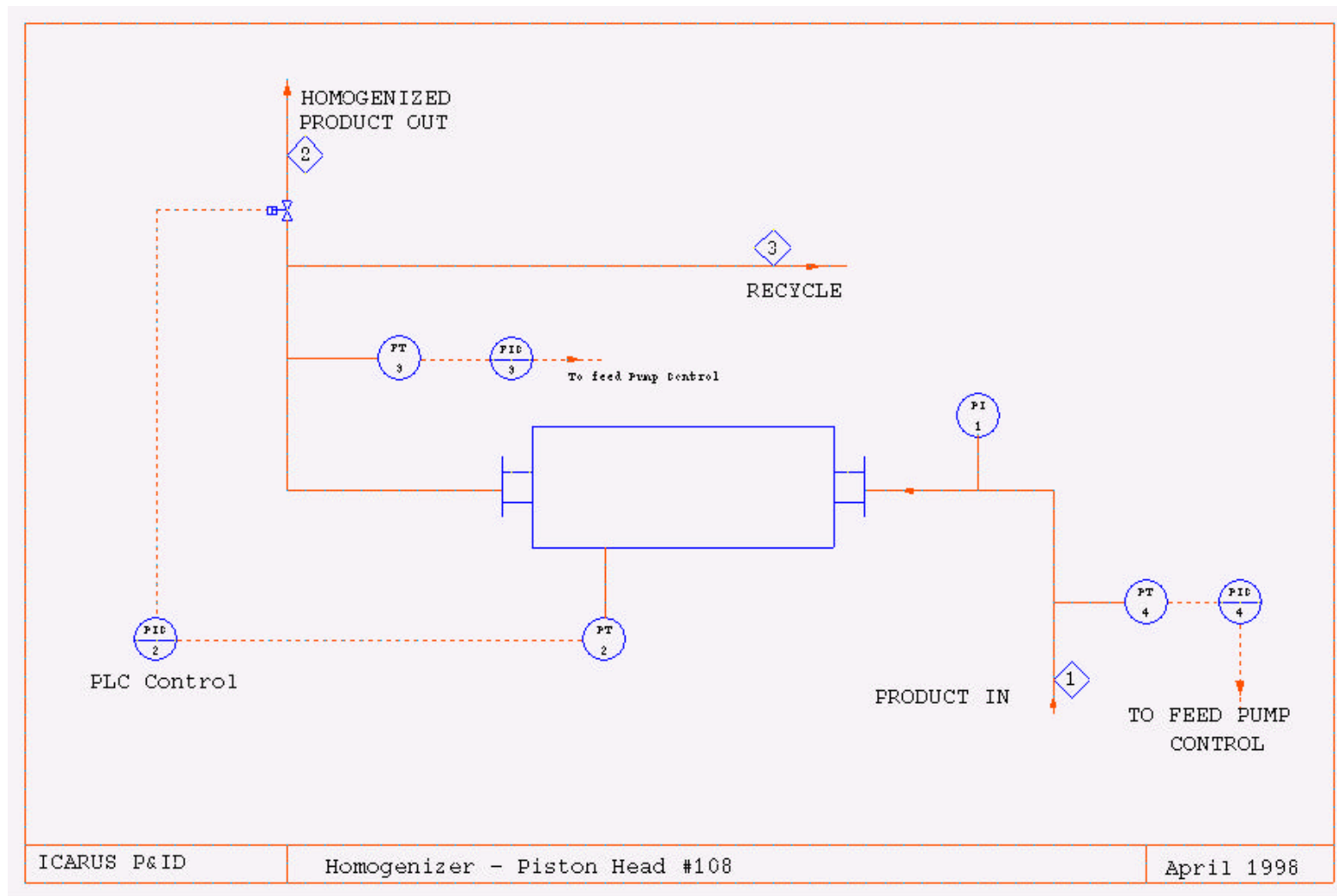
106 Fluming Reclaim Reel



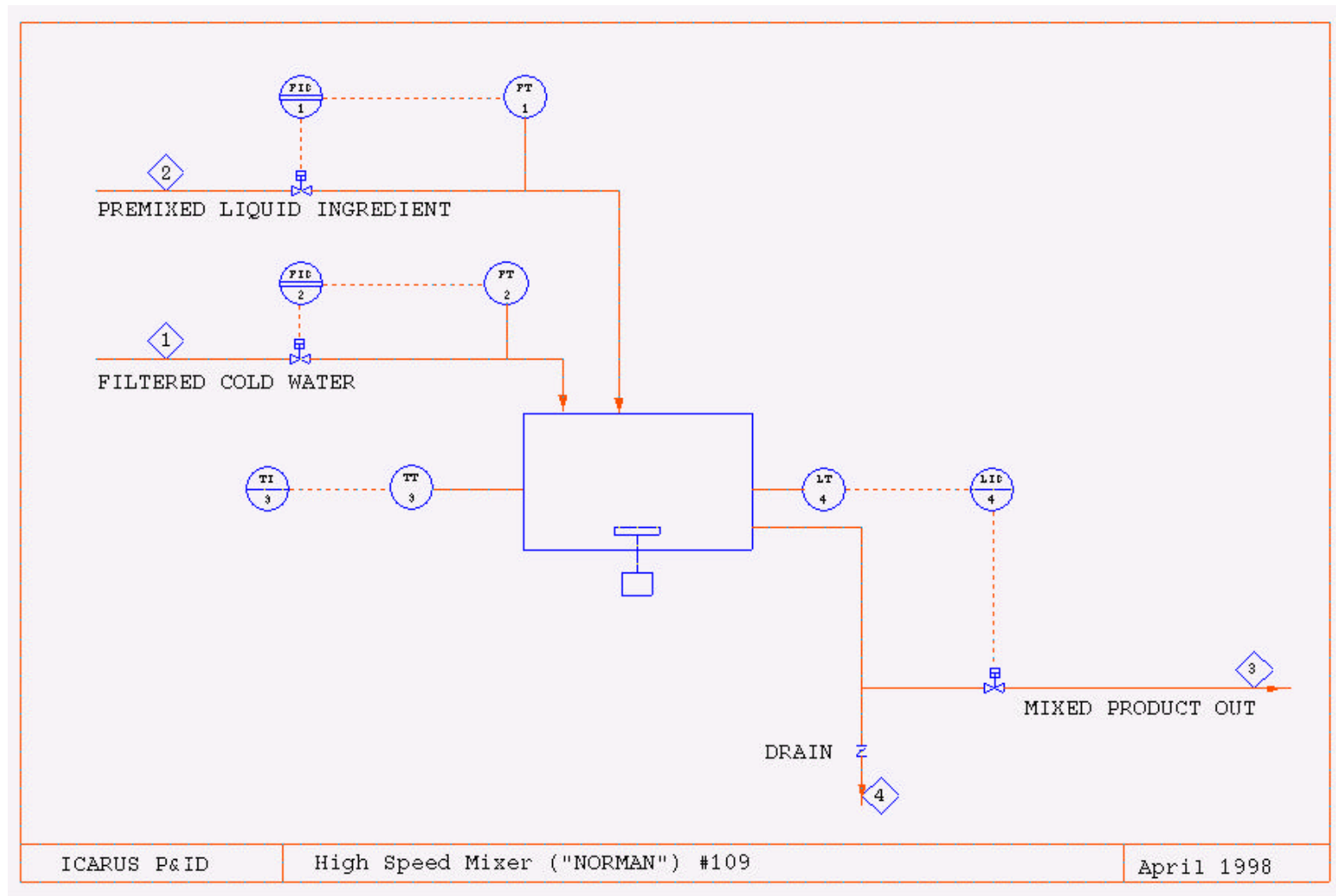
107 Shear Pump Homogenizer



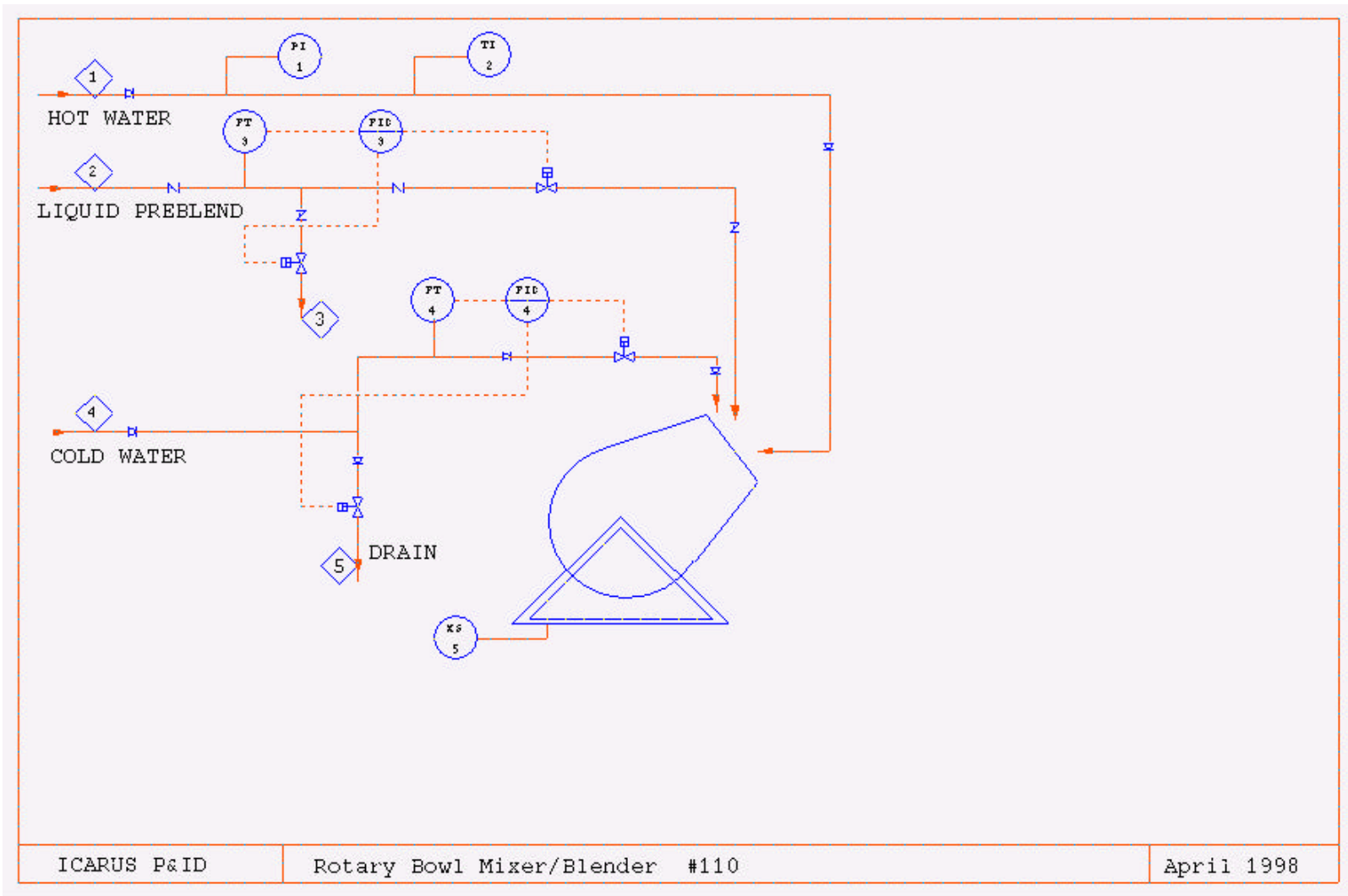
108 Homogenizer – Piston Head



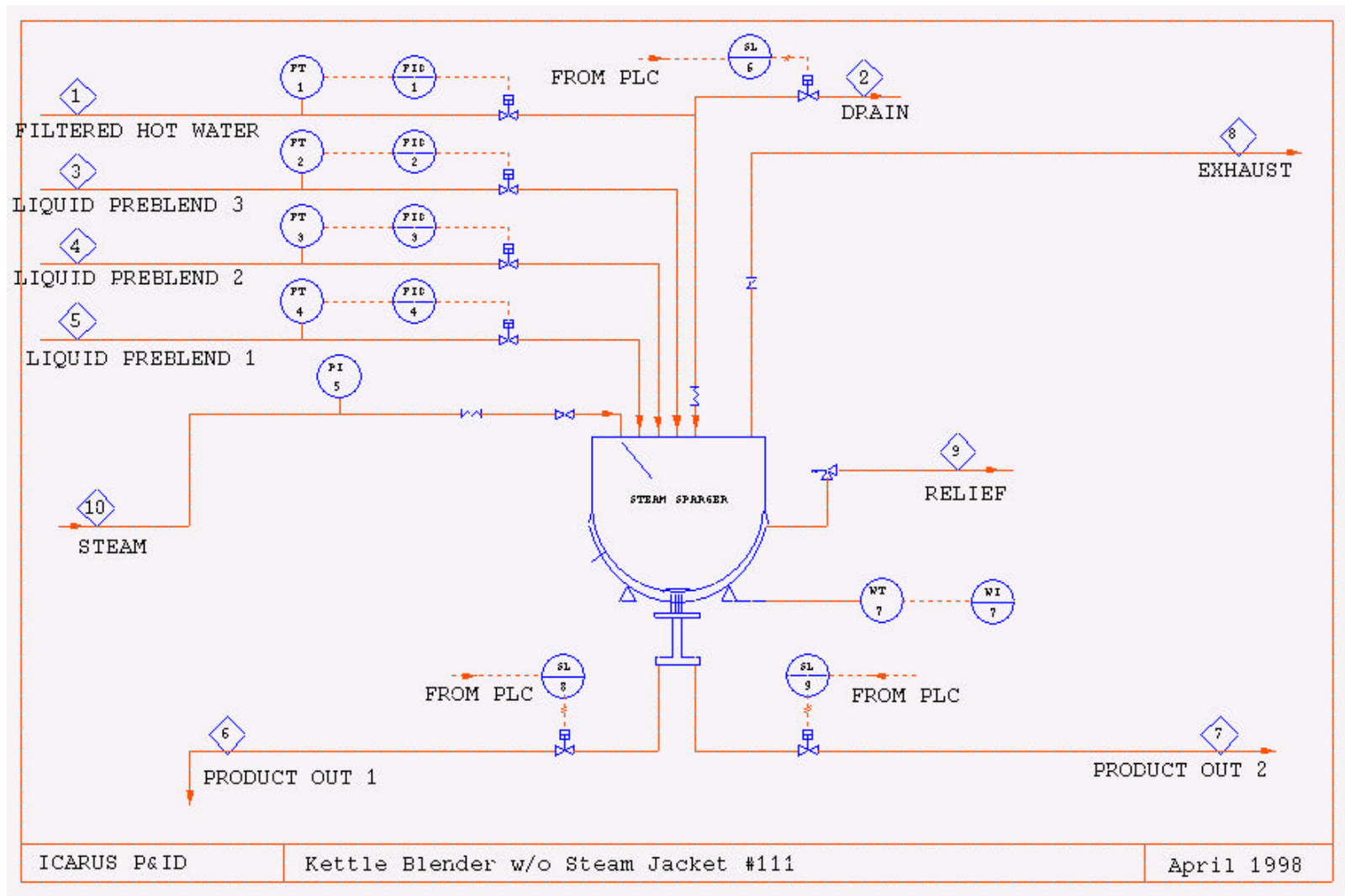
109 High-Speed Mixer ("Norman")



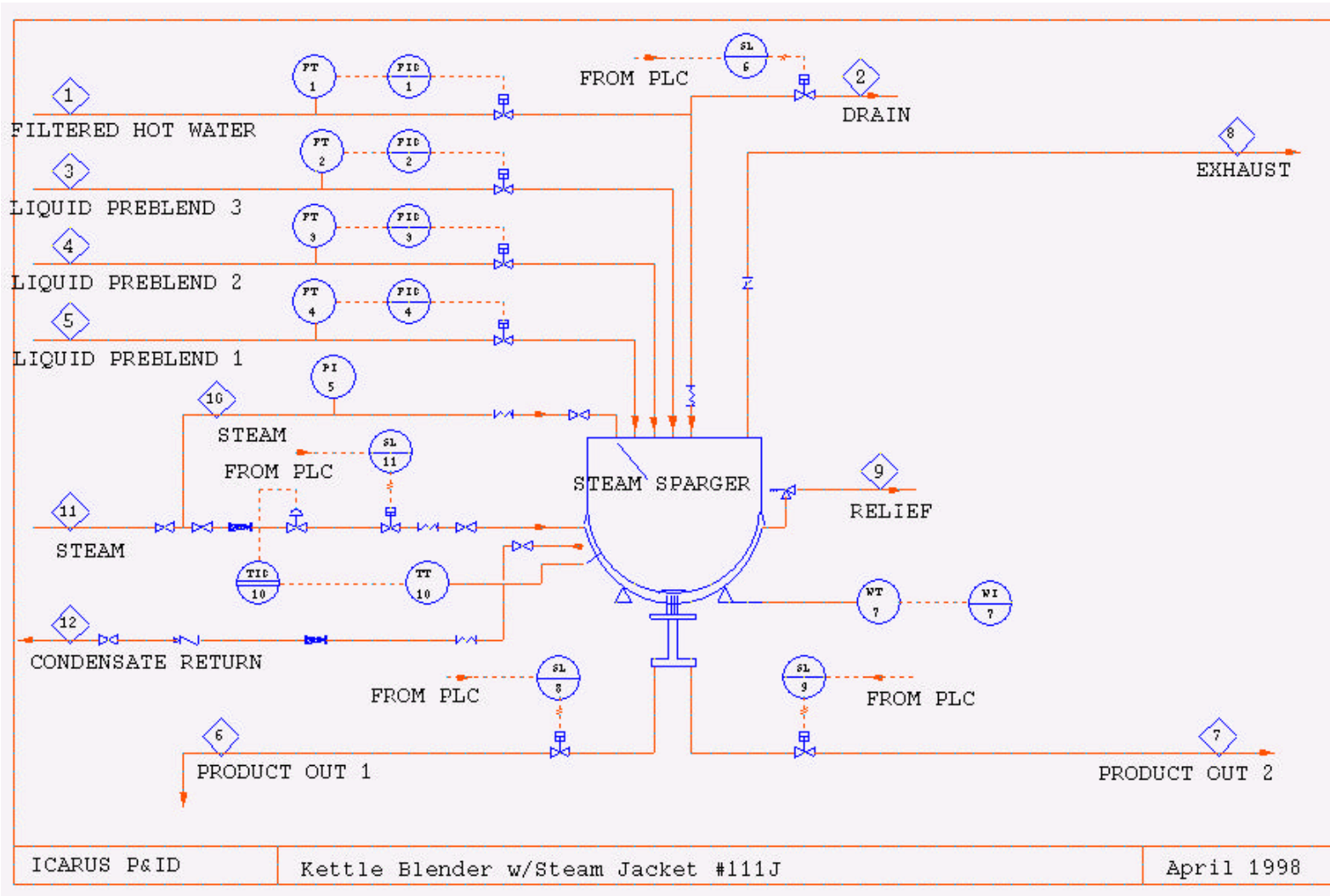
110 Rotary Bowl/Mixer Blender



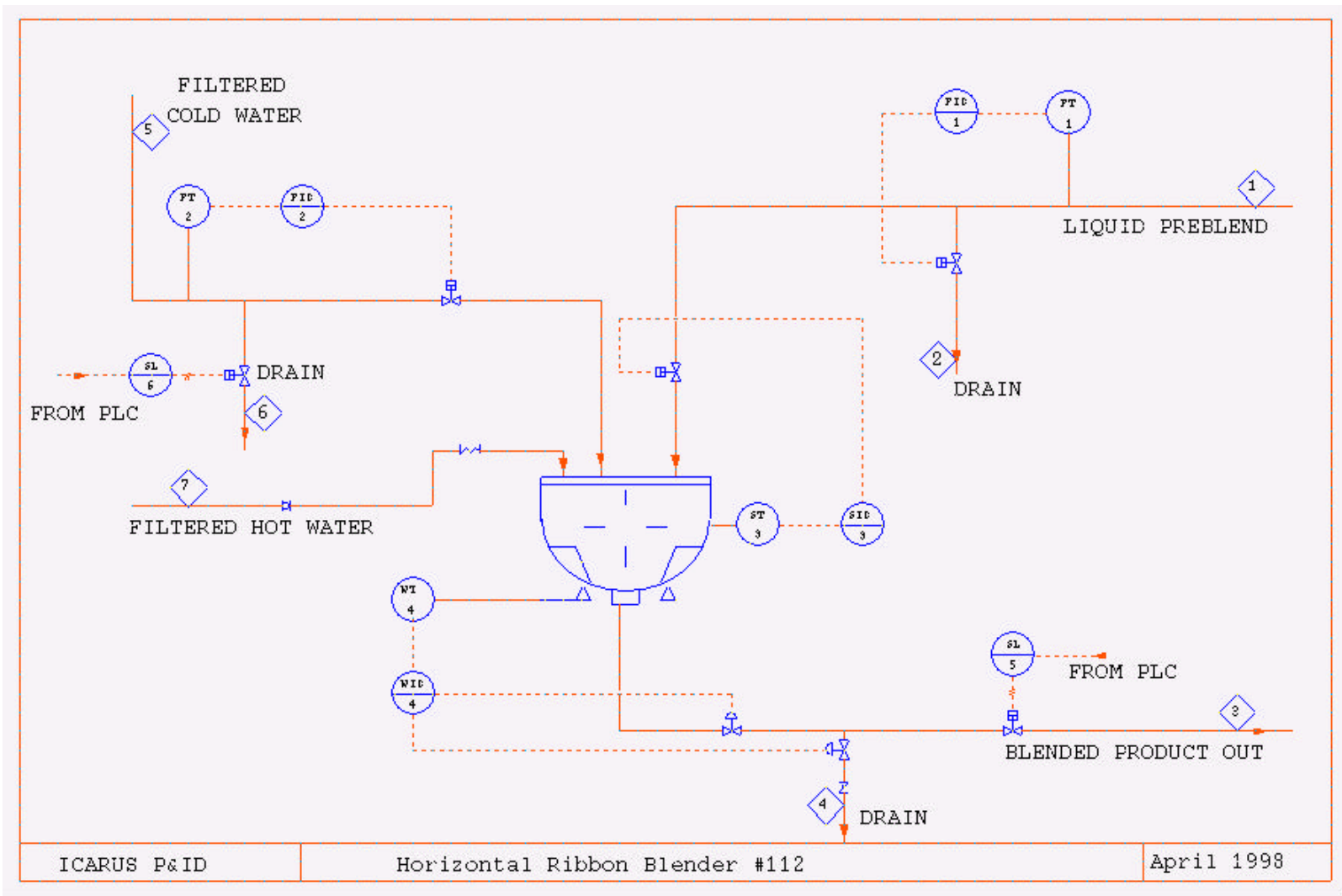
111 Kettle Blender Without Steam Jacket



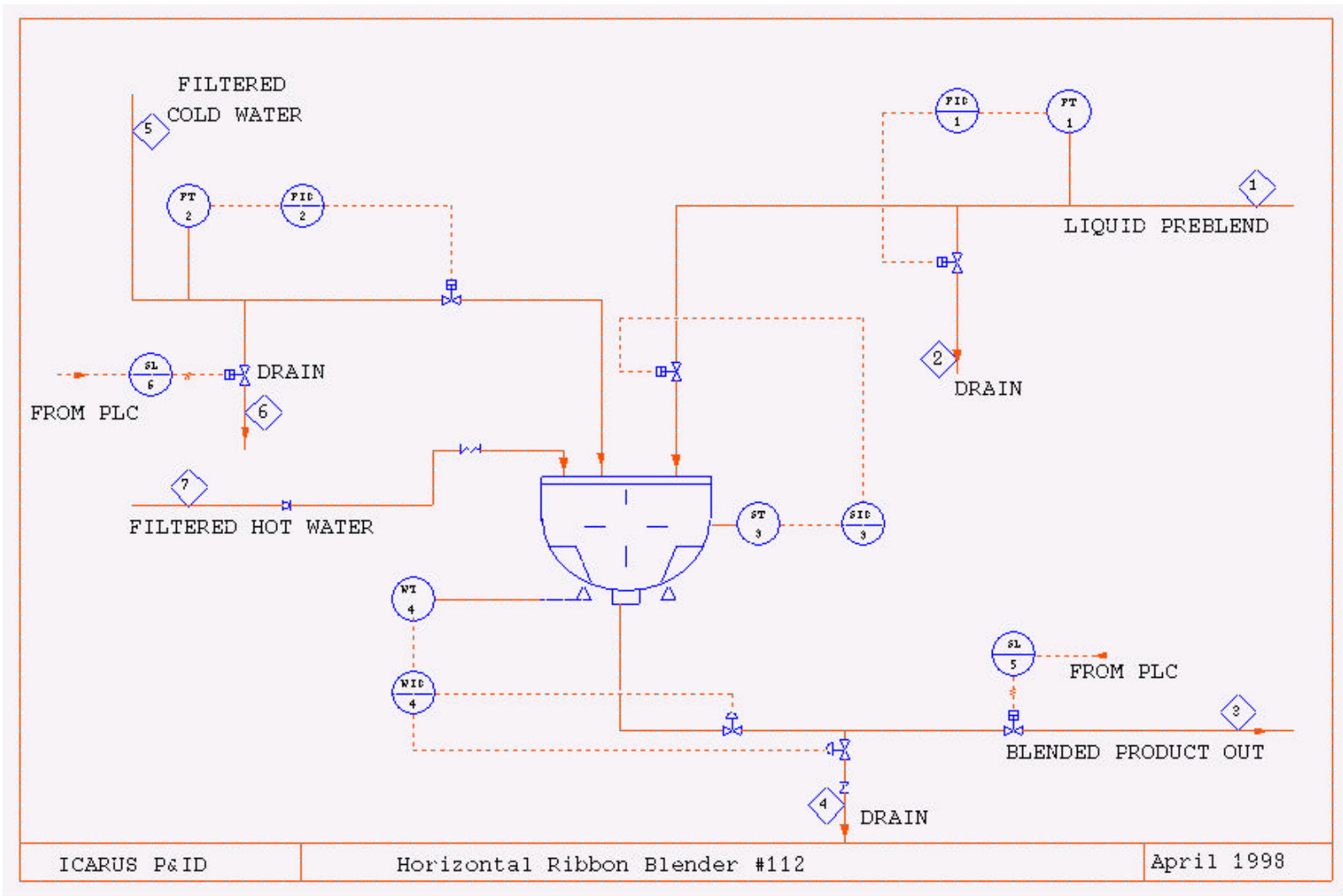
111 Kettle Blender With Steam Jacket



112 Horizontal Ribbon Blender



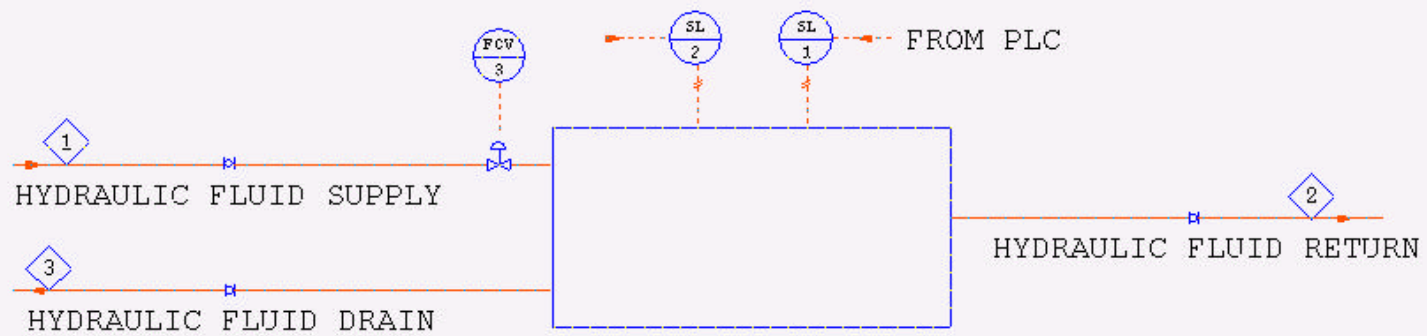
112 Jacket Horizontal Ribbon Blender



113 Reversing Anchor Agitator

Remarks:

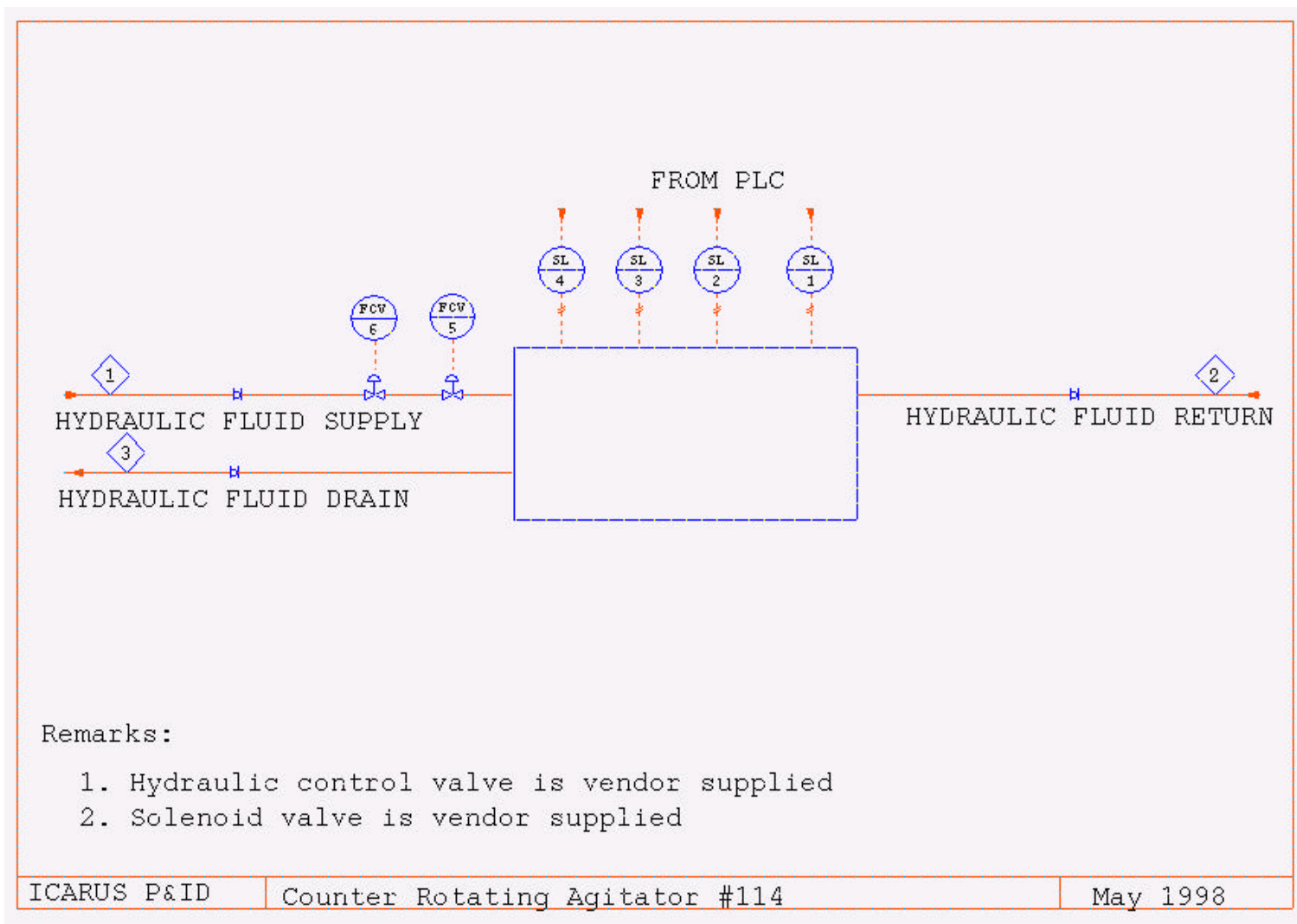
1. Hydraulic control valve is vendor supplied
2. Solenoid valve is vendor supplied



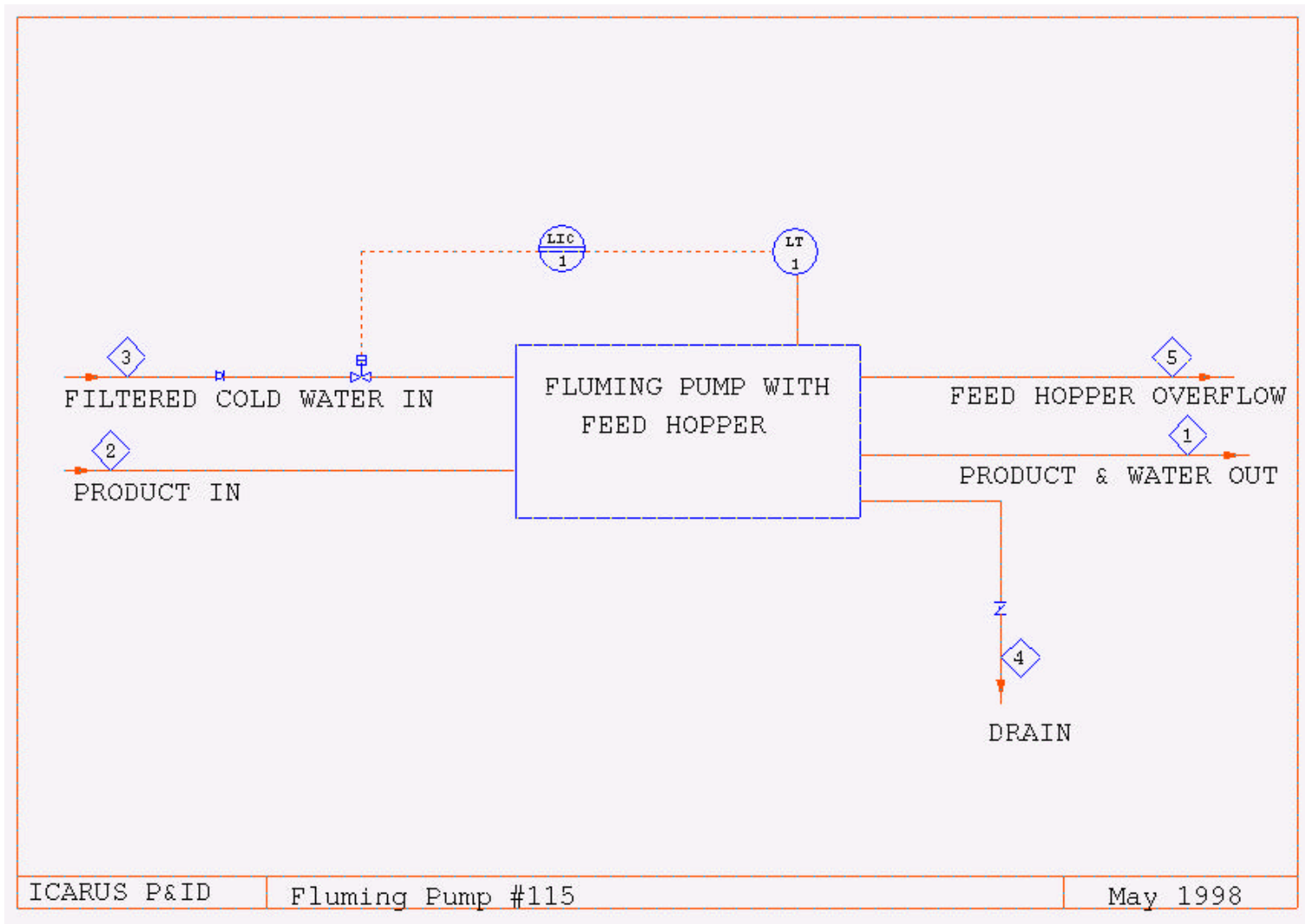
ICARUS P&ID Reversing Anchor Agitator #113

May 1998

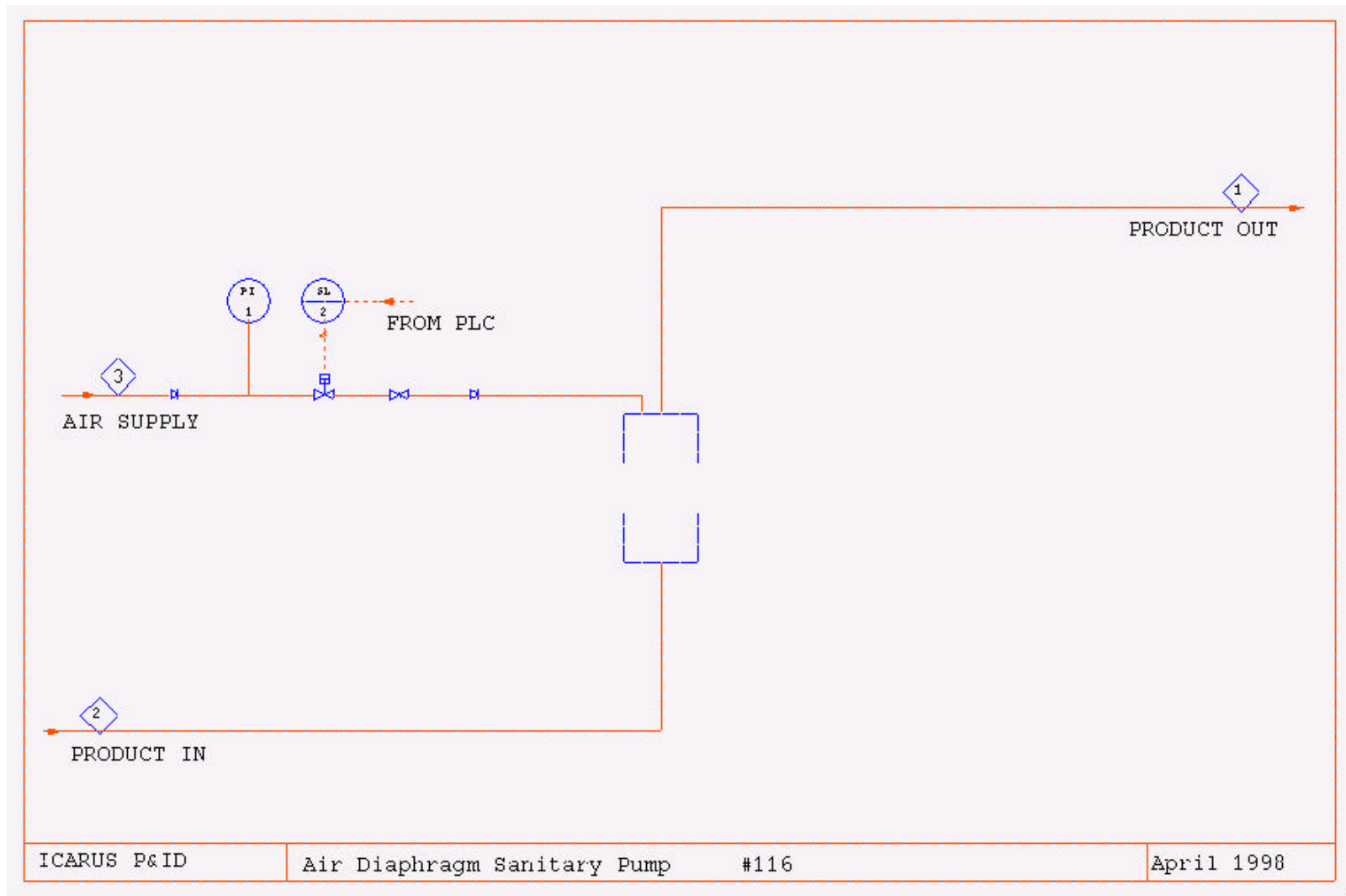
114 Double Motion Agitator



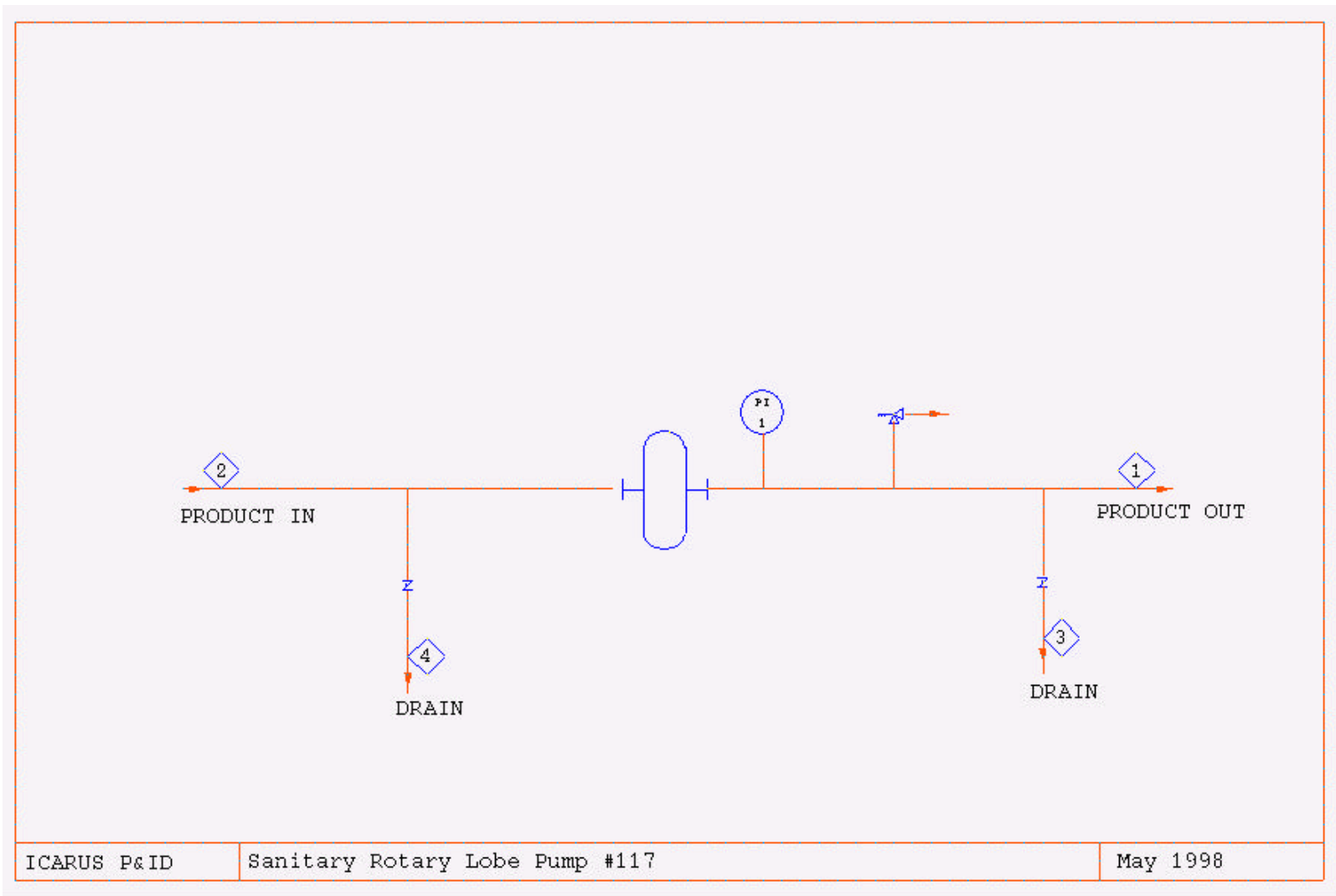
115 Fluming Pump



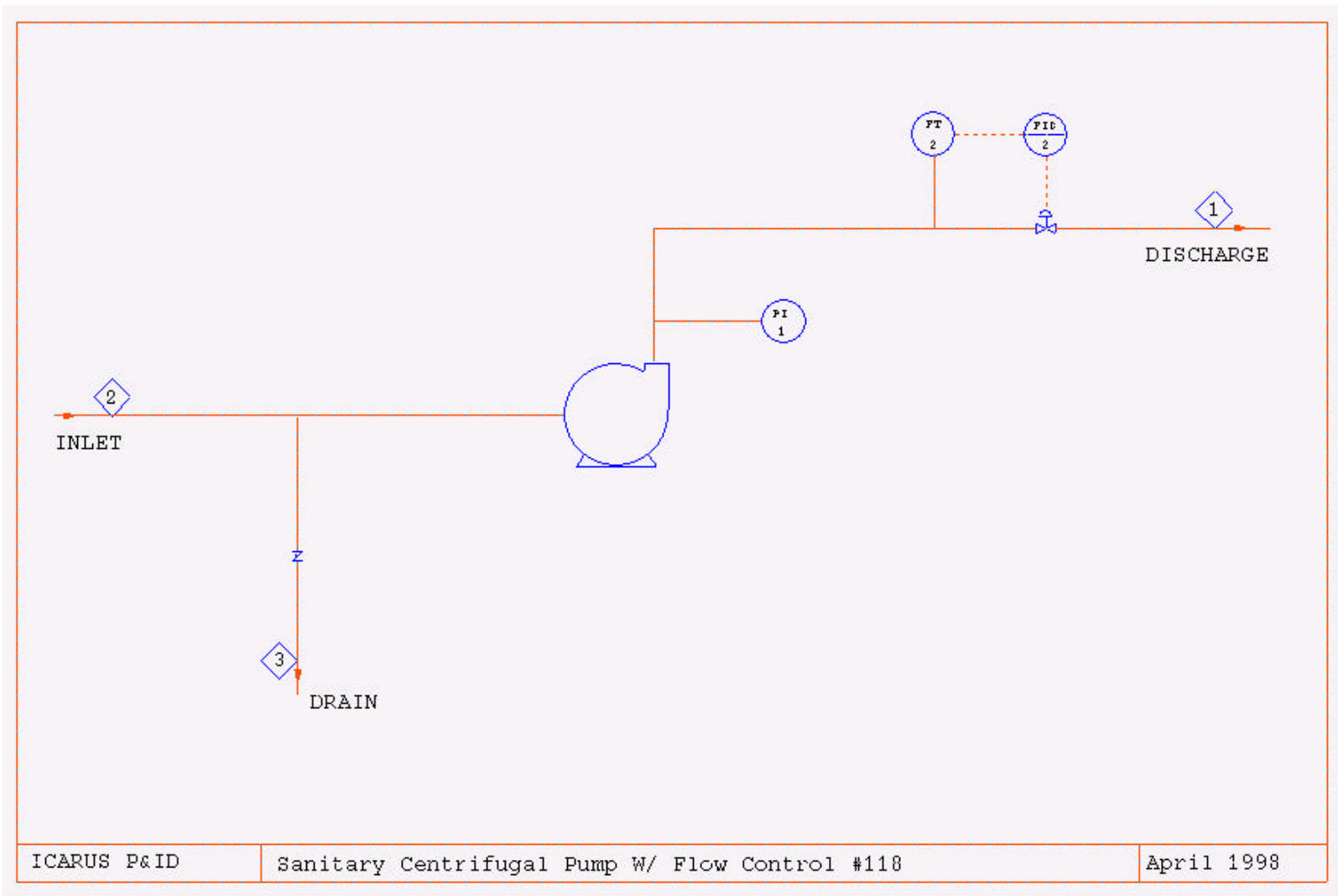
116 Air Diaphragm Sanitary Pump



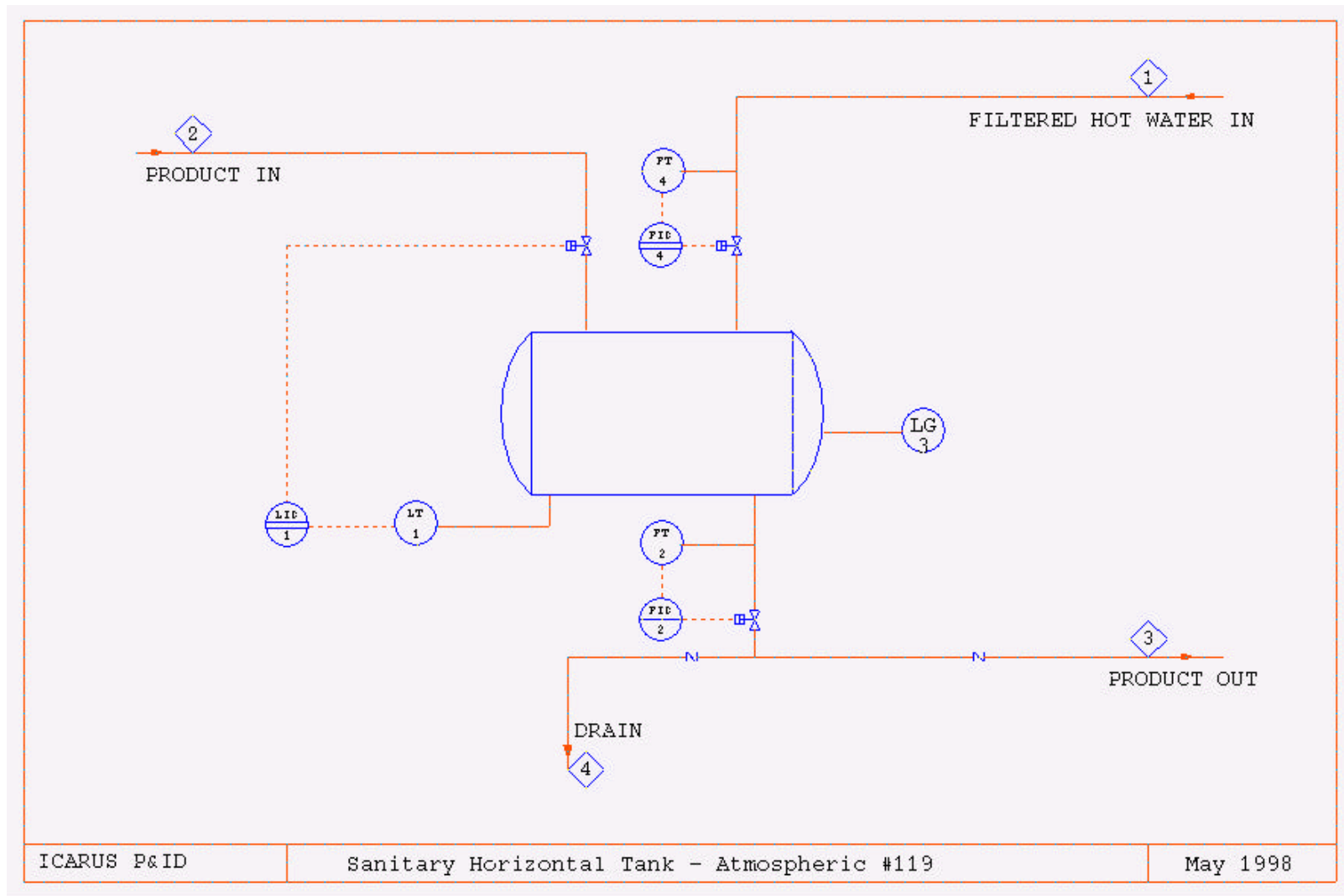
117 Sanitary Rotary Lobe Pump



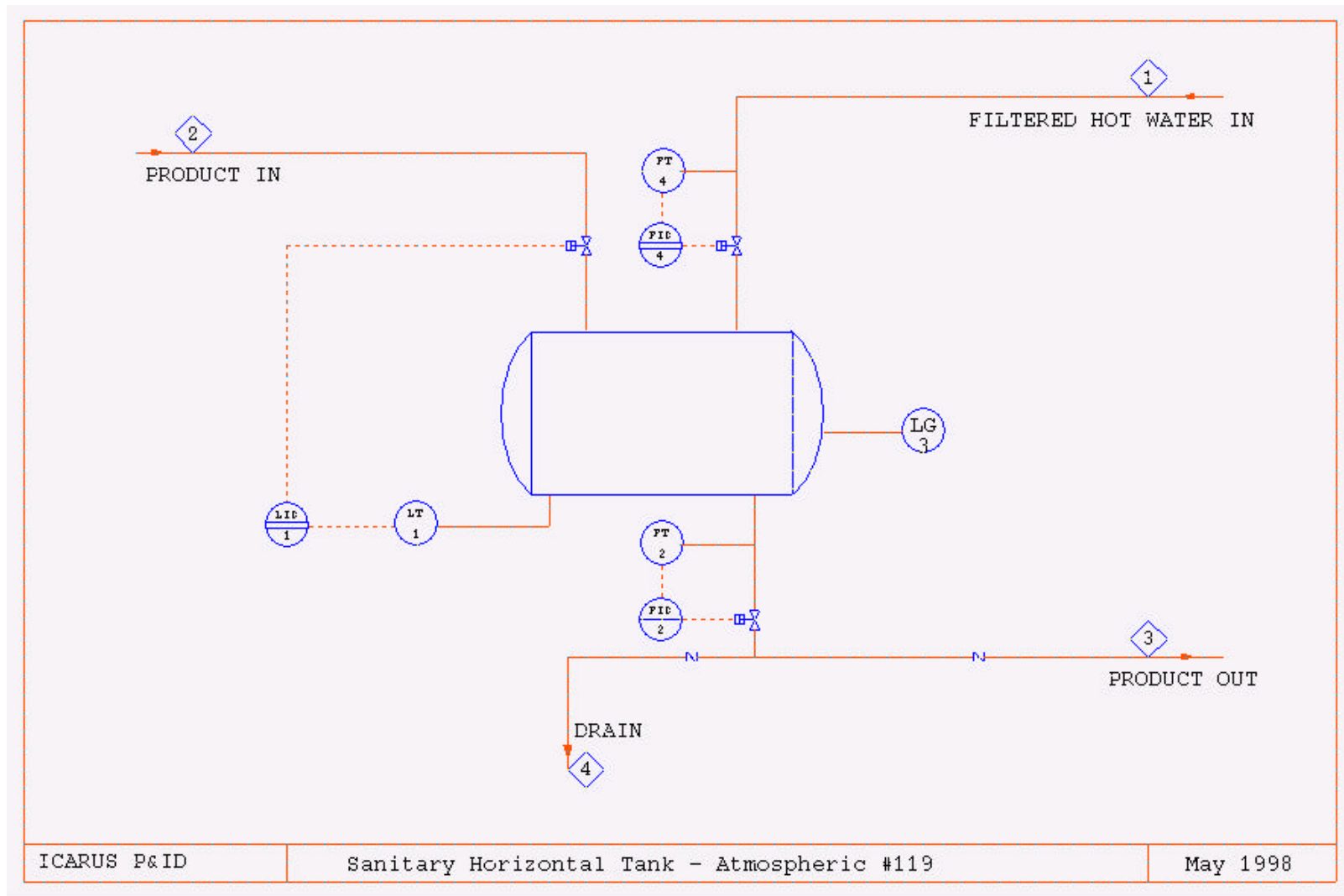
118 Sanitary Centrifugal Pump With Flow Control



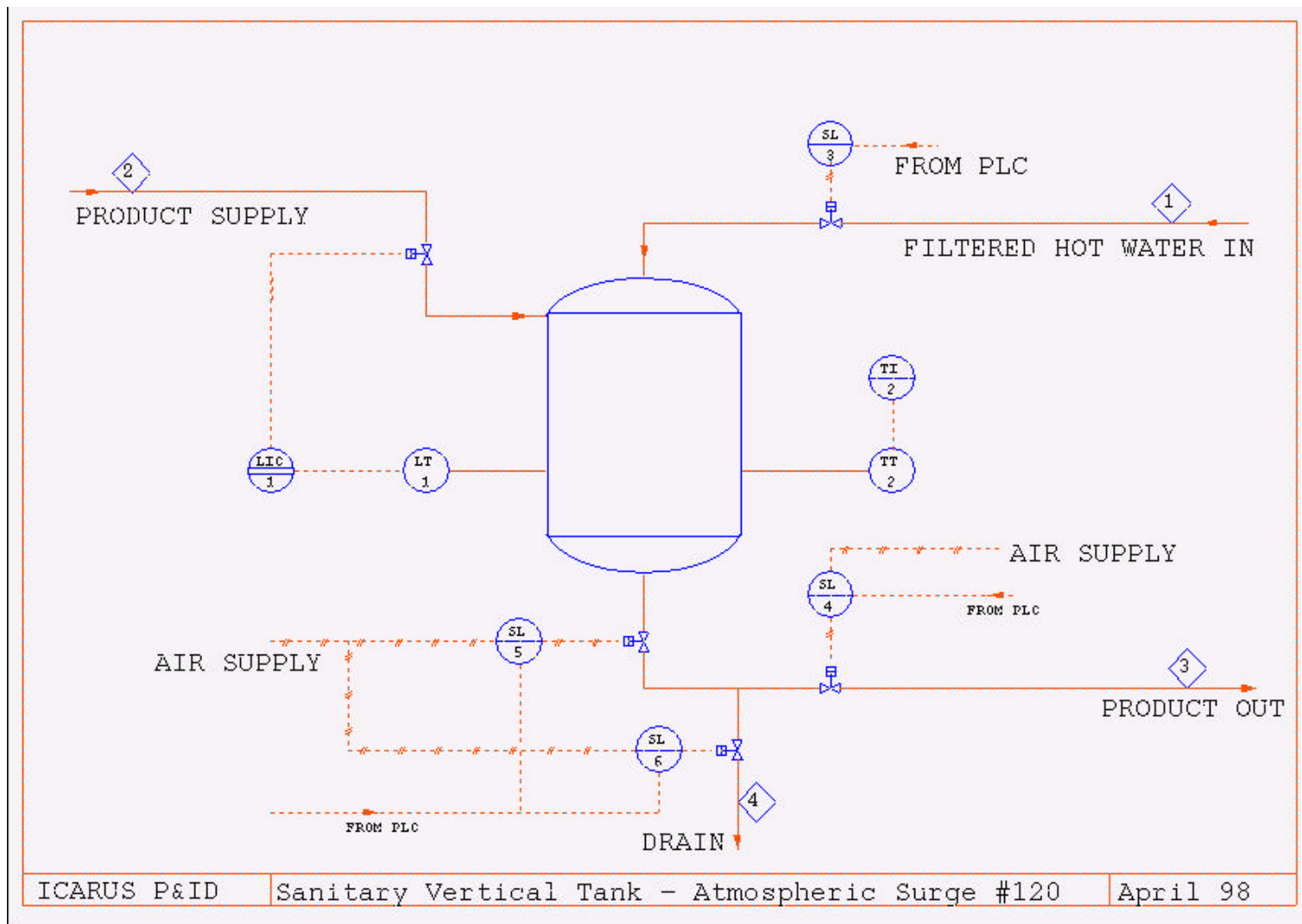
119 Sanitary Horizontal Tank



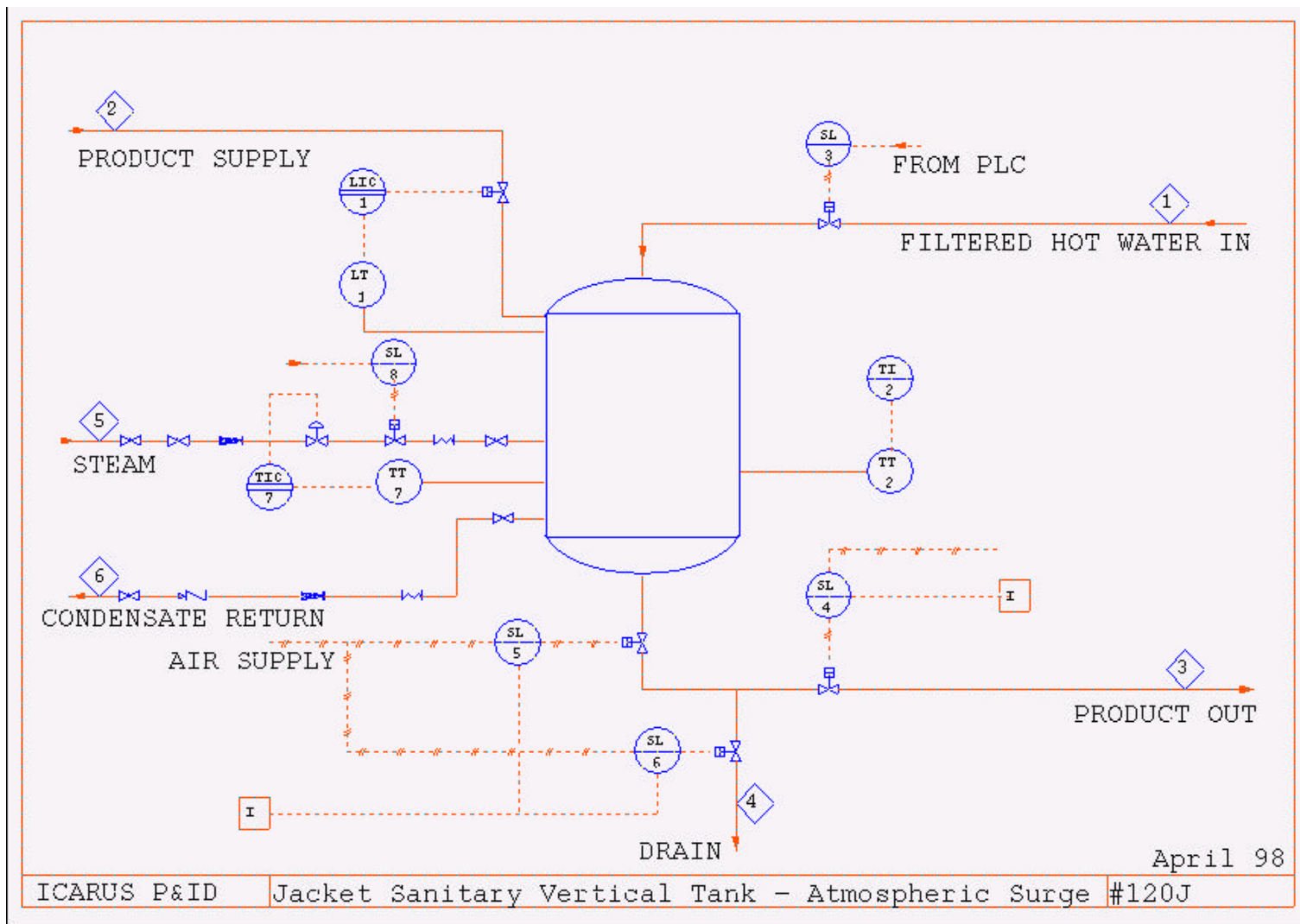
119 Jacket Sanitary Horizontal Tank



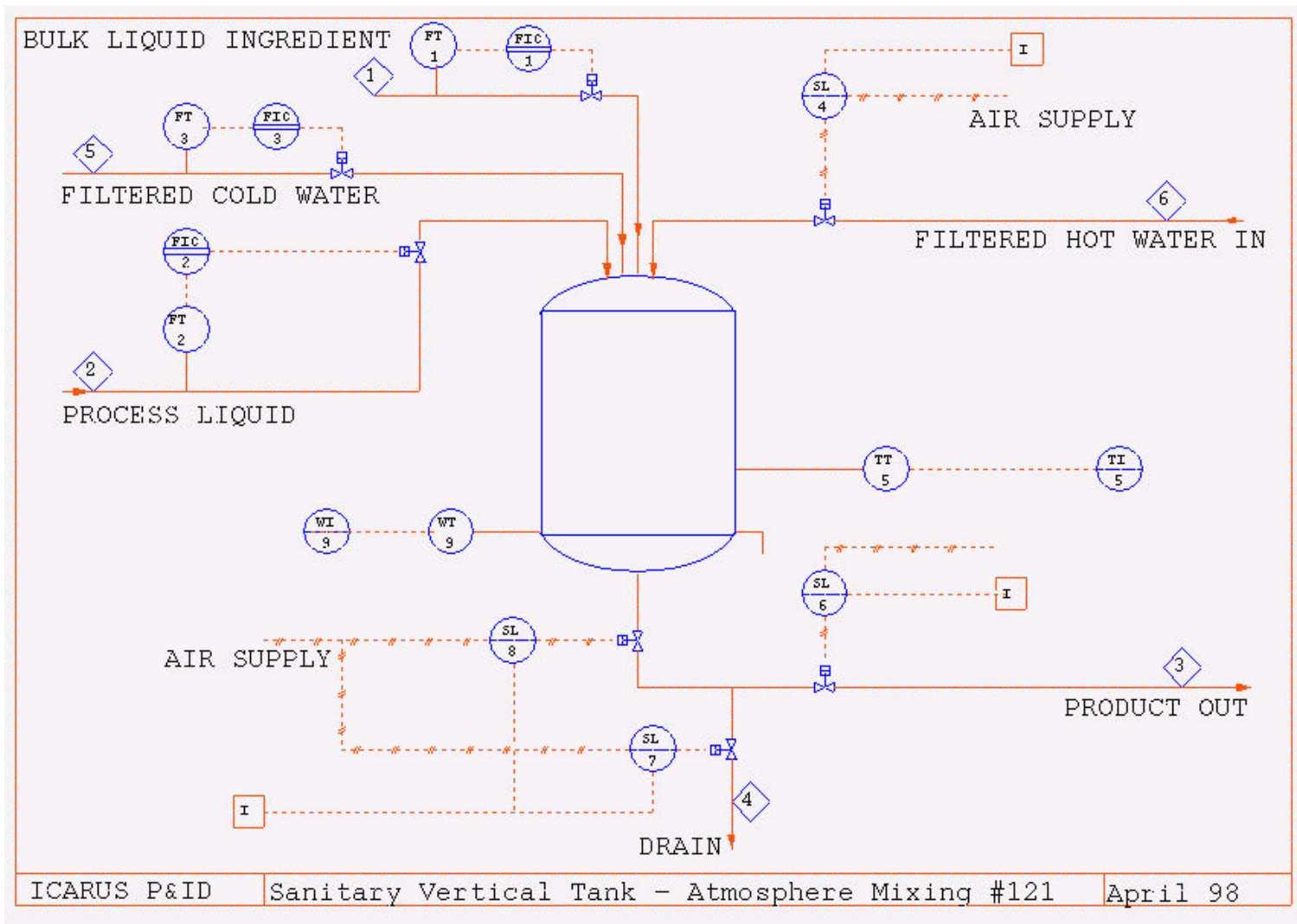
120 Sanitary Vertical Tank – Atmospheric Surge



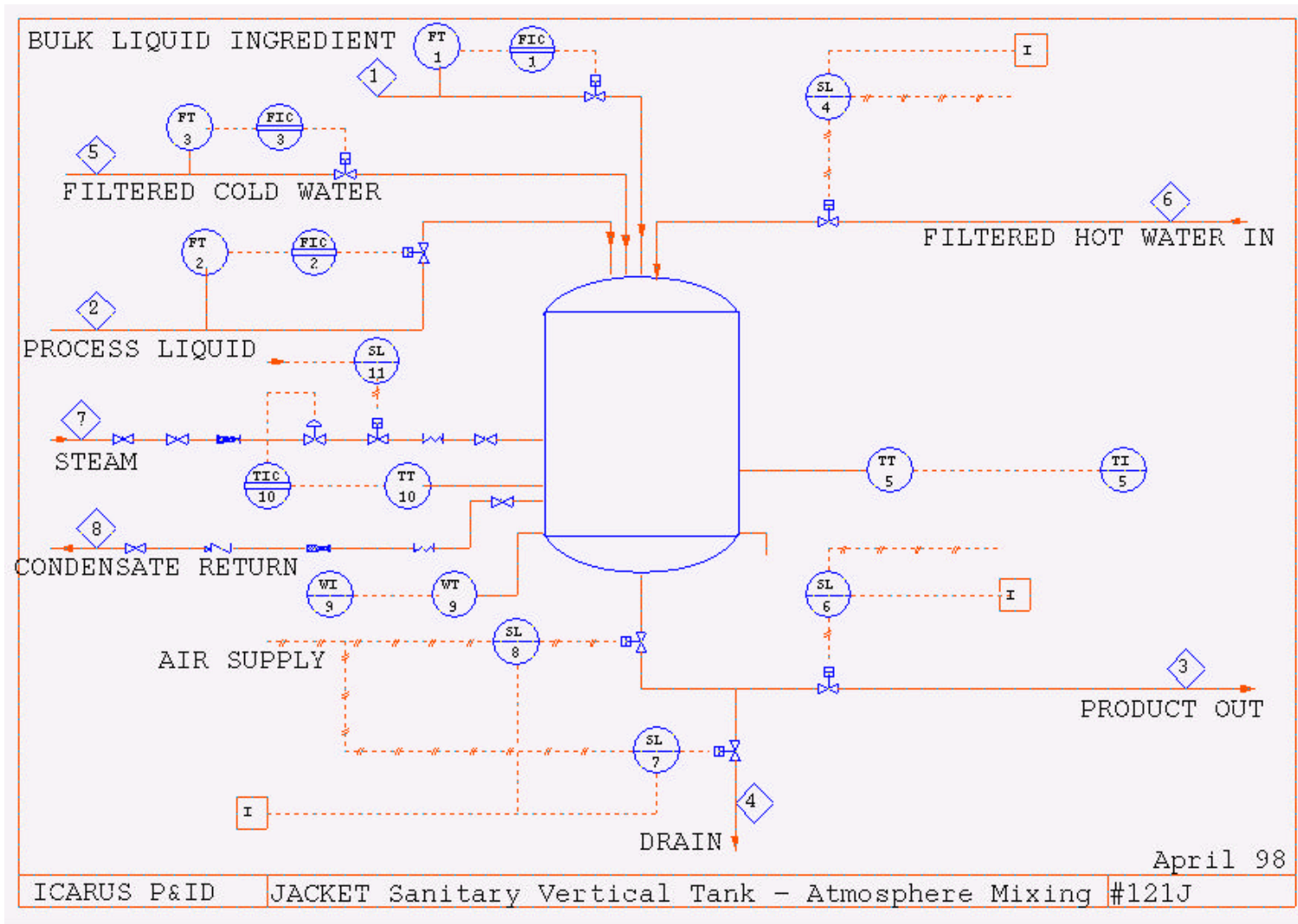
120 Jacket Sanitary Vertical Tank – Atmospheric Surge



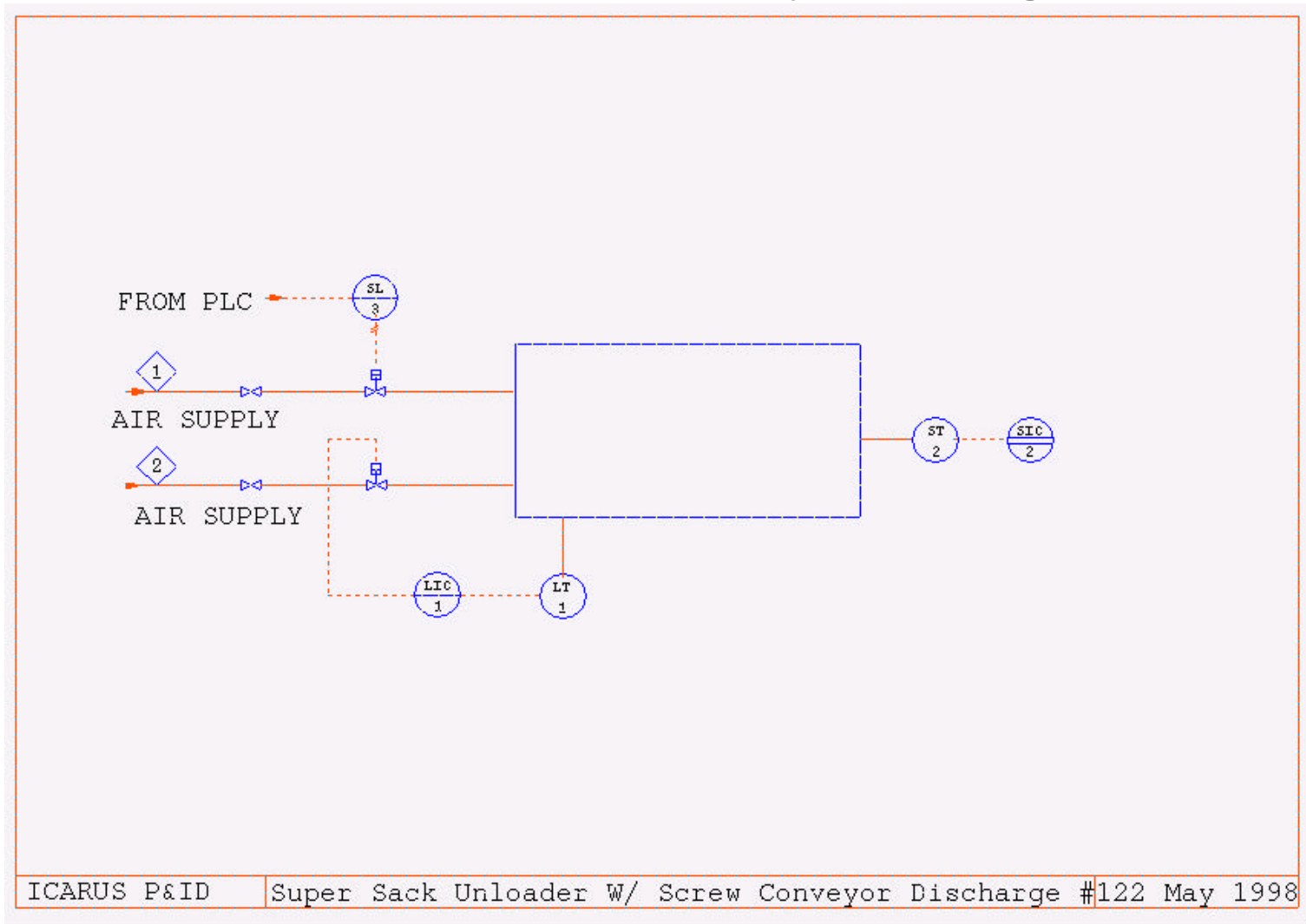
121 Sanitary Vertical Tank – Atmospheric Mixing



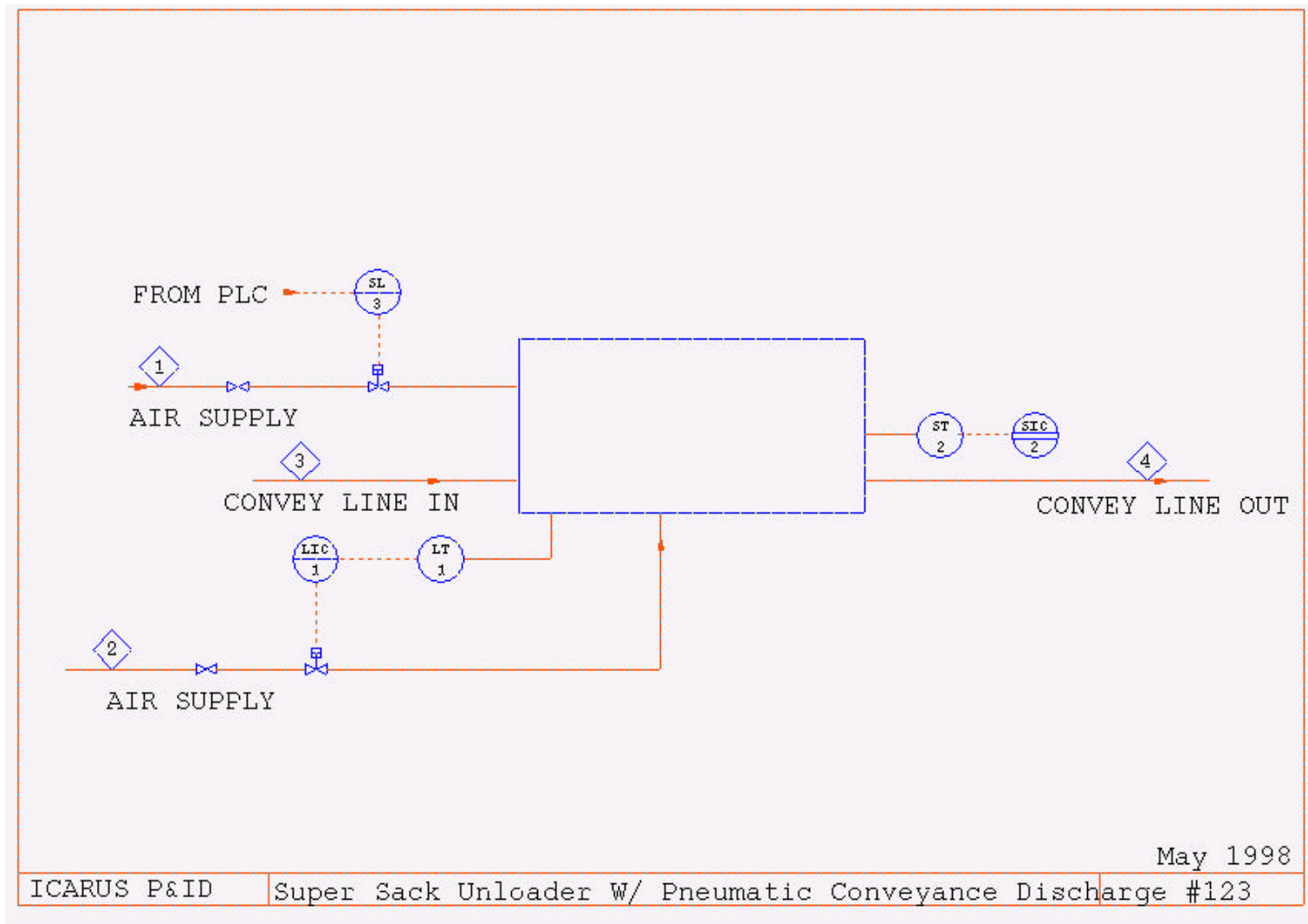
121 Jacket Sanitary Vertical Tank – Atmospheric Mixing



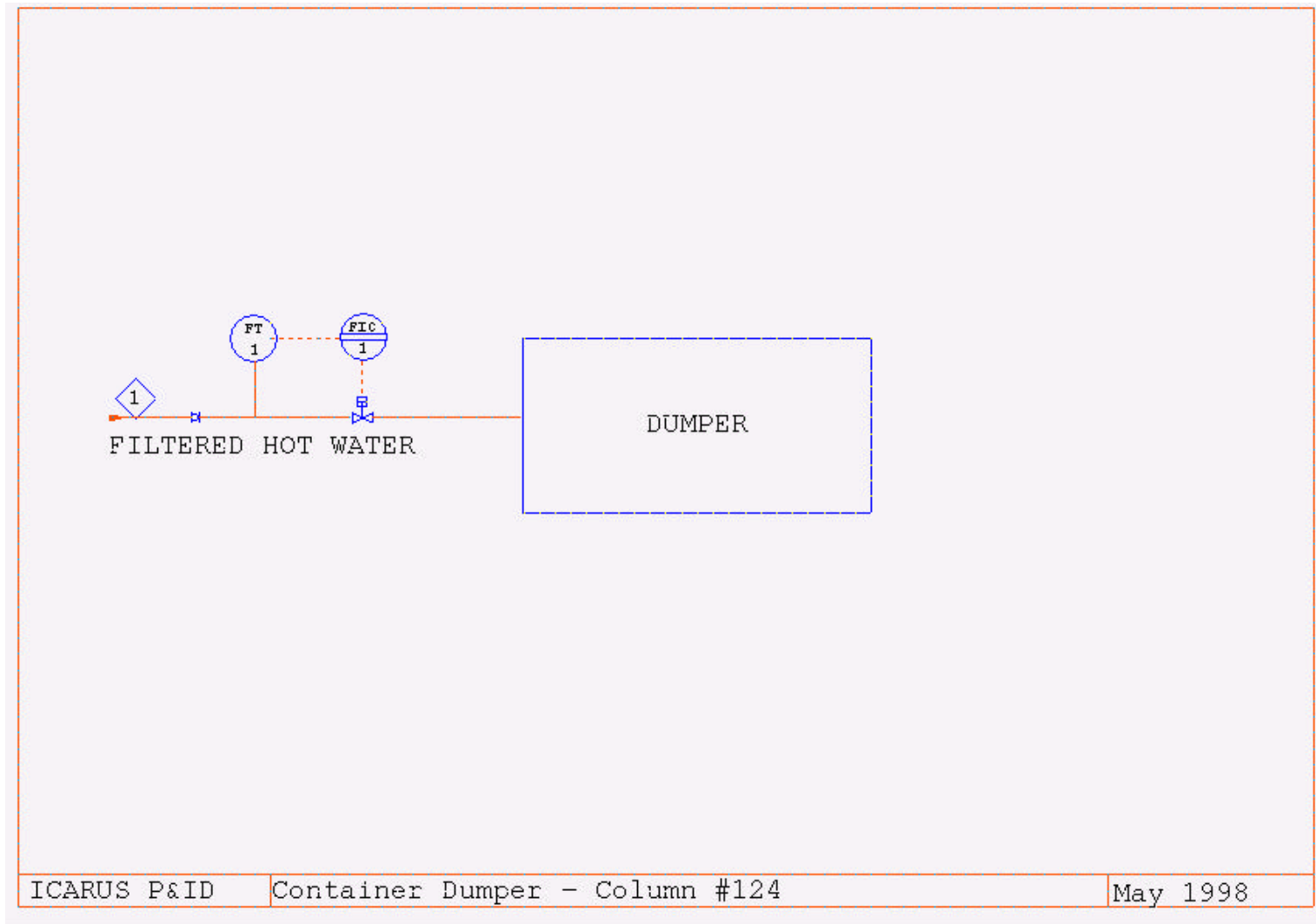
122 Super Sack Unloader With Screw Conveyor Discharge



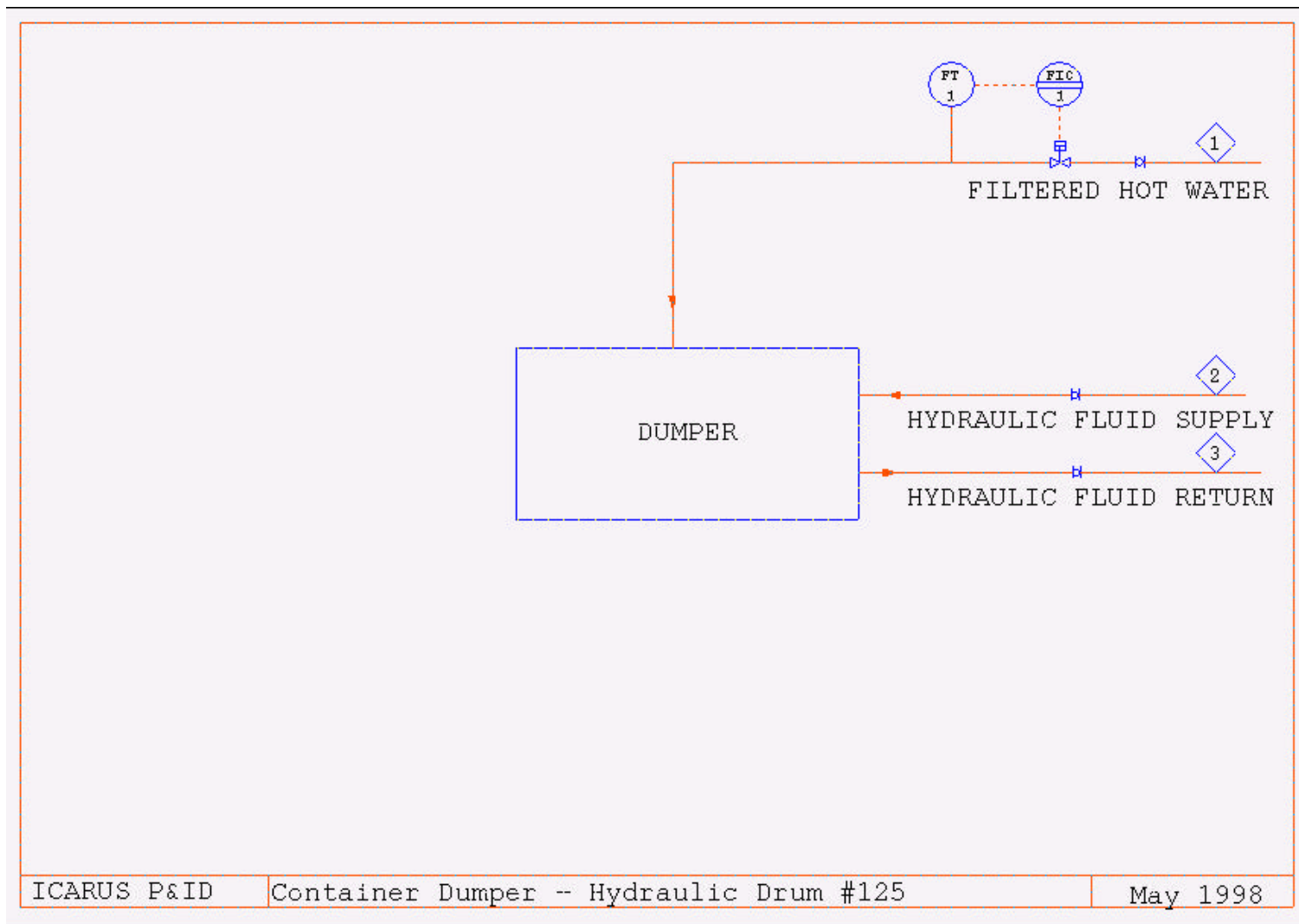
123 Super Sack Unloader With Pneumatic Conveyance Discharge



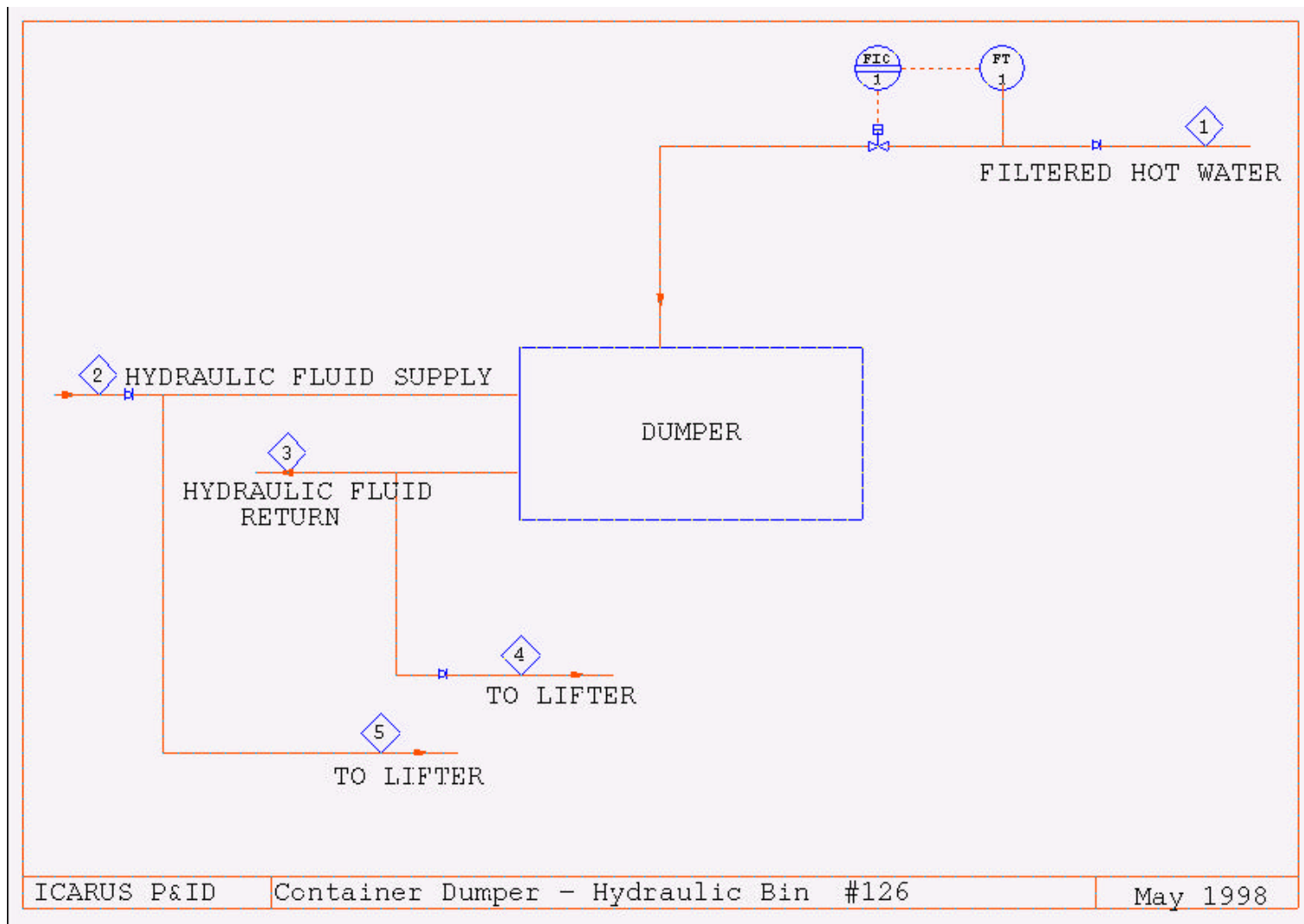
124 Container Dumper – Column



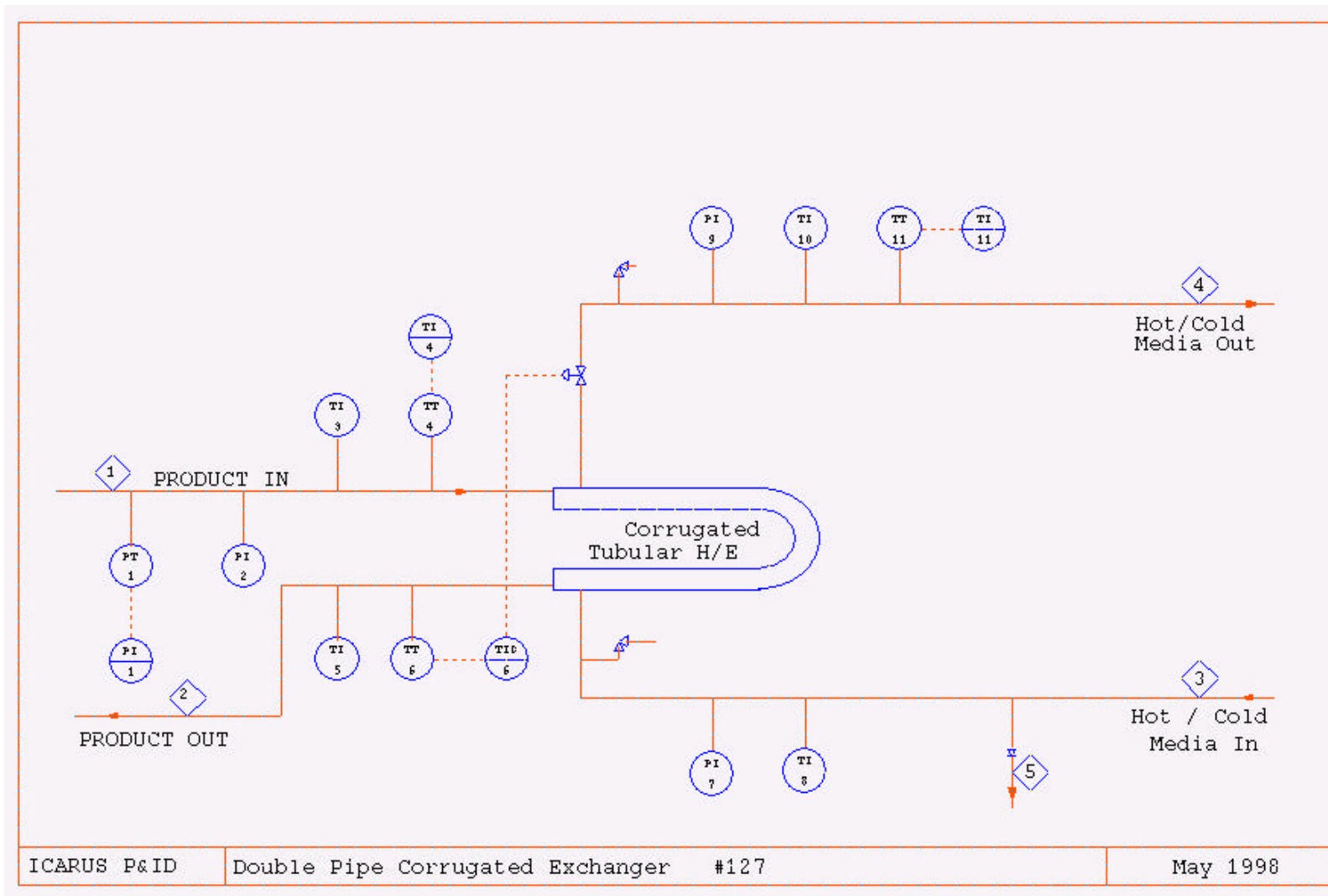
125 Container Dumper – Hydraulic Drum



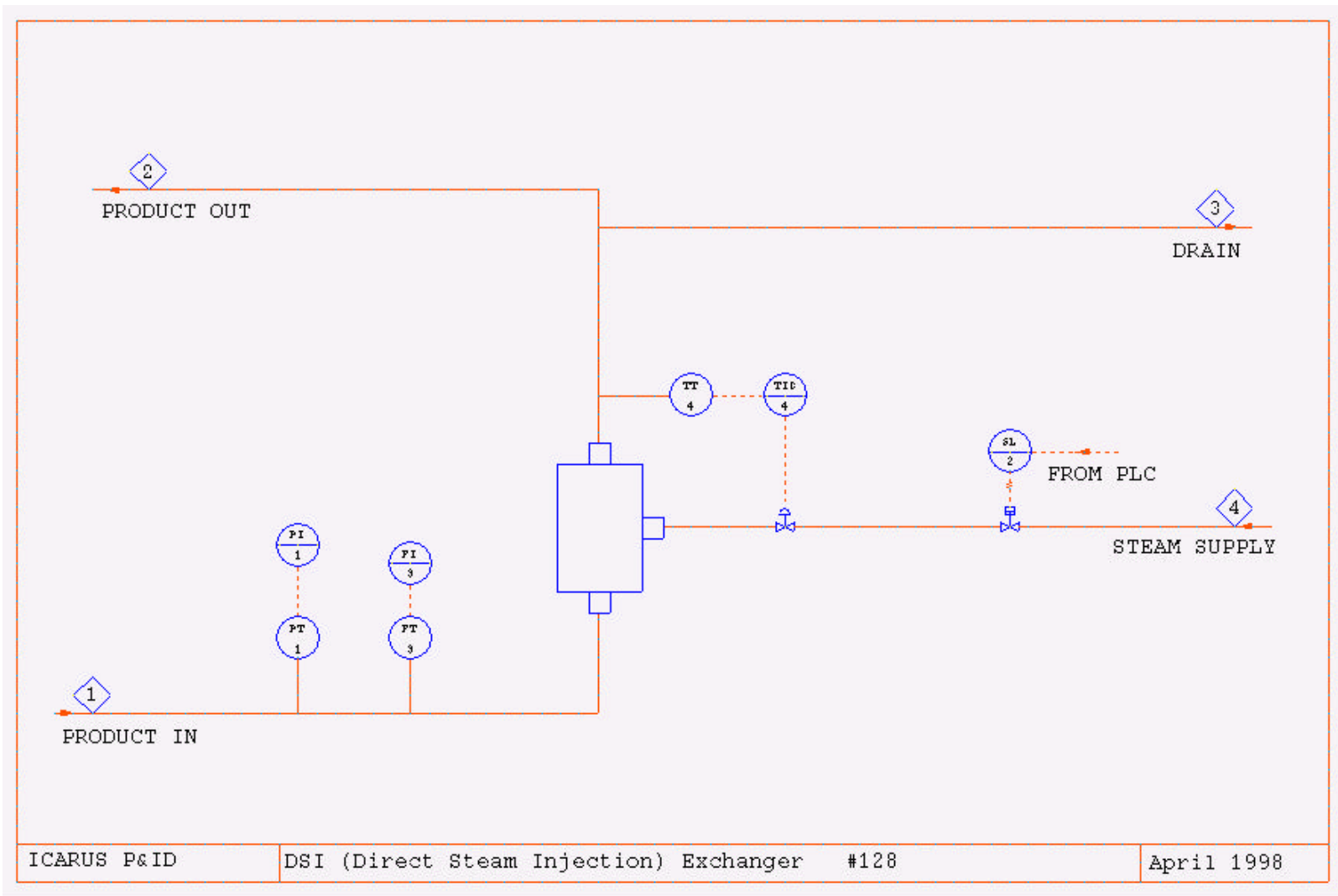
126 Container Dumper – Hydraulic Bin



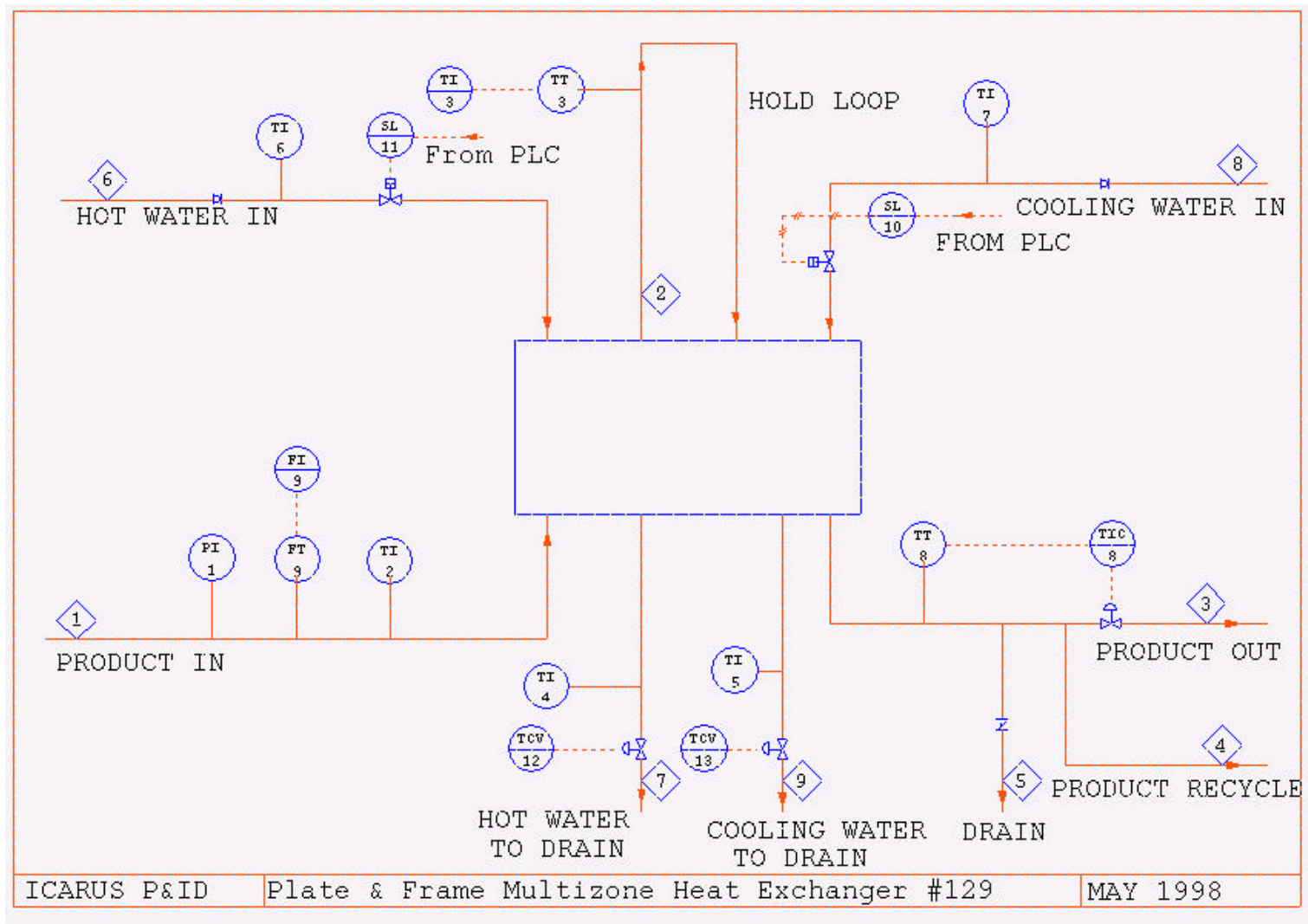
127 Double Pipe Corrugated Exchanger



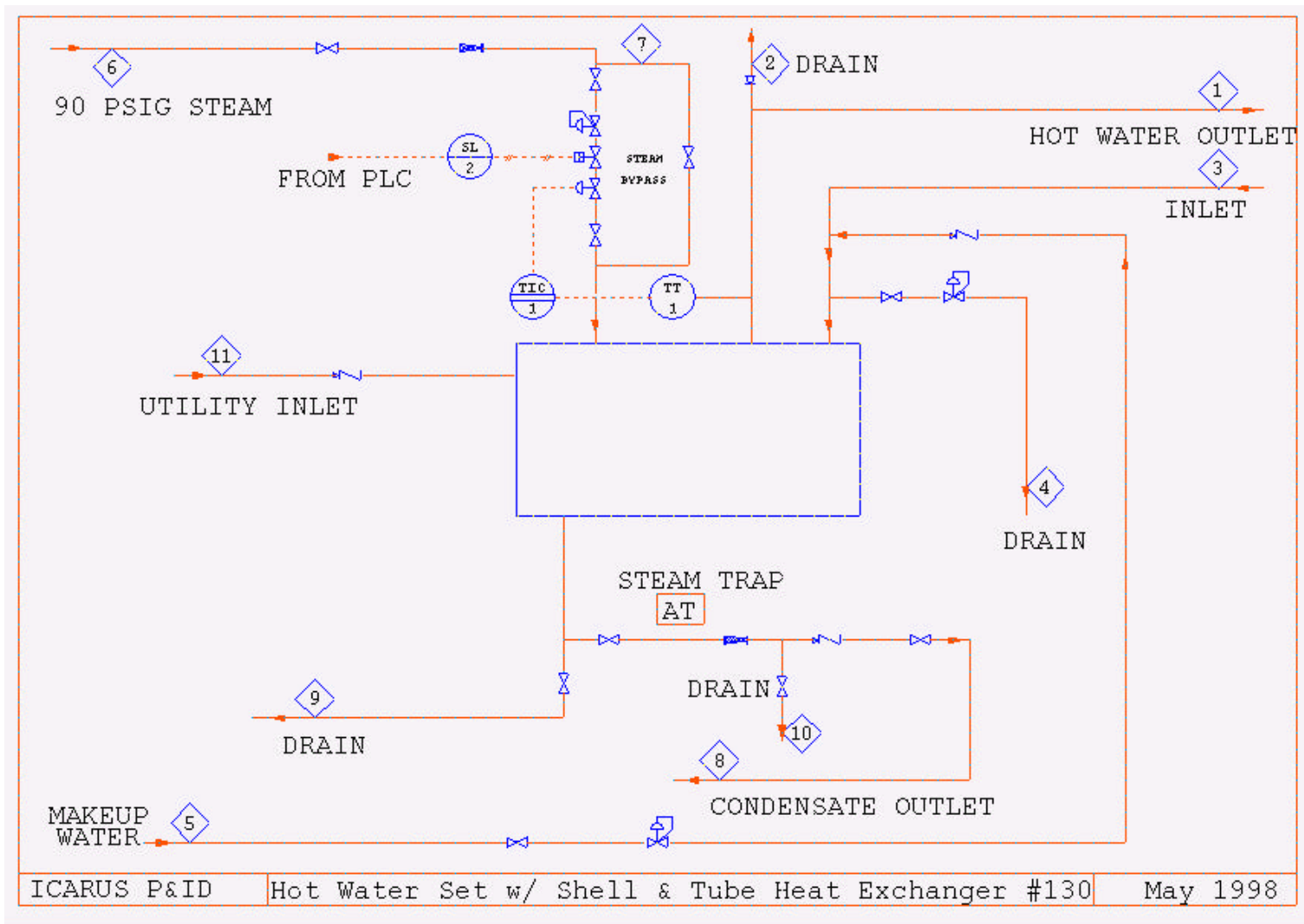
128 Direct Steam Injection (DSI) Exchanger



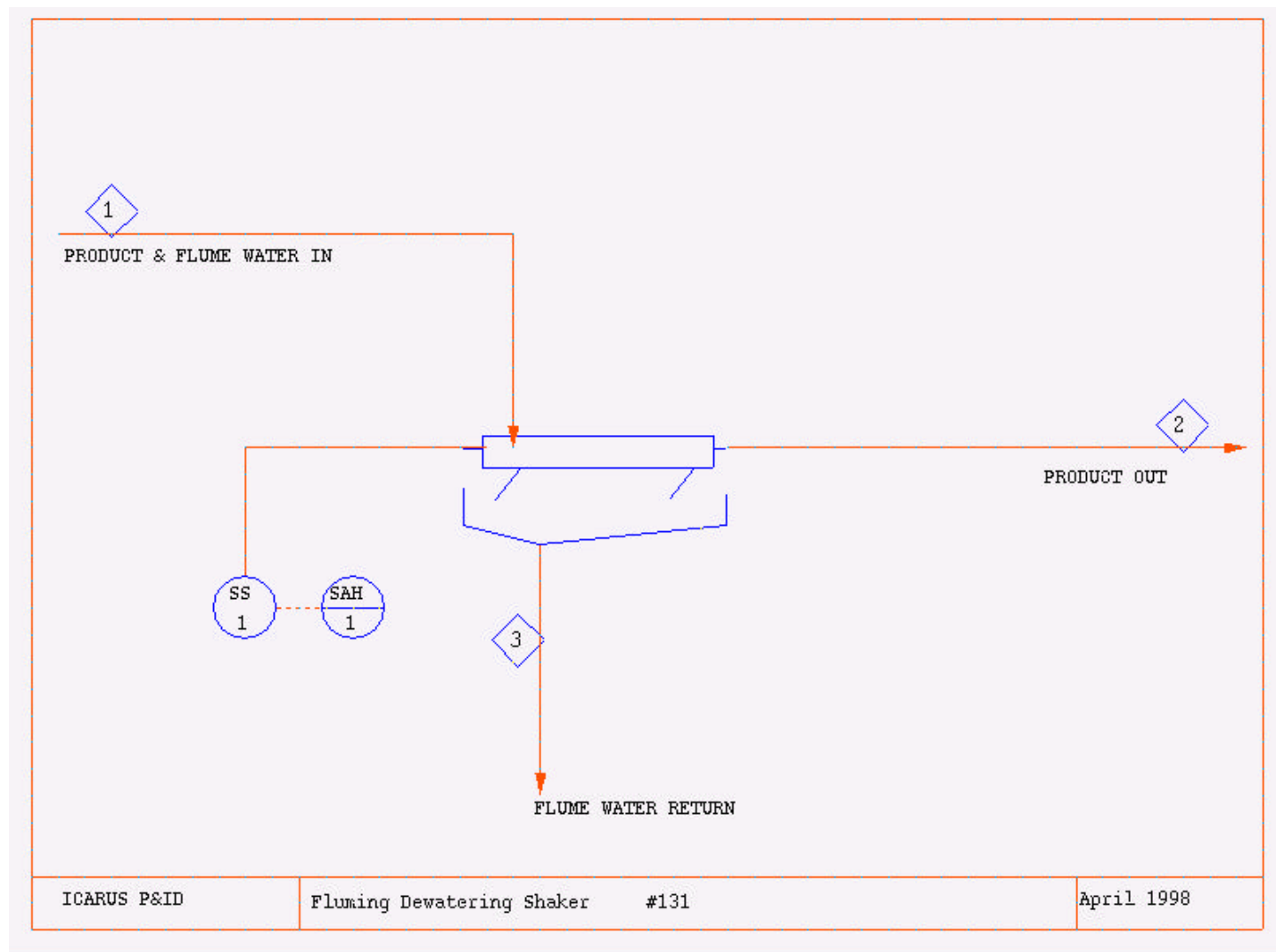
129 Plate & Frame Multizone Heat Exchanger



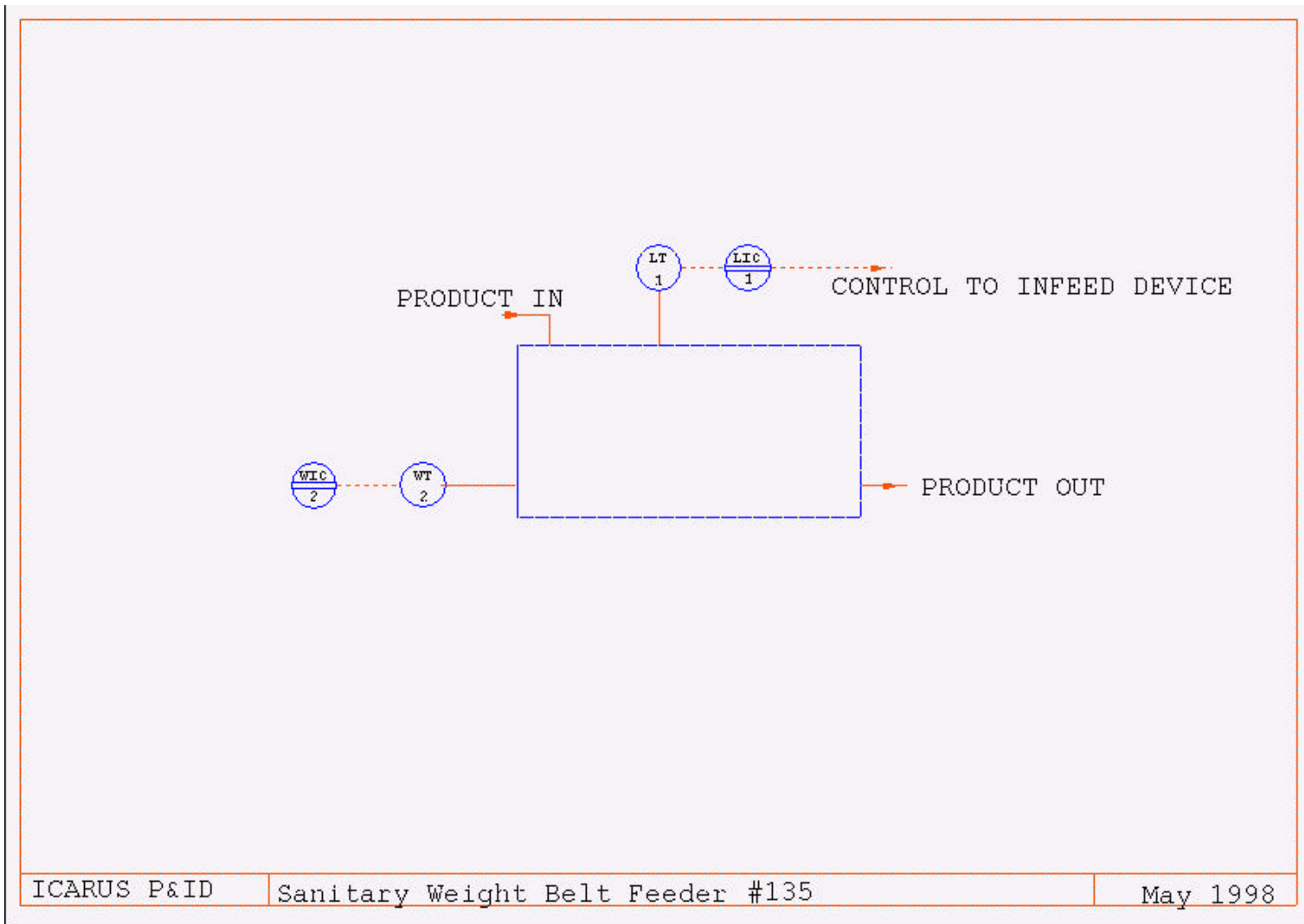
130 Hotwater Set With Shell & Tube Heat Exchanger



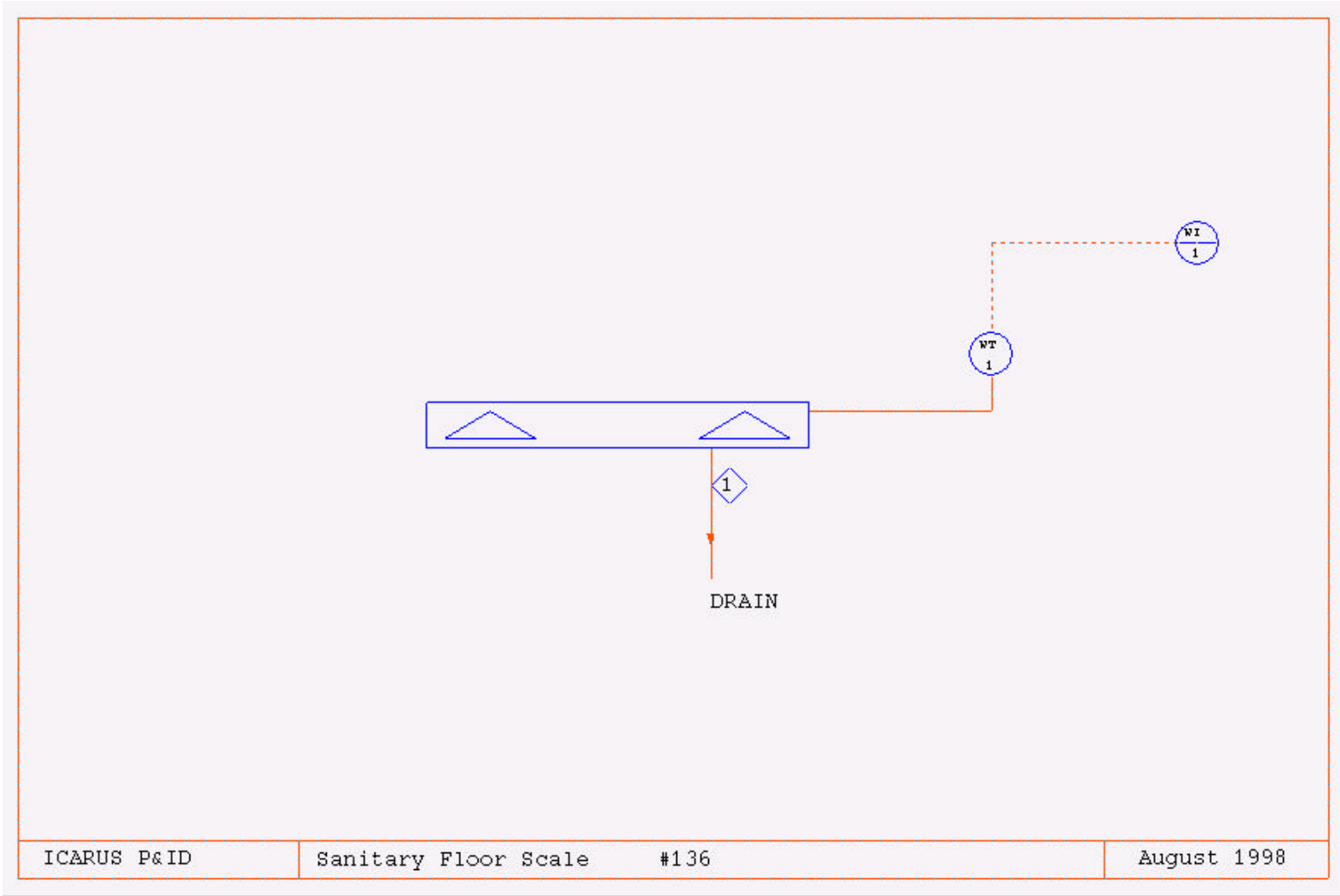
131 Fluming Dewatering Shaker



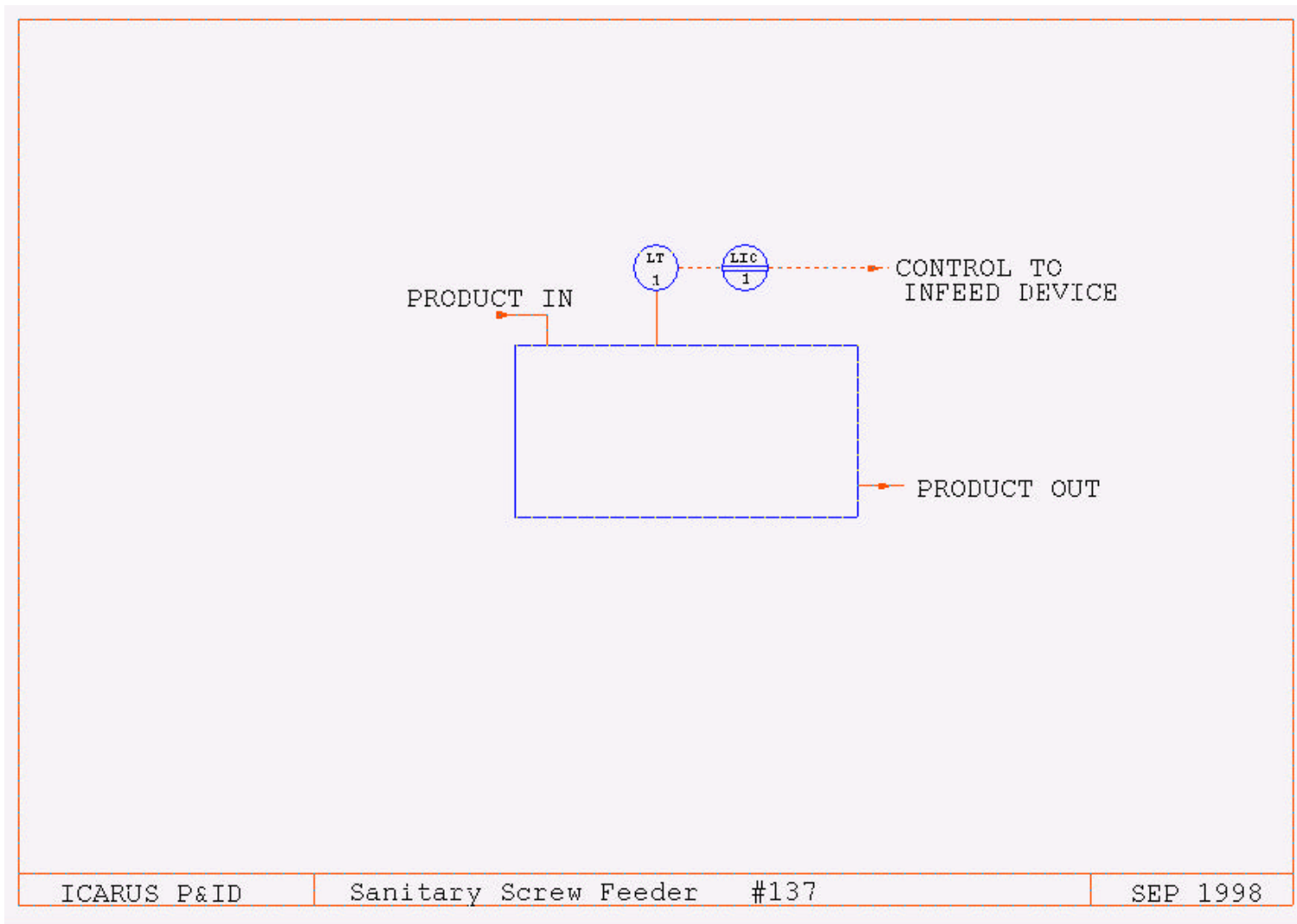
135 Sanitary Weight Belt Feeder



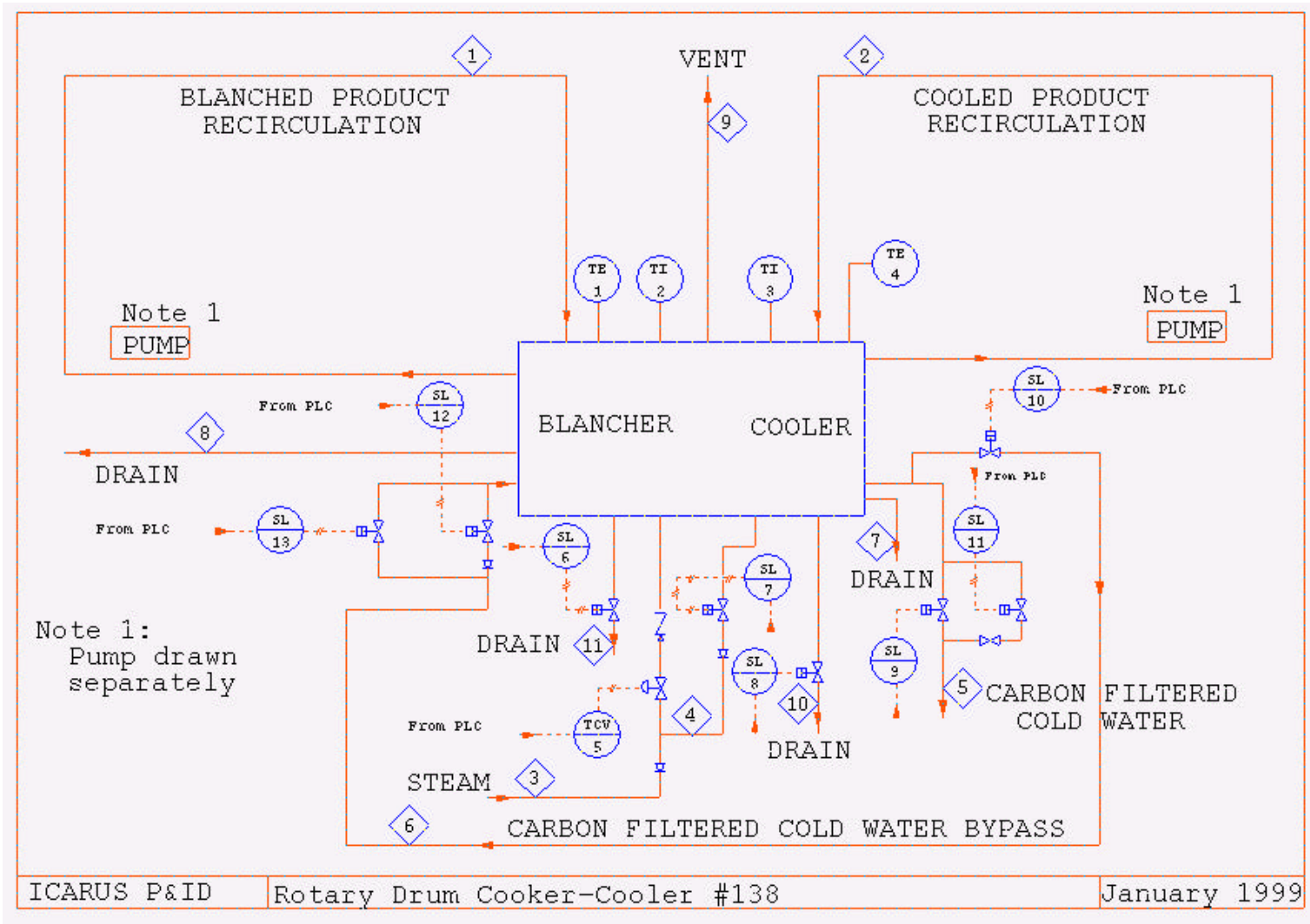
136 Sanitary Floor Scale



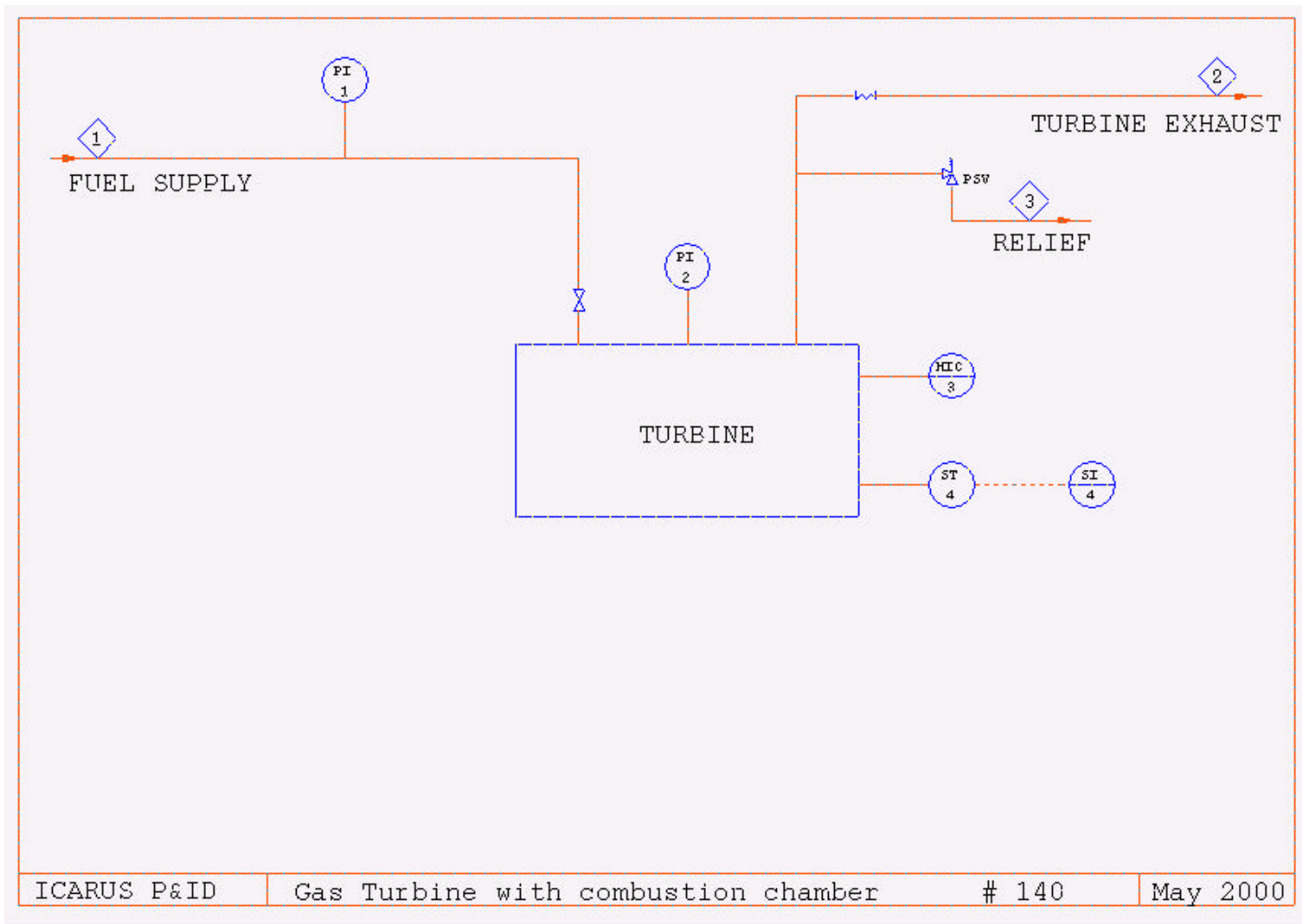
137 Sanitary Screw Feeder



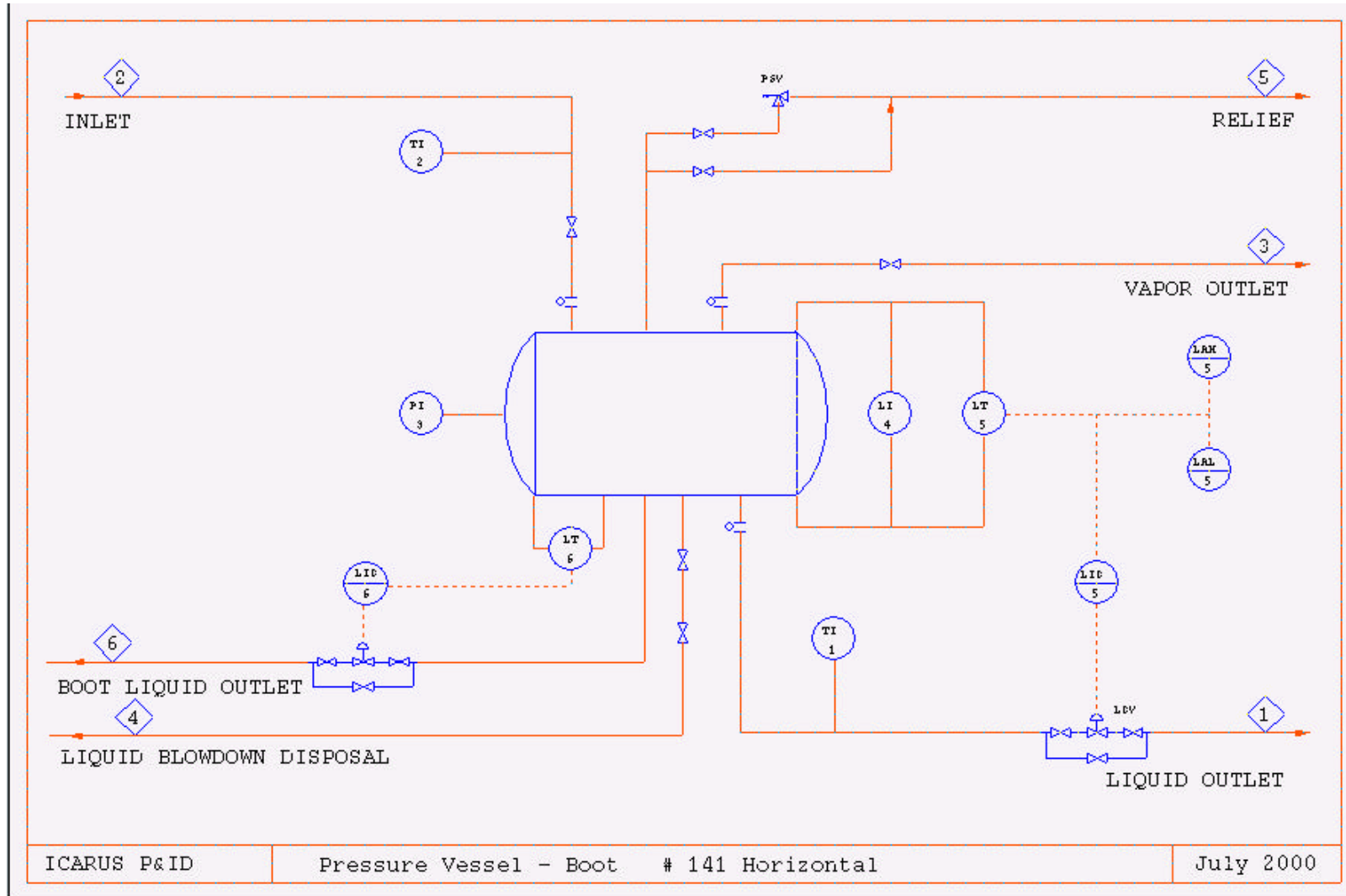
138 Rotary Drum Cooker-Cooler



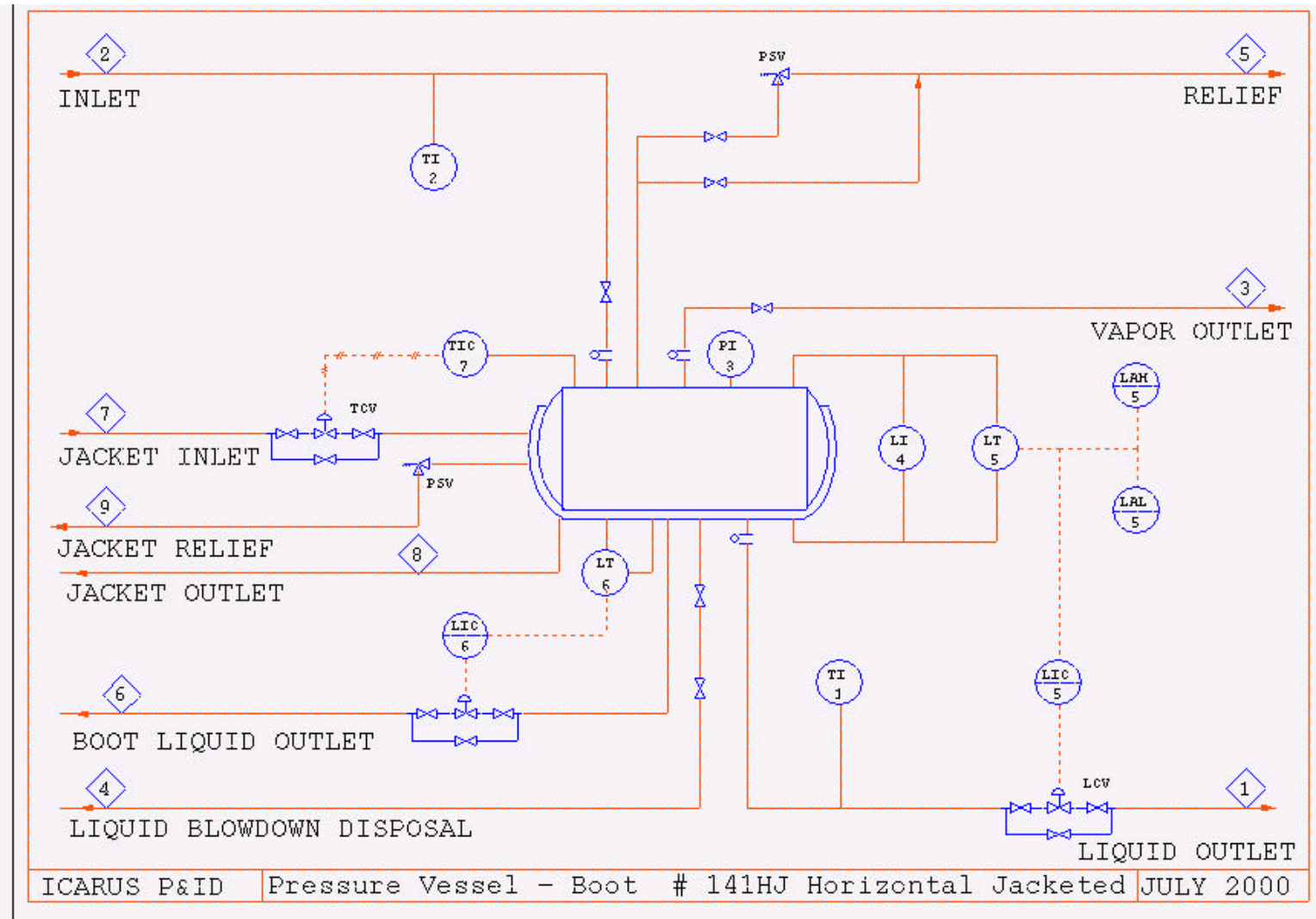
140 Gas Turbine With Combustion Chamber



141 Horizontal Pressure Vessel With Boot

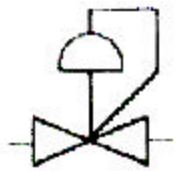


141 Horizontal Jacketed Pressure Vessel With Boot



Appendix A: Symbols

Piping Symbols



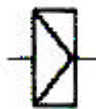
Regulating Valve



Pressure Safety Valve



Spectacle Blind

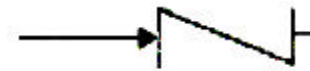


Rupture Disk



Check Valve

or



Flanged Connection



Reducer

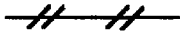
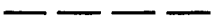









Drain



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)		Device (second position of name; MODE: F=field, P=panel)			Qualifiers (last position)	
<u>Symbol</u>	<u>Description</u>	<u>Symbol</u>	<u>Mode</u>	<u>Description</u>	<u>Symbol</u>	<u>Description</u>
C	Consistency	R	R,P	Recorder	H	High
F	Flow	I	F,P	Indicator	L	Low
T	Temperature	C	F,P	Controller	HH	High High
P	Pressure	RC	F,P	Recording Controller	LL	Low Low
dP	Differential Pressure	IT	F	Indicating Transmitter		
L	Level	S	F	Switch		
S	Speed	E	F	Element		
PN	Position	A	O	Alarm (F-O-P)		
PH	pH Analysis	Y	P	Relay (B-O-P)		
XM	Axial Motion	EY	F	Solenoid		
XR	Radial Motion	EL	P	Electric Light, Indicator		
H	Hand (no measurement)	PB	P	Push Buttons, Start/Stop		
X	Miscellaneous (e.g., Vibration)	CV	F	Control Valve		
		SV	F	Safety Valve		
Special		Thermocouple Devices				
TW	Thermowell	JI	P	Multipoint Indicator		
S.P.	Set Point	JR	P	Multipoint Recorder		
ESD	Emergency Shut-Down					

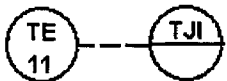
Examples:



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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