

DOWLEX
OPERATING
MANUAL

JANUARY, 1981

DOW CONFIDENTIAL

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INDEX

1. INTRODUCTION
2. DOWLEX DEFINITIONS AND EQUIPMENT NUMBERING
3. EMERGENCY SYSTEMS
4. RAW MATERIALS
5. THEORY OF PROCESS
6. ETHYLENE PURIFICATION AND COMPRESSION
7. CATALYST
8. REACTION
9. CALCIUM STEARATE
10. DEVOLATILIZATION AND VACUUM SYSTEM
11. SOLVENT RECOVERY AND PURIFICATION
12. RECYCLE ETHYLENE COMPRESSION
13. SOLVENT AND OCTENE STORAGE
14. ADDITIVE SYSTEMS
15. GEAR PUMPS AND PELLETIZER
16. PELLET WATER SYSTEM
17. MATERIAL HANDLING
18. DOWTHERM SYSTEM
19. CHILLED WATER SYSTEM
20. COOLING TOWER
21. OTHER UTILITIES
22. ELECTRICAL SYSTEMS
23. MISCELLANEOUS SYSTEMS
24. QUALITY ASSURANCE AND PROCESS ANALYZERS
25. COMPUTER AND CONTROL SYSTEMS
26. INDUSTRIAL HYGIENE AND ECOLOGY
27. EQUIPMENT LIST
28. SIMPLIFIED FLOW SHEETS, MATERIAL AND ENERGY BALANCE

1. INTRODUCTION

The Dowlex plant is designed to produce linear low density polyethylene, a tough, flexible plastic used in packaging film, trash cans, houseware, trash bags, and many other applications. The plant can also produce high density polyethylene. The design capacity of the plant is 400 million pounds per year of Dowlex resin produced in two trains.

Ethylene from the Light Hydrocarbon plants at 400 psig is purified and compressed to 650 psig and is mixed with a solvent (Isopar E). This solution is chilled to 10°C and is fed to a reactor. Catalyst injected to the reactor causes the ethylene to polymerize to polyethylene. The reactor runs at 450 psig and 200°C and is liquid full. The polyethylene density is controlled by adding octene to the solvent and the melt index is controlled by adding hydrogen to the ethylene. About 85% of the ethylene feed is converted to polyethylene in the first reactor. A further 7% conversion is obtained in a second reactor at 220°C.

The polyethylene - solvent solution from the reactors is heated to 260°C by a Dowtherm vapor heat exchanger. The solution then flows to a first stage devolatilizer at 20 psig where ⁸³~~89~~90% of the solvent is vaporized. A gear pump transfers the concentrated polyethylene through a Dowtherm liquid plate heat exchanger to heat it back to 260°C. The mixture then flows to a second stage devolatilizer at 5 mmHg vacuum where the remainder of the solvent is removed. A second gear pump pumps the molten polyethylene to a pelletizer.

Solvent vapor from the first stage devolatilizer flows to the bottom of a scrubber column to remove entrained polyethylene. The vapor from the column is used to generate 15 psig steam.

Unreacted ethylene is separated from the condensed solvent. The solvent is purified in silica gel and molecular sieve beds and is recycled back to the reactor. The ethylene is compressed in three stages from 10 psig to 650 psig and is returned to L.H.C. or it can be recycled back to the reactor.

Additive systems can inject four separate additives; calcium stearate in solvent, two separate hot melt additives and pellet concentrate using a sidearm extruder.

Auxilliary systems include three absorption refrigeration units (ARU) for reactor feed cooling, a cooling tower, pellet water system, Freon refrigeration for the vacuum system and a Dowtherm furnace.

The material handling system for the final product has six blenders and 11 million pounds of storage capacity.

2. DOWLEX DEFINITIONS AND EQUIPMENT NUMBERING

2.1 DEFINITIONS

1. Additive - certain raw materials that are injected into the process to modify polyethylene properties.
2. ARU - absorption refrigeration unit.
3. Agitator - a motor driven shaft that has blades attached. Used for mixing. Usually has a gearbox.
4. Catalyst - a substance used in the reactor to initiate and maintain a chemical reaction (maintain a set temperature in the reactor).
5. Density - the mass of a substance per unit volume.
6. Devolatilization - that part of the process where solvent, unreacted ethylene and hydrogen are removed from the polyethylene.
7. Dowtherm - a liquid or vapor used for heating.
8. Diverter valve - a three way valve used in the material handling system.
9. Heat exchanger - a vessel used for removing or adding heat.
10. Furnace - an enclosed structure in which heat is produced.
11. Fin-Fan - an air cooled heat exchanger
12. Hopper - a storage vessel for polyethylene pellets.
13. Pelletizer - a piece of equipment that converts molten polymer into small round spheres.
14. Palletizer - a piece of equipment used in the bagging area that takes bags of polyethylene pellets and stacks them on pallets.
15. Reactor - a spherical vessel in which the product is made.
16. Rotary feeder - an air lock chamber with a paddle wheel-like assembly

that turns 360° to feed polyethylene into a transfer line at a controlled rate.

17. Melt Index - the amount of polymer that passes through a given opening in a given time with a constant force. A measure of molten polymer viscosity.
18. Material Handling - the moving, storage, and shipping of the poly pellets.
19. Screen Pack - a fine mesh screen that filters out impurities in the poly stream.
20. Specks - black or gray spots on the pellets.
21. Gels - a hard lump or other imperfection that sometimes forms in film.
22. Regenerate - to renew a bed that has been exhausted.
23. Purge - to remove undesirable elements.
24. Sidestream - an injection point other than the mainstream. In this process ATE is a sidestream.
25. Static Mixer - a series of baffles that makes the poly change direction for blending.
26. Molecular Sieve - a fine sand-like granular substance with a large surface area to remove water and other impurities.
27. Silica Gels - a fine sand-like granular substance with a large surface area to adsorb water and other impurities.
28. Solvent - a liquid substance used in Dowlex to absorb the heat of reaction and keep polymer in solution. Also known as Isopar-E.
29. Film - a thin flexible transparent sheet.
30. Polyethylene - the ethylene after it has been changed to plastic.
31. U.P.S. - an uninterruptable power supply. Provides emergency power

for certain lights, plant intercom, and critical instruments.

32. Substation - the housing for the electrical switchgear in the block.
33. Level control - any device (pump speed, control valves) used to maintain a liquid level in a vessel.
34. Pressure control - any device (speed control, pressure control valves) used to maintain a certain pressure in a vessel.
35. Granulation - the size or shape of the polyethylene pellets.
36. Cross contamination - when two different product types are mixed together, unintentionally.
37. Classifier - a piece of equipment used to separate small or large polyethylene pellets from the desired size pellets.
38. Cooling Tower - a large vertical construction open to atmosphere with water falling down and air being pulled up to cool the water.
39. Catalyst Kill - any of a number of elements that will stop the polymerization process. Calcium stearate is used in the process.

2.2 DOWLEX NUMBERING

The block number for Dowlex is Block 86.

The equipment numbering system for Dowlex follows a systematic pattern. It is the same as that used for Trains "C" and "D" at Polyethylene III in Texas Division and other Dowlex plants built throughout the world. Major equipment is numbered as follows:

XX NNN A/B

XX - equipment type abbreviation, list below

NNN - equipment number; first digit describes the area of the plant, second digit the train, third digit the actual number.

A/B - used for two identical pieces of equipment serving same purpose on
the same train.

EQUIPMENT ABBREVIATIONS (cont'd)

C	Compressor
CH	Check Hopper
CL	Classifier
CT	Cooling Tower
D	Drum or Tank
DPW	Drum for Pellet Water
DV	Diverter Valve
E	Heat Exchanger
F	Furnace
FACP/FACV	Air Conveying Filter
FL	Filter
FN	Fin-Fan
FV	Flare Stack
H	Hopper
HA, HAS	Additive Hopper
HB	Bagging Hopper
HL	Car Loading Hopper
HMB	Make-Blend Hopper
HS	Storage Hopper
HUH	Hold-Up Hopper
K	Pelletizer
M	Motor
MX	Static Mixer
NSV	Automatic Slide Valve
P	Pump
POC	Oil Pump on Air Compressor

POX	Oil Pump on Extruder
PR	Refrigerant Pump on ARU
PS	Solution Pump on ARU
PW	Pump for Pellet Water
R	Reactor
RAC	Receiver in Air Conveying - also acts as a Deduster
RF	Rotary Feeder
SACP/SACV	Silencer
SAM	Sample Collector
SD	Spin Dryer
VP	Vacuum Pump
WS	Weigh Scale
XS	Additive Extruder
Y	Adsorption Bed
YB	Blower on regeneration system for adsorption beds
YE	Heat Exchanger on regeneration system for adsorption beds
YD	Drum on regeneration system for adsorption beds
YH	Electric heater on regeneration system for adsorption beds

Throughout the operating manual the numbers shown in the text are those for Train I. The same explanation or description applies for Train II.

2.3 PLANT MODEL

For the engineering of this plant, a model was built using the modular concept. That means Train I and Train II are modelled as identical modules and the one model applies to both trains. In the areas around the pelletizing building, including the devolatizers, T611 and T621, both trains are modelled

because in these areas the trains 'mirror' in to the pelletizing building.
The common equipment - solvent storage, catalyst mixing and storage, ARU's,
air compressors, Dowtherm furnace are modelled.

The model scale used is $3/4" = 1'0"$.

3. EMERGENCY SYSTEMS

3.1 SAFETY SHOWER AND EYEWASH SYSTEM

Potable water is used for the safety shower system. Potable water is received from the Division's water treating plant and enters the block in a four inch header at about 70 psig. There is a flow and pressure transmitter located on the incoming line that indicates and alarms on TDC 2000. The alarms are low pressure and high and low flow. The incoming line goes to all buildings, the pellet water system, and E-906. (Fig. 3.1)

E-906 is a heater designed to heat gpm of water 100°F above the inlet cold water temperature. The temperature will be controlled on a field mounted controller. 15# steam will be used for temperature control. The condensed steam will be returned to the condensate return header going back to D-908 (condensate storage). (Fig. 3.2)

The safety shower system is a closed recirculating system requiring make-up water only if potable water in the safety shower is used. P-906 A&B are the recirculating pumps and get suction from the safety shower return header, discharging into E-906 and returning to the supply header. On the discharge of the P-906 pumps is a low pressure switch. On low header pressure, this switch automatically starts the P-906 pump that is not running. Low pressure also alarms on TDC 2000. P-206 A&B should always be left in the automatic field position with suction and discharge valves open.

There are 42 safety shower and eyewash stations located throughout the plant. The alarms on each station is a field mounted push button type. Push the button and the alarm activates. Pull the button out and the alarm deactivates. In the control room each safety shower has its own alarm light on a graphical display of the block.

The board operator will have to acknowledge any safety shower alarm, even if the alarm has been deactivated in the field. The list of safety shower locations are located on Figure 3.2.

3.2 FIRE PROTECTION

The Dowlex plant will have several different types of fire protection systems. All systems will use the rate of rise method (5° temperature rapid rise will trip the system involved). These deluge systems can be tripped remotely in the control room and manually at the deluge valve. Several systems will have an optional foam system than can be manually tripped in the control room or in the plant. (Fig. 3.3) The foam can be injected along with the water and sprayed throughout the system.

Storage area - deluge system and will have a connection for mobile foam equipment from the fire department.

Warehouse - Wet-filled system. Sprinkler heads will be fused and only those heads unfused by fire will be activated.

Catalyst Storage & Mixing - Deluge system only.

Dowtherm Area - Deluge system. Also in the pipeway directly north of the Dowtherm area will be a water curtain to isolate the Dowtherm furnace from the process area.

Process Area - Deluge system with foam option.

Truck & Rail Unloading - Deluge system only.

Collection Pond - Foam system only.

All of the fire protection systems will have alarms in the control room to show that they have been activated. No deluge valves can be reset by any of the trip methods. They have to be reset manually at the valves. Close the valve, reset, open the valve.

Deluge systems will be designed for directional and area coverage. Directional coverage is direct spraying on one piece of equipment, and area coverage is a specified area. The directional coverage is calculated as .35 gallons per minute water per square foot of surface area.

Example: D-811 diameter is 16 feet X 16 feet

16 X 16 equals 1,056 square feet of area

1056 X .35 = 369.6 gallons of water per minute

Area coverage is calculated the same way using .2 gallons per minute instead of .35. Area coverage would be like spraying the entire storage area.

Fire protection water comes from the division looped process fire water system. This encircles the block at the block limits. These lines are designed to give Dowlex (Block 86) the total demand of all systems flowing at the same time. The block is also looped internally to supply the deluge systems, fire monitors, and fire hydrants. The system inside the block is not a boosted system and runs at division pressure which would be approximately 85 psig at the block limits. The deluge system inside the block is designed for 55 psig at a deluge valve. (Fig. 3.7)

1) Location of the plant monitor guns (Fig 3.4)

<u>NUMBERS</u>	<u>LOCATION</u>
1	Southeast of cooling tower CT901
2	West of substation #1
3	East of T-611
4	North of substation #2
5	North of Catalyst mix tanks
6	West of C-721
7	South of Y-122 A/B

1) Location of the plant monitor guns (cont'd.)

<u>NUMBERS</u>	<u>LOCATION</u>
8	West of E-221
9	Southeast of E-627
10	Northwest of E-621
11	South of C-902
12	Southwest corner of storage area
13	Northwest corner of storage area
14	Southwest corner of pallet storage
15	North of Catalyst storage
16	Northeast of cooling tower CT901

2) Hydrant Locations (Fig. 3.6)

- a. Southwest corner of pallet storage.
- b. East of Substation #2
- c. Northwest corner of storage area
- d. Northwest of cooling tower CT901

3) Location of Deluge Valves (Fig. 3.5)

<u>NUMBERS</u>	<u>LOCATION</u>
1	South wall of storage, southwest of D-801
2	South wall of storage, southeast of D-802
3	South of Catalyst mix tank
4	East of C-111
5	East of C-121
6	Northwest of Y-211 A/B
7	West of Y-211 A/B
8	Northwest of Y-211 A/B

3) Location of Deluge Valves (cont'd)

<u>NUMBERS</u>	<u>LOCATION</u>
9	West of E-627
10	Southwest of VP-512 A/B
11	North of E-261
12	West of C-903

3.3 DIKES AND DRAINAGE

The storm sewer system is designed to handle the full flow of deluge systems when set off on trains one through four, solvent storage area, and the cooling tower area. Fire and rain water will be carried by the storm sewer system from the process areas to the collection pond. The collection pond is sized to handle the first 3/4 inch of rainfall on the areas described above. The plant drainage system is divided up in small areas in order to size the system. The areas that flow into the collection pond are divided into three sections. Fig. 3.11 will show drainage areas.

The solvent/comonomer storage area is diked for containment of spills. A valve box is located outside the diked area so this area can be drained to the collection unit. The valves must remain closed at all times except to drain rainwater. An operator must remain at the valves all the time they are open. Also tied into this area's drainage is the rail and tank car unloading drains and Catalyst storage drains.

The pelletizer buildings drains tie into the sewer going to the collection pond, but before going into the sewer, the water flows through a pellet trap to remove pellets before entering the sewer.

The area of the plant south of the south-most entrance road does not drain to the storm sewer system except the drains around the flare system

(D-904, FV-904). The flare drains do tie into the storm sewer system. The hopper car loading, pellet storage, warehouse, and pallet storage areas all flow into a pellet trap then out on the east side of the block.

Another diked area is the Dowtherm system consisting of F-501, D-500, D-502, and associated pumps. The area is diked to prevent Dowtherm from escaping into other areas. This area drains into the storm sewer system.

The plant's ground level is sloped in such a manner that all pipe racks and instrument/electrical trenches are on the high points. The reasoning behind this is to minimize the possibility of fires under the piperacks and keep liquid out of the trenches.

On both outlet trenches on the storm sewer system there are weirs to maintain a liquid-full level in the sewer system at all times. This is done to prevent hydrocarbon gases from forming an explosive mixture in the sewer piping.

3.4 EMERGENCY BLOCK VALVES

Emergency block valves are located throughout the plant in different process lines to enable areas of the plant to be shutdown in an emergency situation to protect both people and equipment. On train one, there are 25 block valves (HV) and 9 flow, level, temperature, and pressure control valves that can serve as emergency block valves. There are equivalent valves on Train 2. (Fig. 3.12)

The 25 block valves are of different sizes and some require more pressure to operate than others. Our plant air pressure is not sufficient to operate some valves so 200 psig nitrogen will be used. Also some will have reservoirs installed to aid in closing the valves. On the next page is a list of these 22 valves and information on each.

- HV 1141 - Located on the incoming propylene line near the block limit. This is a 3 inch gate valve and can be operated from the control room only. Fail safe position is closed.
- HV 1003 - Located on the incoming ethylene line near the block limit. This is an 8 inch gate valve and can be operated from the control room only. Fail safe position is closed.
- HV 2240 - This valve is located on the incoming feed line to R-211. This is a 6 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the control room only. Fail safe position is closed.
- HV 2242 - Located on the bottom outlet of R-211. This is a 6 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the control room only. Fail safe position is to fail in place.
- HV 2246 - Located on the top outlet of R-211. This is a 12 inch gate valve requiring 200 PSIG nitrogen to operate from the control room only. Fail safe position is to fail in place.
- HV 2278 - Located on the top outlet of R-212. This is a 12 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the control room only. Fail safe position is to fail in place.
- HV 2280 - Located on the bottom inlet of R-212 from P211's. This is a 4 inch gate valve that will operate off of plant air pressure. This valve can be operated from the control room only. Fail safe position is closed.

safe position is closed.

HV 9005 - Located on the incoming chlorine to CT 901. This is a 2 inch gate valve that will operate off plant air. This valve can be operated from the control room only. Fail safe position is closed.

HV 9026 - Located on the incoming hydrochloric acid header going to CT901. This is a 2 inch Teflon-lined plug valve that will operate off plant air. This valve can be operated from the control room only. Fail safe position is closed.

HV 2317 - Located on R211 bottom to dump to D212. Air operated 3 inch gate valve with air reservoir to enable operation in an air failure. On power failure will fail in place.

HV 2318 - Located on R212 bottom to dump to D212. Same as HV 2317.

HV 5024 - Located on bottom outlet of D-500 going to P-500 A/B/C to Dowtherm liquid system. This is a 20 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the field and from the control room. Fail safe position is to fail in place.

HV 5115 - Located on the Dowtherm vapor inlet line to E-511. This is a 14 inch gate valve requiring 200 PSIG nitrogen to operate. This valve is furnished with an override hand wheel operator and can be operated from the control room. Fail safe position is to slowly close.

HV 5253 - Located on D-500 outlet to P-501 A/B/C suction going to F-501. This is a 24 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the field and from the control room. Fail safe position is to fail in place.

- HV 2281 - Located on bottom inlet of R-212 from R-211. This is a 12 inch gate valve requiring 200 PSIG nitrogen to operate. This valve can be operated from the control room only. Fail safe position is to fail in place.
- HV 5086 - Located between MX212 and E511. Nitrogen operated 12 inch gate valve. Fail safe in place. Operate from the control room.
- HV 3094 - Located on the discharge of P-311 A, B, & C. These are one
& 3095 half inch 3 way plug valves. Upon tripping these valves, the flow is diverted from going to R-211, back to D-311. P-311 A/B/C are positive displacement pumps so they cannot be dead headed. Valves can be operated from the control room only. Fail safe position is to D-311.
- EV 5001 - These valves are located on the fuel gas inlet lines to F-501
A,B,C,D, (Dowtherm furnace). These valves are electronic Maxon valves.
E&F The block valves fail closed. The bleed valves fail open.
EV-5001 D, E, & F are located on the pilot gas line.
EV-5001 A, B, & C are located on the main gas line.
- HV 6005 - Located on the bottom outlet of T-611. This is a 10 inch gate valve requiring 200 PSIG nitrogen to operate. This valve is furnished with an override handwheel operator. Can be operated from control room also. Fail safe position is fail in place. This valve also has a reservoir tank to aid in operating.
- HV 7019 - Located on the recycle ethylene line back to LHC. This is a 3 inch gate valve that will operate off plant air. This valve can be operated from the control room only. Fail

This valve also has a reservoir tank to help operate this valve.

The above valves are operated by switches on a graphic panel in the control room. They all have limit switches and lights on the panel to indicate whether opened or closed.

There are 10 control valves that can be used as Emergency Block Valves during an emergency. The following is a list of the valves, location, and fail safe position.

FV 1123 - Ethylene flow control located downstream of E-111. Fail safe position is closed.

FV 2227 - Solvent/octene flow control valve to R-211 located between P-211 A/B/C and EJ-211. Fail safe closed.

PV 2248 - Reactor pressure control valve. Located between E-511 and D-511. Fail safe is closed.

LV 5243 - D-500 level control valves. These are split range valves. LV-
A&B 5243 A is on the return header from trains 1 and 2. LV-5243 B is on the make-up from D-502 to D-500.

TV 5252 - Temperature control valves that control the temperature of the
A&B Dowtherm liquid to train 1. TV 5252 A is on the train 1 return header going to D-500. TV 5252 B is on the line going from train 1 return to the suction of P-500 A/B/C. Fail safe on TV-5252A is open, for TV 5252B is closed.

FV 6000 - Wax flow from T-611 bottoms to D-511. Fail safe position is closed.

FV 8038 - Flow control valve for octene makeup. This valve is located downstream of P-803 A/B. Fail safe position is closed.

3.5 GAS DETECTORS

The gas detectors in the Dowlex plant will be Rexnord brand detectors. We have an extensive gas detector system, locations are shown on ^{Table 3.1}~~Figure 3.5~~.

Dowlex has both single channel and eight-channel units. The single channel units are used for combustible gas measurements which are input to the TDC 2000 so gas concentration can be trended. The eight-channel units are used for area gas detectors.

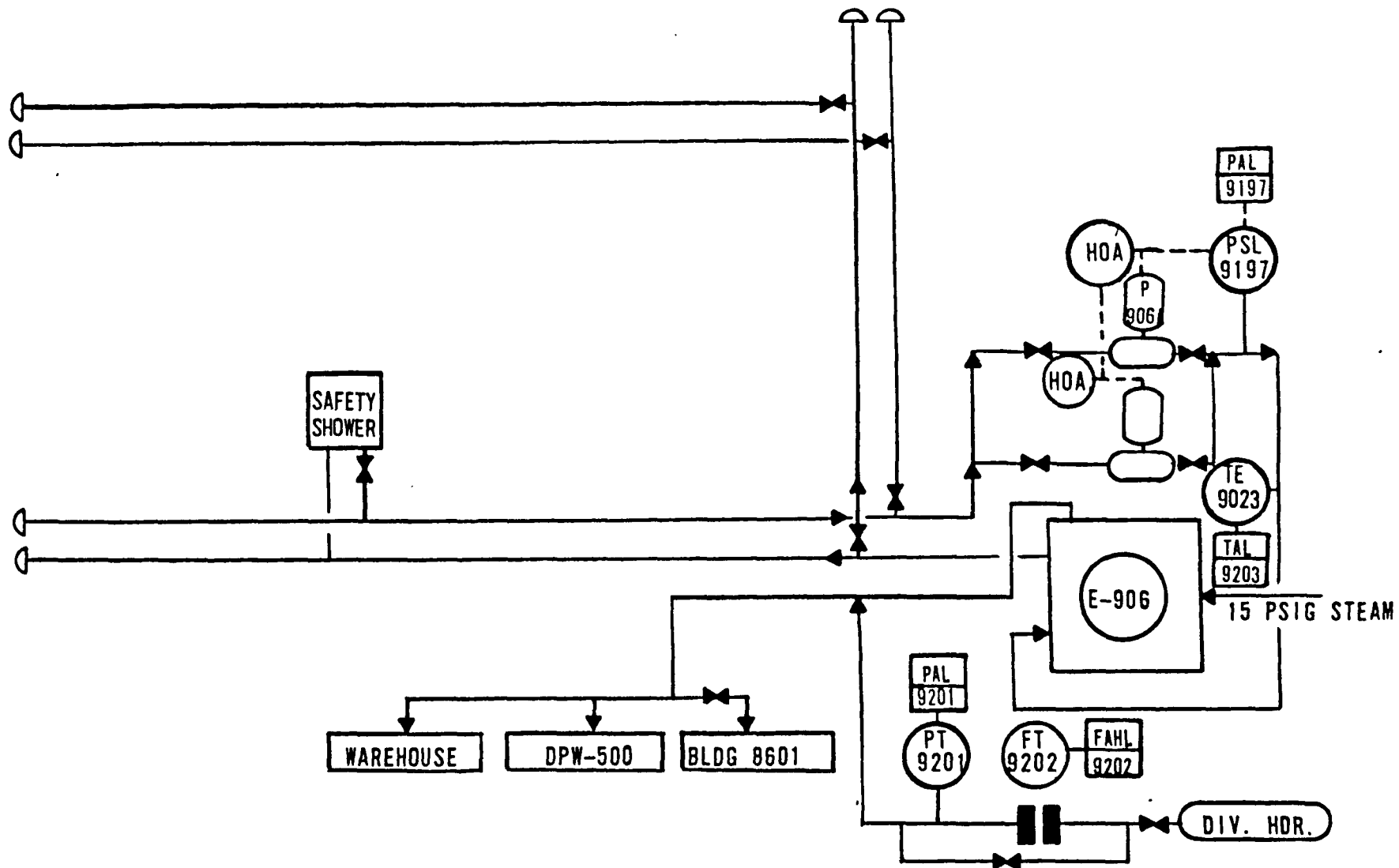
TABLE 3.1
GAS DETECTOR LOCATIONS

The following is the location of gas detectors in train 1 and equipment common to both trains. Train two has the same detector locations as train 1.

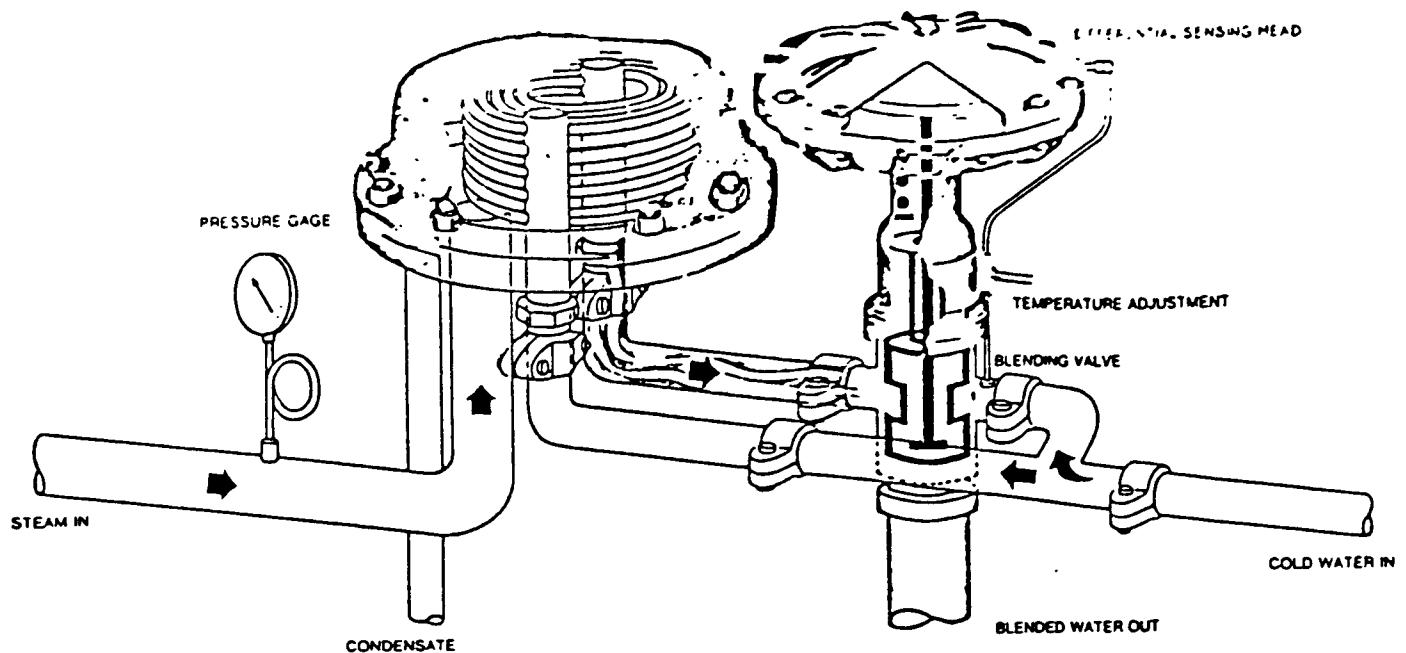
1. Near F501	43. Near FV2227	64. Near T611
2. Near P500 A/B/C	44. Near R211	65. Near P611 A/B
3. Near P501 A/B/C	45. Near A211	66. Near P612 A/B
4. Flare area	46. Near R212	67. Near YB611
5. Near C902	47. Near A212	68. Near P802 A/B
6. Near C903	48. Near D301C	69. Near P809
7. Check Hopper 1A	49. Near D305	70. Near P811 A/B
8. " 1B	50. Near D308	71. Near P806 A/B
9. HMB (blindlers) 1A	51. Near D311	72. D202 Vent
10. " 1B	52. Near D312	
11. " 1C	53. Near P312 A/B/C	
12-19 Hoppers 1-8	54. Near P511	
20-25 Hopper silos 1-6	55. Near D511	
26-27 Hopper bagging 1-2	56. Near P519A	
28-35 Hopper loading 1-8	57. Near P519B	
36. Near D111	58. Near E512	
37. Near C111	59. Near D512	
38. Near E111	60. Near VP512A	
39. Near YB211	61. Near VP512B	
40. Near P211A	62. Hold Up Hopper #1	
41. Near P211B	63. Near P614 A/B	
42. Near P211C		

EMERGENCY SYSTEMS FIGURE INDEX

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
3.1	Potable Water System
3.2	Potable Water Heater
3.3	Block Layout for Fire Protection
3.4	Plant Monitor Gun Locations (overview)
3.5	Deluge Valve Locations (overview)
3.6	Hydrant Locations (overview)
3.7	Underground Fire Water
3.8	Wet Filled Sprinkler Head
3.9	Deluge Valve
3.10	Foam Tank
3.11	Storm Sewer Drainage
3.12	Emergency Block Valves
3.13	Pneumatic Cylinder Gate Valve Operations



POTABLE WATER SYSTEM



adjust steam pressure to the heater shell . . . admitting steam as the load or demand for hot water increases . . . and reducing it as the demand decreases. Even if the blender plug is held open by an object, and movement of the valve is restricted, a yielding arrangement comes into play to automatically permit shutdown of the steam to the heater.

SAFETY DESIGN

Even if something should go wrong with either unit . . . it would produce only cooler water, or no water at all.

A safety system designed to help protect personnel and process from scalding.

TEMPERATURE ADJUSTMENTS

Temperature settings are easily made on the Leslie-Constantemp by using the adjusting rod located on the stem of the blending valve. A simple movement of the rod in one direction of the other allows outlet water temperature to be preset.

As an added precaution, the adjusting rod locks with a lock ring and set screw . . . a deterrent to tampering . . . the blending device, however, remains free to move in response to demand.

In climates where the cold water supply temperature varies greatly from summer to winter, a quick seasonal adjustment is easily made with the adjusting rod to keep temperature differential within the desired operating range.

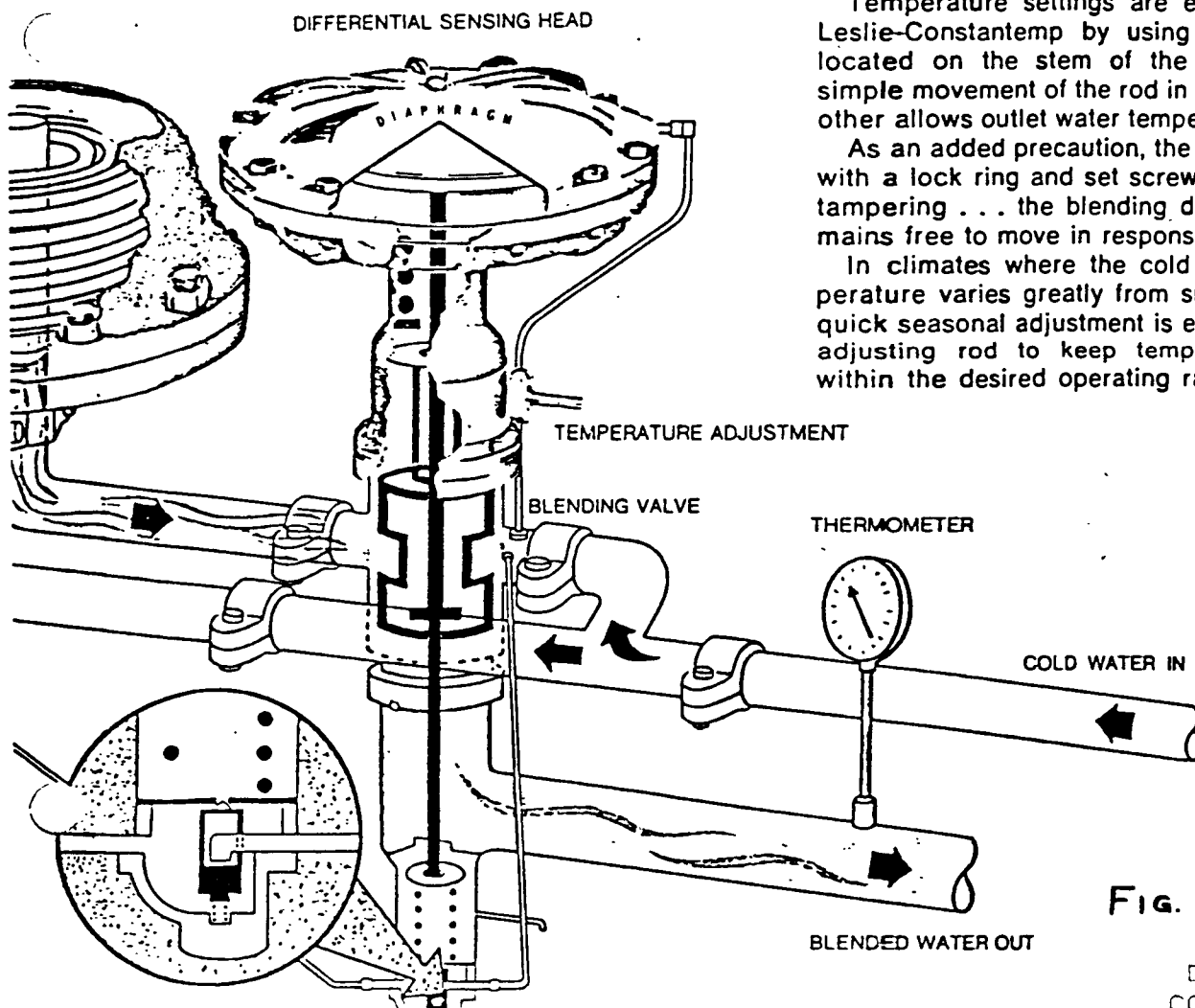
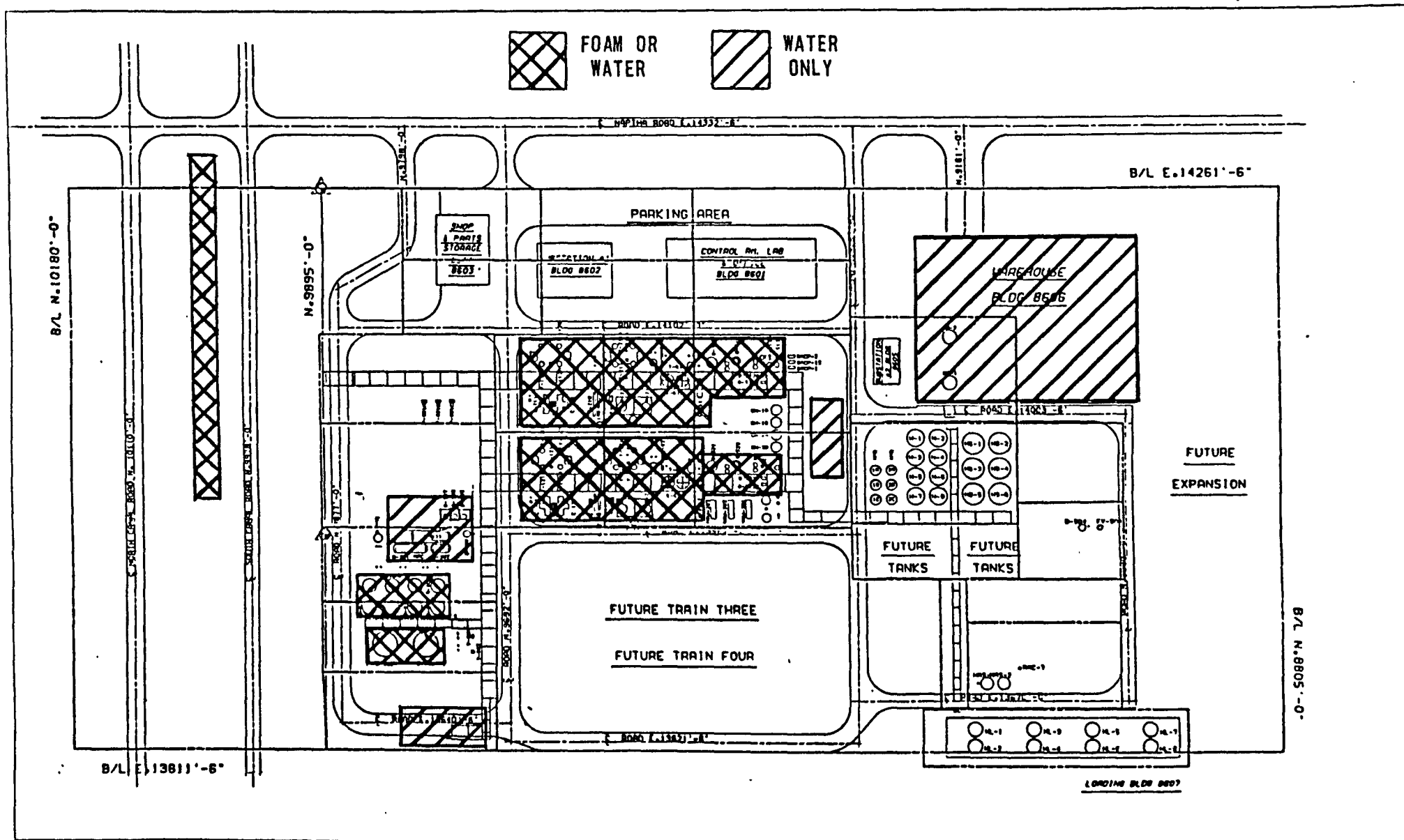


FIG. 3.2



FIRE PROTECTION

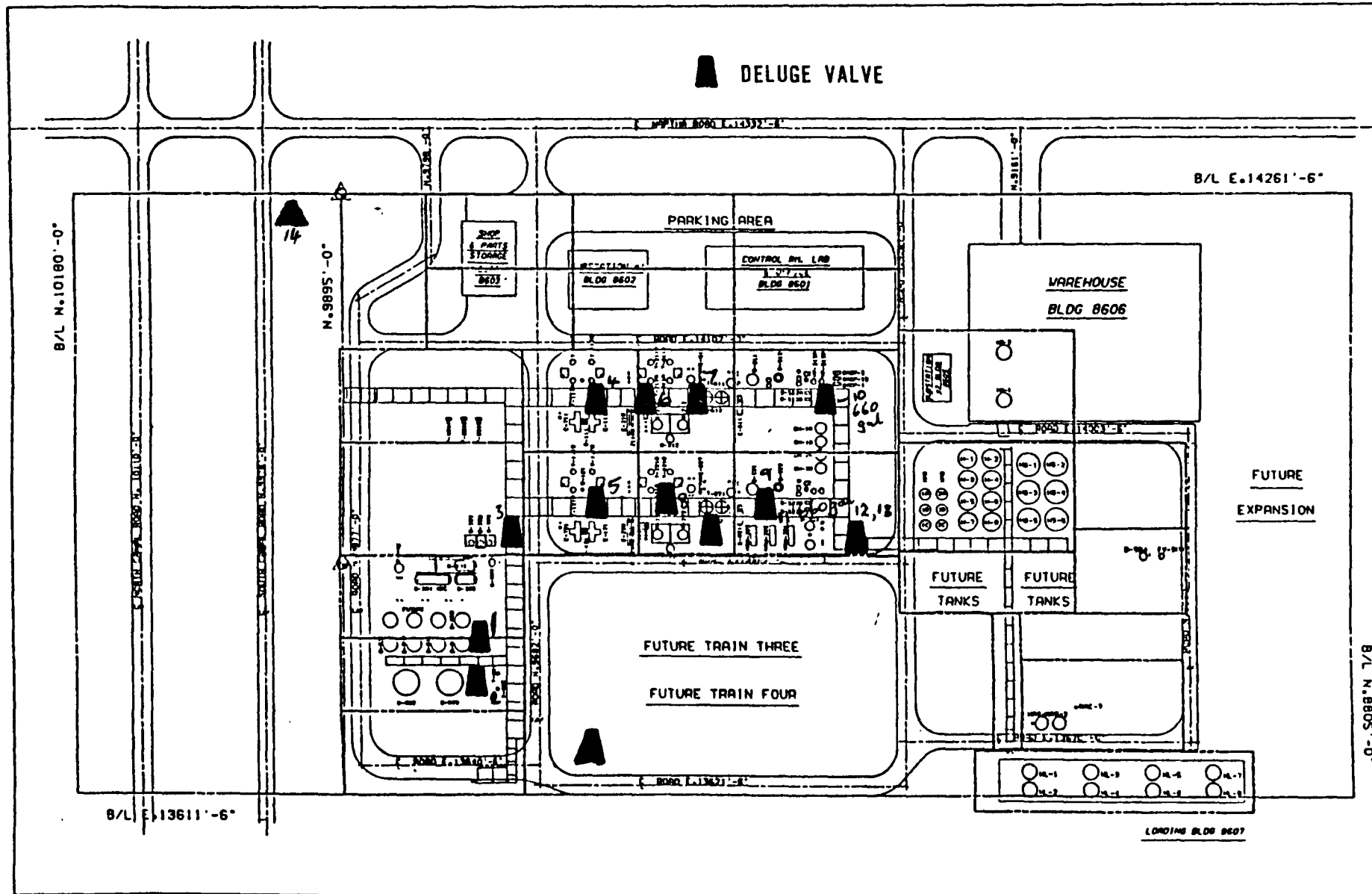
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FIG 2 A

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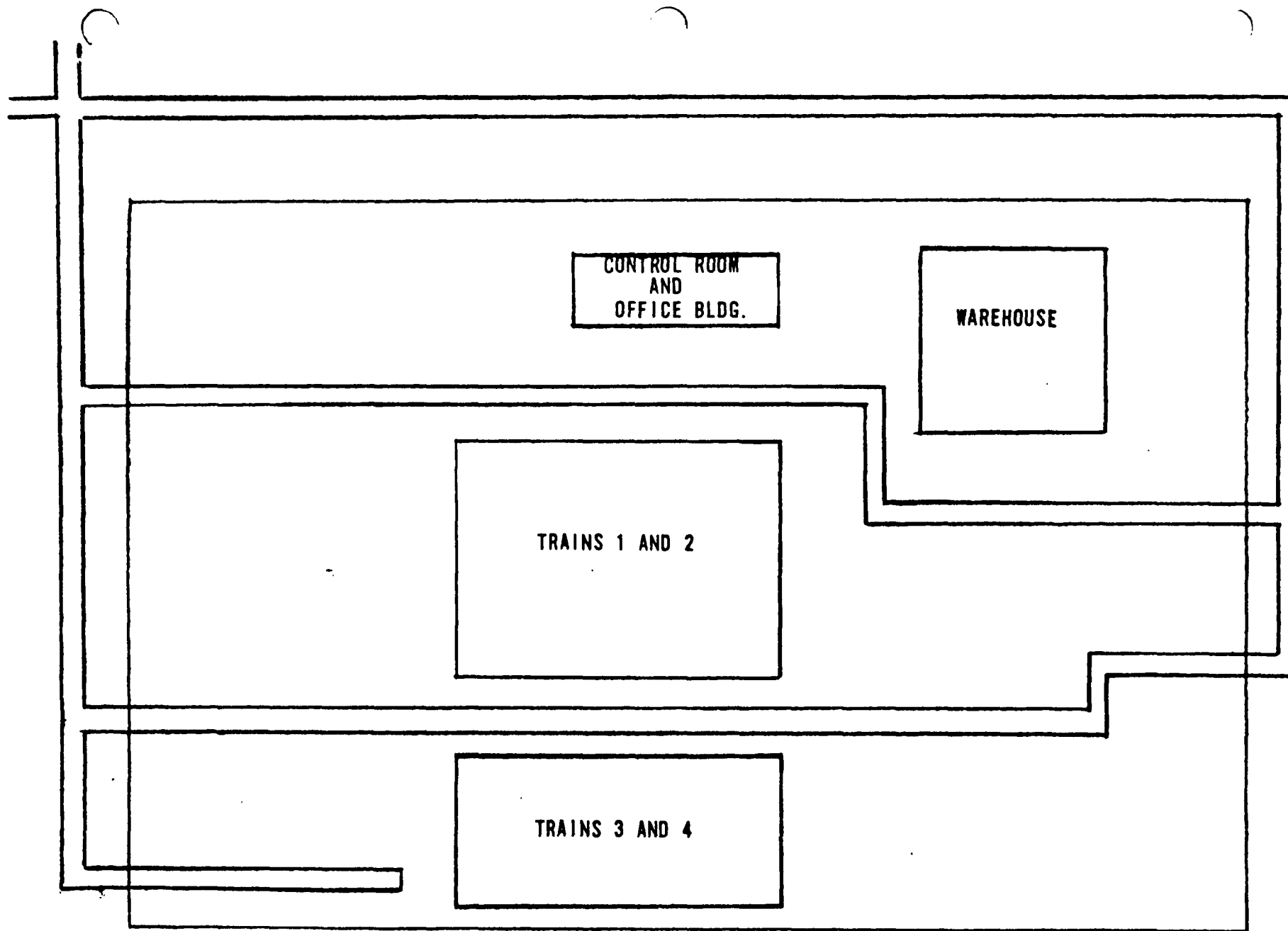
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The site plan illustrates the layout of the Borden Chemical Plant. Key features include:

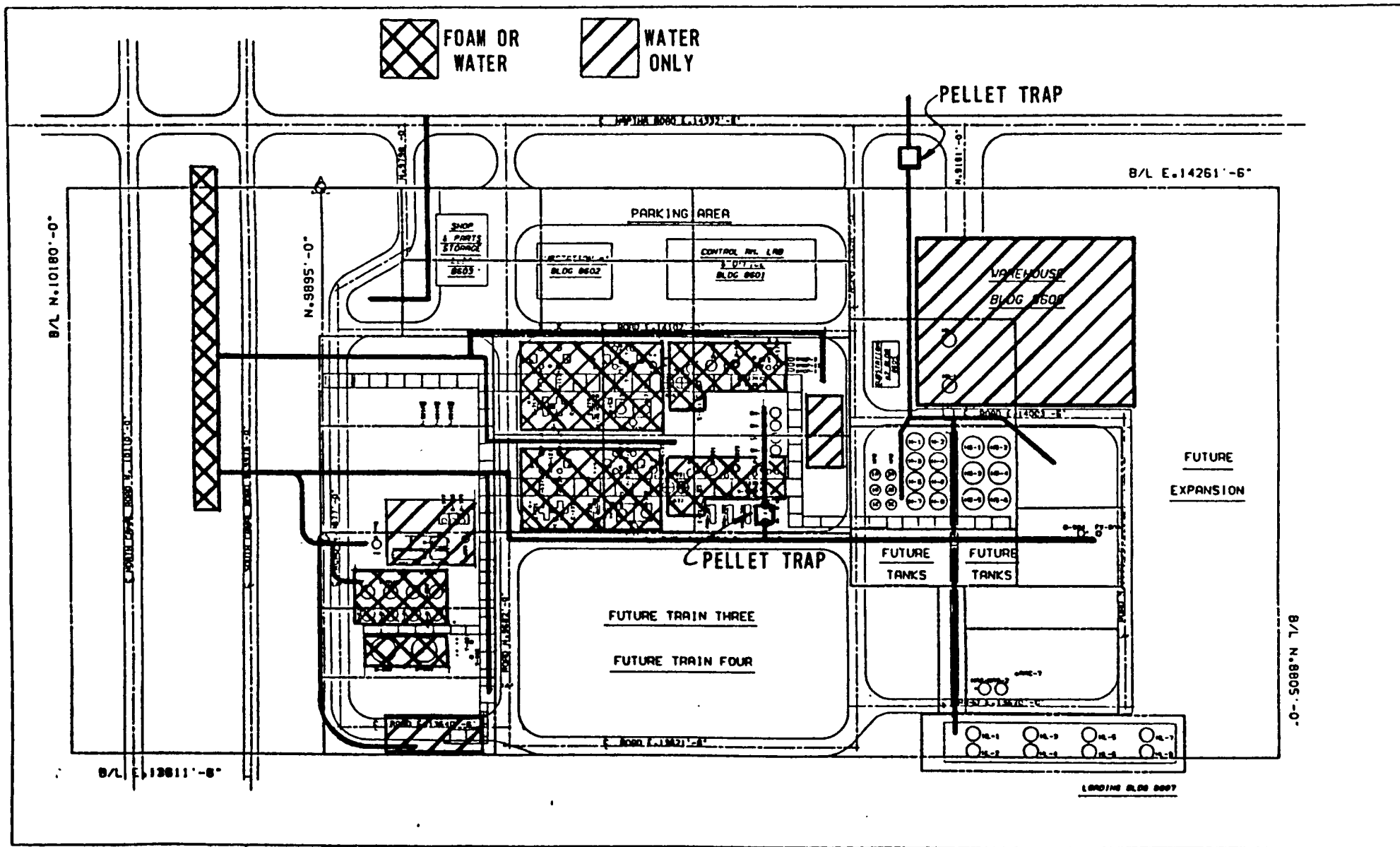
- Existing Structures:**
 - WAREHOUSE BLDG 8506:** A large rectangular building on the right side.
 - BLDG 8502:** A building located in the upper left, near the parking area.
 - CONTROL BLDG 8501:** A building located in the upper center, near the parking area.
 - BLDG 8503:** A building located in the lower left, near the future train areas.
- Parking Area:** A designated area in the upper center of the site.
- Future Expansion:**
 - FUTURE TRAIN THREE** and **FUTURE TRAIN FOUR:** Large rectangular areas in the lower center.
 - FUTURE TANKS:** Two sets of circular tanks located to the right of the future train areas.
 - FUTURE EXPANSION:** A designated area on the right side of the site.
- Hydrants:** Indicated by black triangles. One is located near the top center, another near the bottom left, and a third near the future expansion area.
- Dimensions:**
 - Overall site dimensions: **B/L N. 10180'-0"** (left), **B/L E. 14261'-6"** (top), **B/L N. 8805'-0"** (right), and **B/L E. 13611'-8"** (bottom).
 - Internal dimensions and offsets are also provided, such as **N. 5895'-0"** and **E. 13111'-0"**.
- Other Labels:**
 - LOADING BLDG 8507:** Located at the bottom right.
 - BLDG 8504:** Located near the future tanks.
 - BLDG 8505:** Located near the future tanks.

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UNDERGROUND FIRE WATER

FIG. 3.7



DRAINAGE

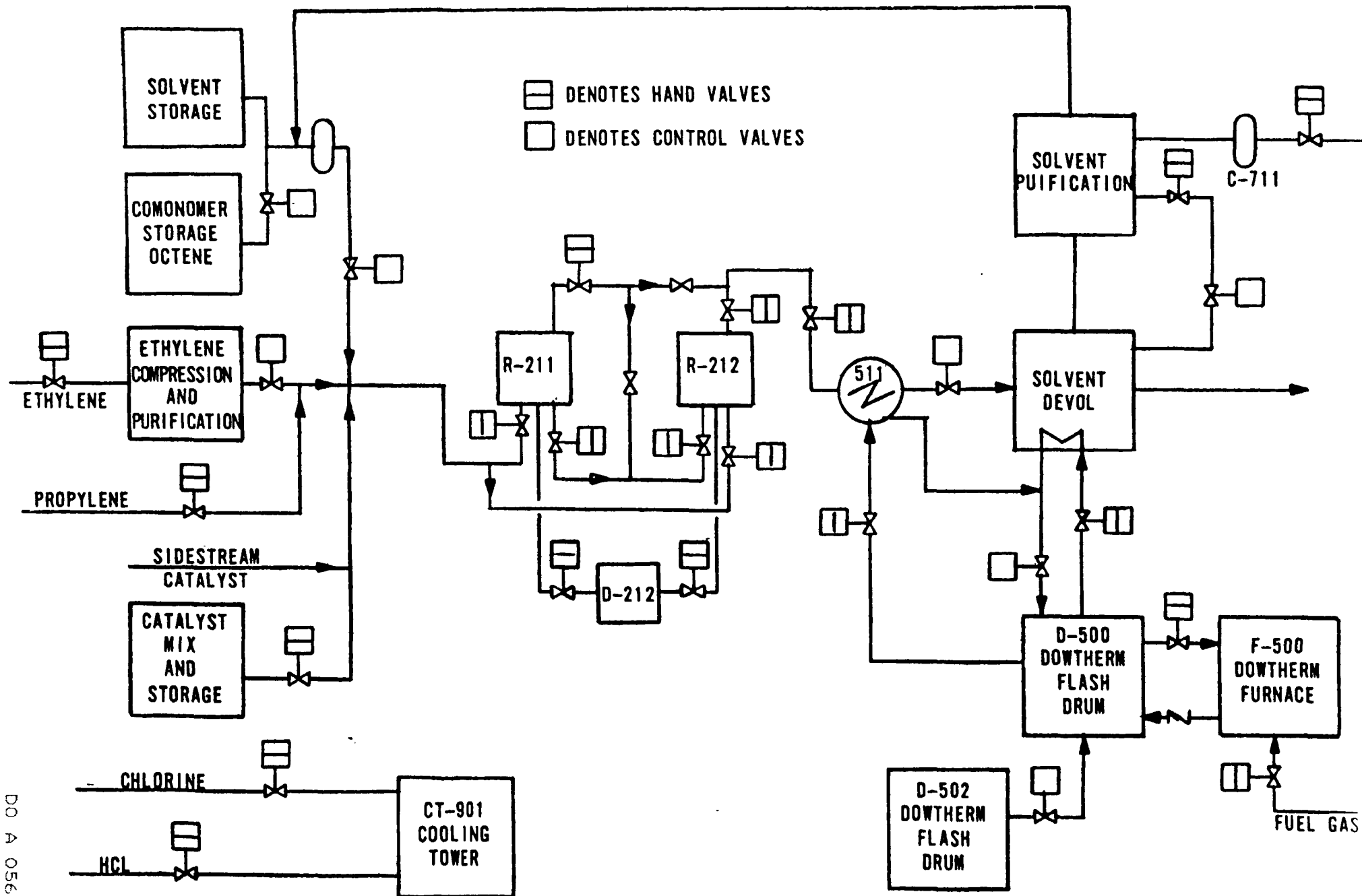
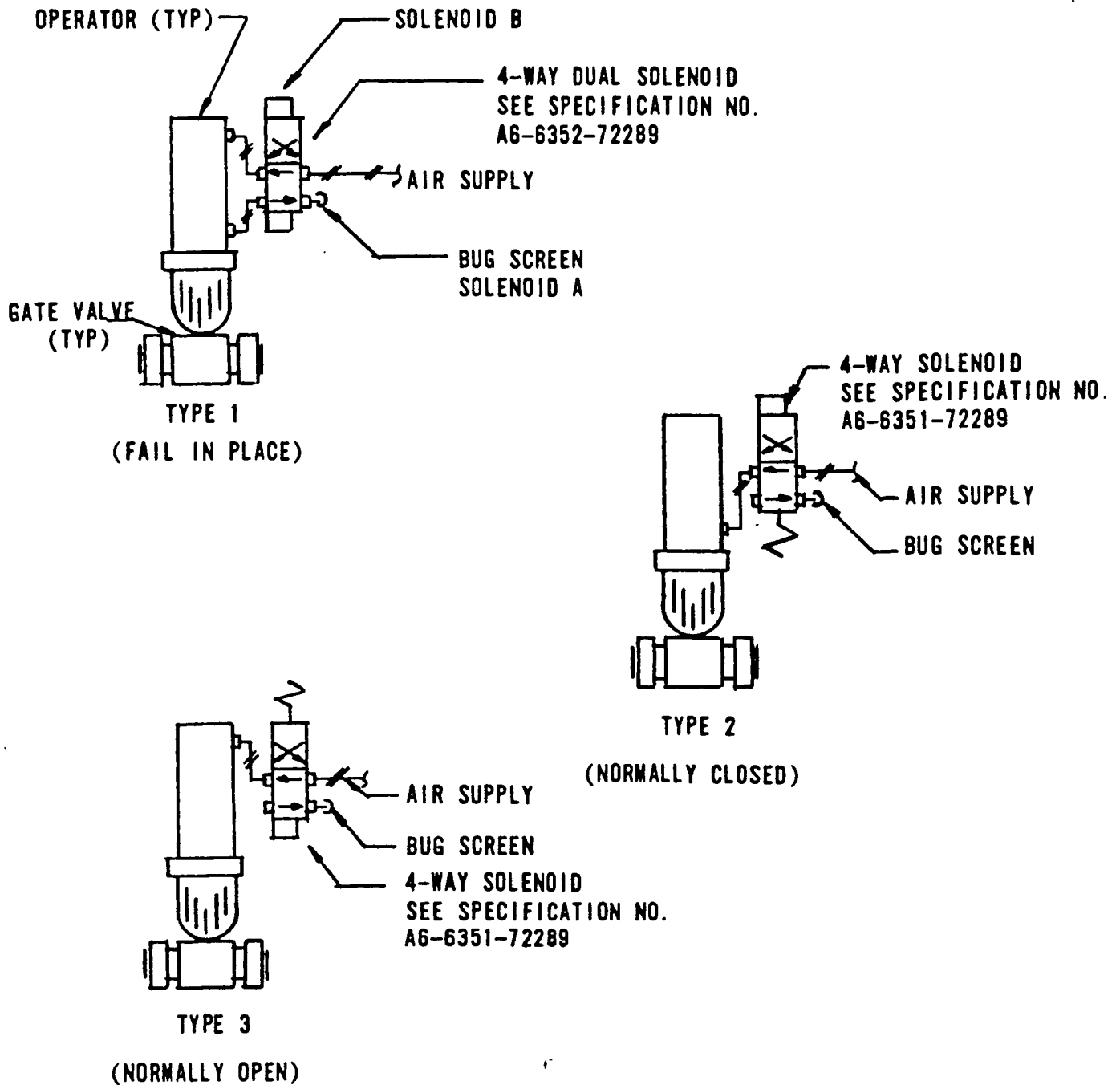


FIG. 3.12

EMERGENCY BLOCK VALVES

SOLENOID PIPING TYPES ARE AS FOLLOWS:



CONTROL VALVES ON-OFF CYLINDER OPERATED

FIG. 3.13

4. RAW MATERIALS

The following materials are used either directly or indirectly at Dowlex:

Octene-1	Slip
Isopar E	Superfloss
Ethylene	Mineral Oil
Propylene	Dowtherm A
Hydrogen	Silica Gel
Magnesium Alkyl	Molecular Sieve
Triethyl Aluminum	Chlorine
Tetraisopropyl Titanate ADC	Fuel Gas
HCl - anhydrous	Nitrogen
Calcium Stearate	Steam
Irganox 1010	Condensate
Weston 619	~~Freon 22~~
UV531	Lithium Bromide
~~UV531~~	Activated Alumina
~~Irganox 1076~~	~~Heptane~~
Betz 2020/2040	~~35% aq. HCl~~
DLTDP	Lithium Chromate
~~BHA~~	Octanol

This section describes the important information relating to the above materials. Table 4-1 lists some properties. The raw material specification sheets and other useful data are included at the end of this section.

4.1 RAW MATERIALS

Ethylene (C_2H_4)

Flammable gas received by pipeline at 400 psig from the LHC plants (I, II, and III). Usage is 406 million pounds per year. It has a characteristic sweet odor, is not toxic but acts as an anesthetic. Explosive limits are 3% to 34% in air. It has about the same density as air. In an ethylene fire the best action is to shut off the fuel supply and activate the plant deluge system. Small fires such as valve packing can be extinguished using a dry chemical extinguisher. About 8% of this ethylene is recycled back to L.H.C. unreacted.

Ethylene decomposition

Octene (C_8H_{16})

Flammable liquid received in tank cars or tank trucks from Gulf, Shell, and Ethyl. Usage is about 39 million pounds per year and it depends on the type of products that are made. Octene is used to control polymer density and densities are varied between products. It will be stored in two nitrogen padded, 100,000 gallon tanks. It has a characteristic sweet odor and is non-toxic. Fire fighting should consist of deluge water and foam or dry chemical on small fires.

Propylene (C_3H_6)

This is a flammable gas at ambient temperature and pressure. It is received as a liquid from LHC under 250 psig pressure. Propylene is used if high or intermediate density polyethylene is made. It is not used to make Dowlex. It is used to control density. It is similar to ethylene in odor and toxicity. Propylene is heavier than air so a leak will stay at ground level. In case of a large leak and fire, the fuel should be shut off before extinguishing the fire to avoid a 'flash back'. The deluge system will cool metal

but probably won't extinguish a fire. Dry chemical should be used on small fires.

Hydrogen (H₂)

A very light, flammable gas received by pipeline from LHC III or in high pressure tube trailers. Usage will be 100,000 pounds per year. It is used to control polymer melt index. It is odorless and non-toxic. Explosive limits are 4.1% to 74.2% in air. The only way to reliably extinguish a hydrogen fire is to shut off the fuel source. Dry chemical may work on small fires.

4.2 PROCESS SUPPLIES

Isopar E

Flammable liquid received in tank cars or tank trucks from Exxon. Usage is 4.6 million pounds per year with 3.6 million pounds of that returned as waste solvent. Isopar E is stored in a 20,000 gallon API type tank. An additional 50,000 gallons is stored in other in-process vessels. Isopar E is a mixture of iso-oct^aene, iso-nonane(C₈ and C₉) and small amounts of other paraffins. It is not toxic and has FDA approval for food contact applications. Flammability limits are 0.9% to 7.0%. Fire fighting should include foam or dry chemical on small fires. Isopar E is the principal solvent in the plant; the catalyst is slurried in it and the reaction takes place in it. It is often called 'solvent'.

Heptane

Flammable liquid used for solvent by magnesium alkyl suppliers. The magnesium alkyl is a 10% to 20% solution in heptane. Properties are similar to those for Isopar E.

Triethyl Aluminum

Commonly known as ATE (aluminum triethyl) or TEA. Received as a 15% solution in isopar E in tank trucks from Ethyl or Texas Alkyls. 100% ATE is pyrophoric - it ignites on contact with air and reacts violently with water. When diluted to 15% it is non-pyrophoric, however, it should be still treated as pyrophoric, because it becomes pyrophoric as the solvent evaporates. Latest fire fighting techniques recommend using a fine mist water spray. Dry chemical is also effective on small fires. ATE is hazardous to personnel because it will cause severe burns. Usage is 48,000 pounds per year of contained ATE. It is used in catalyst preparation.

Tetraisopropyl Titanate

Trade name is Tyzor TPT. Received in 55 gallon drums from Dupont. Usage is 6000 pounds per year for catalyst preparation. It decomposes slowly on contact with air and moisture to form isopropanol which is a flammable liquid. Dry chemical is effective for the quantities that are used.

Magnesium Alkyl

Magnesium alkyl is a general name for di-n-sec-butyl magnesium (DBM) supplied by Lithium Corporation and butyl ethyl magnesium (BEM) supplied by Texas Alkyls. Both chemicals are used interchangeably for mixing catalyst. They are received in tank trucks diluted in heptane or isopar E to a 10% to 20% concentration. At 100% concentration both chemicals are solid. Magnesium alkyl is stored in a 3-compartment tank to keep shipments separated. Usage will be 82,000 pounds per year of contained magnesium alkyl.

Magnesium alkyl is a pyrophoric solid, that is, if exposed to air it will ignite spontaneously. It also reacts violently with water. When diluted to

20% or below in a solvent it is considered non-pyrophoric although it must still be treated as pyrophoric because it can be concentrated if the solvent evaporates. Fire-fighting should be similar to that used for ATE.

HCl - anhydrous hydrogen chloride

A highly corrosive gas when mixed with water. Supplied in 600 pounds net cylinders. Usage is 60,000 pounds per year. It is not flammable. It is corrosive to the eyes, skin, and respiratory tract. HCl is used to mix catalyst.

Diethyl zinc

Also DEZ. Same properties and comments as triethyl aluminum. Usage depends on catalyst research. It is used to mix catalyst.

Mineral Oil (MO)

Received in tank trucks. Usage is about 100,000 pounds per year. A typical oil is Exxon 'Primol' 355. It is used as a barrier fluid on the reactor seals. It is only moderately flammable.

Silica Gel

Received in drums or bags. Usage is about 220,000 pounds per year depending on how often the silica gel is dumped from the beds. It is supplied as clear granules when new but may turn black or brown after being in service. It has a very high surface area that will adsorb many impurities in ethylene and solvent. It is not toxic except that the dust may cause silicosis - a lung disorder. Dust masks must be worn. Silica gel is non-flammable.

Molecular sieve

Received in drums or bags. Dowlex uses two types: 5A molecular sieve and 13X molecular sieve. Usage will depend on how often beds are changed out. Its form is that of off-white solid regular shaped granules. It has a very high surface area per unit weight like silica gel and is used to purify ethylene and solvent. It is not toxic except that dust may cause lung disorders. Dust masks must be worn. Molecular sieve is non-flammable, however it can cause a violent reaction if mixed with ethylene too quickly.

Freon 22

Used in a closed mechanical refrigeration system on both trains. Usage should be zero after initial charging of units. It is non-toxic and non-flammable but is an asphyxiation hazard. Also known as R22 refrigerant.

Lithium bromide/lithium chromate/^{and}octane

These chemicals are used in the absorption refrigeration units. After initial charging, lithium bromide usage should be zero. Small amounts of lithium chromate and octanol (corrosion inhibitors) are needed. All three chemicals are moderately toxic.

Dowtherm A

Received in tank truck ~~or~~ drums for a closed loop heating system. It is a clear liquid when new but degradation may cause it to turn black or brown over several months. It is moderately flammable but it has a low vapor pressure at high temperature. Its normal boiling point is 257°C or 495°F. The flammability limits are 0.5% to 6.2% at 500°F. Dowtherm A is a mixture of diphenyl and diphenyloxide. It is mildly toxic and not corrosive. It has a

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characteristic unpleasant odor. Its freezing point of 54°F requires all equipment be steam traced.

4.3 POLYMER ADDITIVES

Calcium Stearate (CaSt)

A 'soapy' feeling white powder used to neutralize or kill the catalyst. It is received in 2200 pound tote bins. Usage is 600,000 pounds per year. It is non-toxic and approved for food contact applications. It is flammable and calcium stearate dust in air is a dust explosion hazard.

Irganox 1010

A high molecular weight antioxidant that inhibits degradation of polyethylene due to heat and air. It is received in 120 pound fiberpacks. Usage is 96,000 pounds per year. Irganox 1010 is a white, free flowing crystalline powder. It is FDA approved for polyethylene with food contact. It is slightly flammable.

Irganox 1076

Like Irganox 1010 except lower molecular weight. Usage depends on product mix. It is used in the hot melt additive system instead of Irganox 1010 because it has a lower melting temperature.

Weston 619

A secondary antioxidant used in the hot melt additive system. It is received in fiberpacks and usage is 24,000 pounds per year depending on product mix. It is supposed to provide additional processing stability of polymer for customers.

DLTDP

Full name is dilauryl thiodipropionate. It is a secondary antioxidant and is used in the hot melt additive system. It is a 'soapy' feeling solid received in fiberpacks. Usage depends on the product mix.

BHA

Chemical name is Butylated Hydroxy Anisole. Another primary antioxidant. Received in fiberpacks, it is a white powder. It is approved for use in food contact applications.

UV531/TBS

TBS (tert butyl salicylate) and UV531 are both ultra-violet light stabilizers for the polyethylene. TBS is FDA approved for food contact polyethylene but UV531 is not. Usage is 120,000 pounds per year and depends on product mix. Both chemicals are received in fiberpacks. They are used in the hot melt additive system. They are off-white (yellow) powdery solids. Dust masks should be used when handling them.

Slip

Other names are erucamide, Kenamide E, erucylamide, oleamide. It is an off-white waxy solid used in the hot melt additive system. It reduces the coefficient of friction of the polyethylene and allows polyethylene films to be more slippery. Usage is 60,000 pounds per year and depends on product mix. Received in fiberpacks.

Superfloss

Also known as anti-block. It is a blend of polyethylene (75%) and silica (25%). Silica is like sand. It is received in bulk hopper cars and stored in silos. It is added using a side-arm extruder. Usage is 320,000 pounds per year. It reduces the tendency of polyethylene film to stick together.

4.4 UTILITIES

Chlorine (Cl₂)

Green-yellow gas received by pipeline. Usage is about 15,000 pounds per year to control the growth of algae and bacteria in the cooling tower system. It is highly corrosive and harmful to all body systems especially lungs and eyes. Chlorine is non-flammable but can react with steel and titanium under certain conditions.

Fuel Gas

Colorless, odorless gas received by pipeline from the Division system. Consists mainly of methane and hydrogen and is highly flammable. It is non-toxic. It is used to heat the Dowtherm furnace and to keep the flare pilot lit. Usage is about 840 million BTU per day.

Nitrogen (N₂)

Colorless, odorless, inert gas received by pipeline from the Division 400 psig system. Its main use is to pad vessels to keep oxygen from the air from getting in. It is non-flammable and non-toxic; however, a special hazard exists from asphyxiation due to lack of oxygen.

Steam and Condensate

Steam is supplied in two systems: 235 psig and 15 psig. The hazard of steam and condensate is their high temperature causing severe burns. 235 psig steam is used to jacket and trace all polymer and Dowtherm lines.

DO A 056746
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TABLE 4-1

MATERIAL	SPECIFIC GRAVITY 20°C	DENSITY LB/GAL LB/SCF	MELTING POINT °C	BOILING POINT °C	MOLECULAR WEIGHT
Ethylene	0.97	0.079	-169	-104	28.05
Oct ne-1	0.71	5.93		122.5	112
Propylene (gas)	1.45	0.12	-185	- 48	42.1
Propylene (liquid)	0.52	4.35	-185	- 48	42.1
Hydrogen	0.069	0.0056	-259	-253	2.0
Isopar E	0.715	5.96	< - 60	116 to 143	123 AVG.
Heptane	0.685	5.71	- 91	98	100.2
Triethyl aluminum	0.835	6.96	- 58	DECOMPOSES	114.2
15% ATE in isopar E	0.735	6.13	< - 60	--	--
Tetraisopropyl titanate	0.955	7.97	~ 20	--	284.2
50% TPT in isopar E	0.84	6.97		--	--
Dibutyl magnesium	SOLID	SOLID	UNSTABLE	--	138
Butyl ethyl magnesium	SOLID	SOLID	UNSTABLE	--	110.5
10% BEM in heptane	0.72	6.0		--	--
Anhydrous HCl (gas)	1.18	0.095	-114	- 85	36.5
Diethyl zinc	SOLID	SOLID	UNSTABLE	--	147.4
Calcium stearate	--	13 to 33 LB/FT ³	156	--	607
Irganox 1010			120	--	1178
Irganox 1076			50	--	305
Weston 619 (liquid)	0.920 to 0.935		40	--	WESTON 618 732
UV531			48	--	326
TBS (liquid)	1.06		63	--	
Slip (erucamide)			70-85	--	335
Mineral oil					

TABLE 4-1 (CONT'D)

MATERIAL	SPECIFIC GRAVITY 20°C	DENSITY LB/GAL LB/SCF	MELTING POINT °C	BOILING POINT °C	MOLECULAR WEIGHT
Chlorine (gas)	2.32	0.187	-102	- 35	71
Fuel gas (methane)	0.51	0.041	-183	-161	~16
Nitrogen	0.90	0.073	-210	-196	28
Freon 22					
Dowtherm A	1.06	8.85	12	257	166
DLTDP			50	--	514
BHA				--	180

5. THEORY OF THE PROCESS

5.1 INTRODUCTION

Polyethylene is simply ethylene molecules combined with one another to form a distribution of longer, higher molecular weight chains. The chain lengths vary from 2 to over 200,000 ethylene units. This variance is known as the molecular weight distribution.

5.2 DENSITY

Linear low density polyethylene (Dowlex) is characterized by a density range of 0.935 to 0.915.

Octene can be incorporated into the ethylene chains resulting in side chains branching. The polymer chains try to fold upon solidification into a uniform structure called a crystal. This crystalline structure determines, to a large extent, the density of the polymer. Extensive branching hinders other chains from taking their preferred crystallinity, molten and solid densities are not equal quantities. These side chains can also affect the melt index of the product. Fig. 5.1 shows how these octene side chains attach to the ethylene chain. Propylene also reduces density but more is required to give the same effect as octene because the side chains are shorter.

5.3 MELT INDEX

Melt index is a measured property of the polymer and is useful in separating the various grades of products. The melt index is the amount of polymer in grams that will flow through an orifice of 0.0825 inches at 190°C with a 2.16 kg weight as the driving force. The larger the molecular weight of

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chains, the lower the melt index. Melt index is also an indirect way of measuring the viscosity of this non-Newtonian fluid at one shear rate.

The melt index can be controlled and affected in several ways. The addition of hydrogen causes the chains to terminate. So the addition of hydrogen to the reactors causes the smaller polymer chains to form resulting in a higher melt index. The reactor temperature also directly affects the melt index due to thermal chain termination (i.e. the higher the temperature the higher the melt index). Other factors affecting the melt index include impurities in the system, catalyst formations, and reaction conversions. Fig. 5.1 also shows how hydrogen terminates ethylene chain growth.

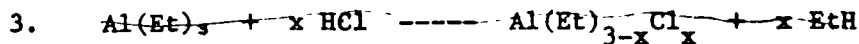
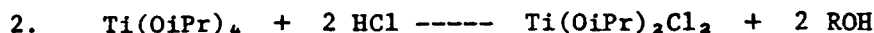
5.4 CATALYST MIXING

The four major catalyst components are ATE (aluminum triethyl), HCl (hydrogen chloride), MgR_2 (magnesium alkyl), and $Ti(OiPr)_4$ (tetraisopropyl titanate). The following reactions occur during premix.



$MgCl_2$ serves as the substrate on which the active ingredient is adsorbed.

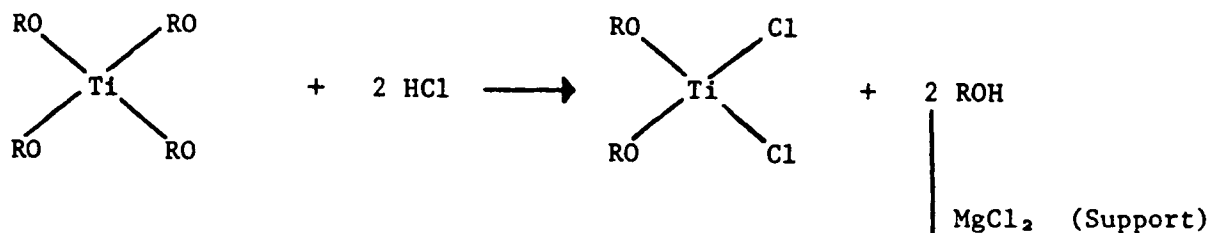
It has a high surface area (250 square meters per gram).



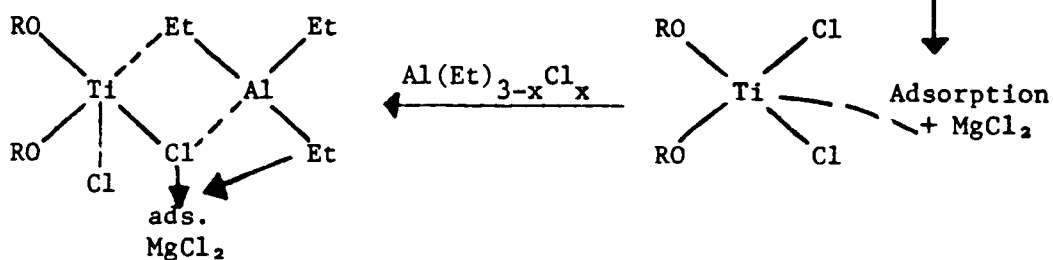
The proposed reaction mechanism is as follows:

(SEE NEXT PAGE)

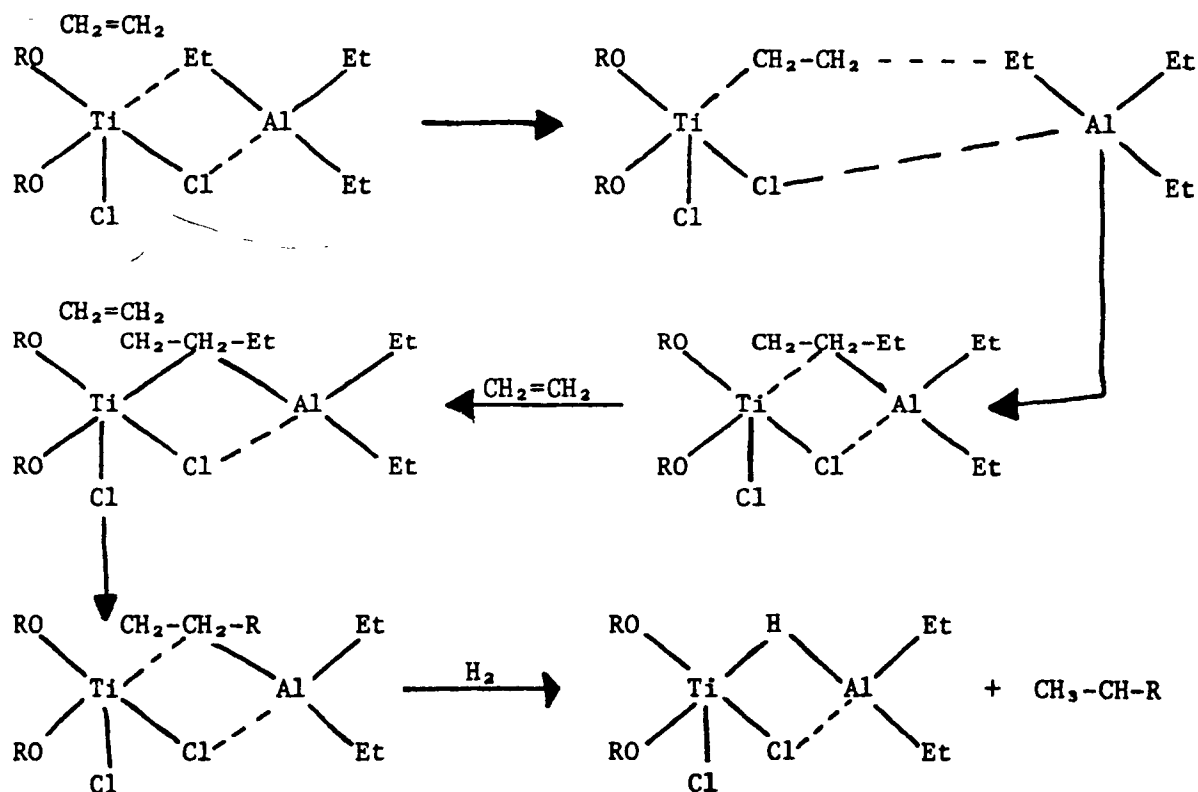
REACTION 2.



REACTION 3.



ETHYLENE POLYMERIZATION

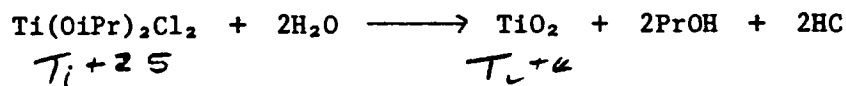
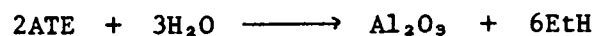
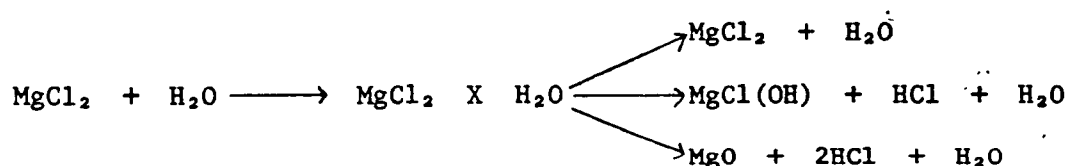


The titanium alkoxy-chloride and the aluminum alkyl chloride form a complex which is adsorbed on $MgCl_2$. The titanium contains an active site for the ethylene molecule and temporarily bonds to it. The ethylene double bond then forms a bond with the ethyl group attached to the aluminum molecule. A new bond forms between the aluminum molecule and the terminal carbon in the chain. This procedure is repeated until H_2 reacts with the aluminum molecule thus terminating the chain. The chain can also be terminated thermally or by the addition of octene (or some other monomer).

High reaction temperatures result in the hydrogen atom migrating from the ethylene β carbon atom to the aluminum molecule. The octene terminates the chain by sterically hindering the catalyst active site.

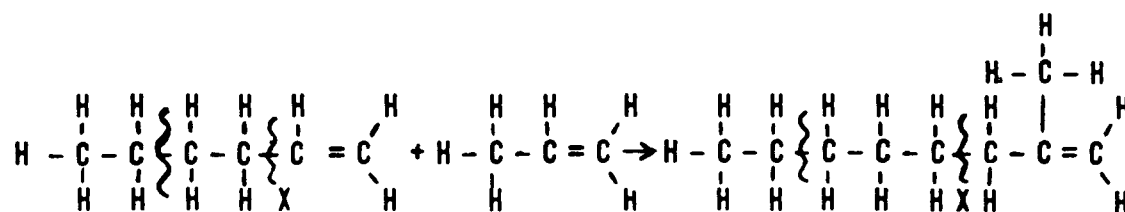
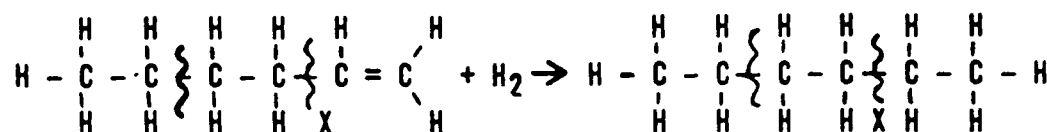
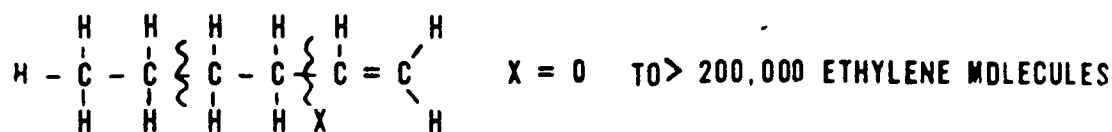
5.5 CALCIUM STEARATE

The catalyst can be killed by the addition of calcium stearate. Calcium stearate contains about 3% water and both of these components result in the following catalyst kill reactions:

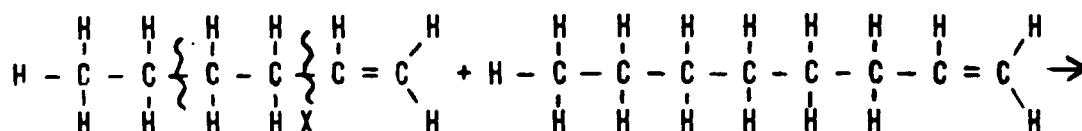


The catalyst substrate ($MgCl_2$) and ATE are destroyed by oxidation while HCl formation is inhibited by the formation of $CaCl_2$.

Other polar compounds such as water, carbon monoxide, and carbon dioxide have the ability to deactivate the catalyst.



HDPE & LDPE



C₈ H₁₆
OCTENE-1

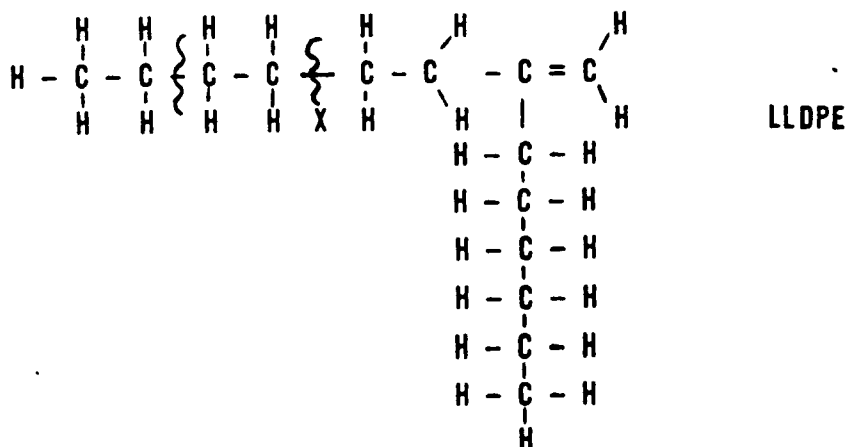


FIG. 5.1

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6. ETHYLENE PURIFICATION AND COMPRESSION

This portion of the plant is used to purify ethylene from the Light Hydrocarbon plants and to increase the incoming ethylene pressure from 400 psig to 650 psig for feed to the reactor. The normal flow path for the ethylene is first through a knock out pot (D-111) which removes "heavies" (generally oil) that may be in the ethylene. The knock out pot is equipped with a high level switch that alarms in the control room. The oil, if not removed, will cause problems in the purification beds such as fouling and plugging.

The purification beds remove impurities such as water, carbon monoxide, carbon dioxide, and methanol. Analyzers before and after the beds measure the impurities which, even in small quantities, will cause the reactor to shut down. (Section 24.2)

There are two sets of purification beds which are Y-111 A/B (silica gel) and the Y-112 A/B (molecular sieve). While 'A' bed say, is in service (absorption cycle) the other 'B' will be in a phase of regeneration.

After the ethylene is purified it then goes through FL-111 which will remove any molecular sieve particles that would cause problems in the compressor.

6.1 ETHYLENE PURIFICATION (Y-111 A/B and Y-112 A/B)

The Y-111 A/B are silica gel beds designed to remove impurities from the ethylene. Silica gel is a clear granule with a high surface area for absorption. The regeneration of a silica gel bed consists of 4 cycles which are:

- A. Depressuring - this is removing the unit from service and bleeding the ethylene pressure off to the recycle ethylene drum, D-711, or

to the flare header.

- B. Heating - this is accomplished by blowing hot nitrogen at 45 psig (which is heated by steam and electric heaters) through the bed in the same direction of normal ethylene flow (downward). This process will dry out the bed and remove the impurities trapped during the absorption cycle. The operating temperature for this phase of regeneration for a silica gel bed is 260°C. The amount of time required for heating will be _____ hours. During the heating cycle a vent valve will open automatically at preset intervals of every 20 minutes, and will remain open for one minute. This is done to purge out any ethylene and impurities remaining in the bed and maintain a high purity of circulated nitrogen.
- C. Cooling - the purpose of this step is to get the bed temperature down to 50°C which is the maximum temperature it would be safe to start the pre-load. Nitrogen will be circulated through the unit the same as in the heating cycle but steam and electric heaters will be bypassed.
- D. Preloading - this means to slowly start to adsorb the ethylene on the bed at a controlled rate so as not to exceed 100°C at any point in the bed.

NOTE: After preload is complete the bed is pressured up to 400 psig manually.

NOTE: All beds have temperature readings at the top, middle, and bottom. These will alarm at 300°C during heating and cooling they will alarm at 100°C during absorption and preload.

A typical flow path for regeneration is shown in Figure 6.5.

The Y-112 A/B are molecular sieve beds designed to remove impurities from ethylene not removed by silica gel. Molecular sieve has a very high surface area (greater than silica gel). The regeneration of Y-112 A/B is exactly the same as for the Y-111 A/B with the following exception: The regeneration temperature during the heating cycle will be approximately 290°C.

Molecular sieve and silica gel beds may have a violent reaction if mixed too rapidly with ethylene. Both Y-111 A/B and the Y-112 A/B have regeneration system isolation safety valves that will close in the event excessive pressure is on the system. Example would be if a bed in service at 400 psig was mistakenly lined up for regeneration.

6.2 E-111 (FIN FAN COOLER)

When a gas is compressed its temperature will rise. Ethylene coming out of C-111 will be at 650 psi and approximately 100°C. To lower this temperature it will pass through E-111 which is a fin fan cooler. The gas leaving the cooler will be 50°C maximum which will allow for a lower feed temperature (and higher production rates) to the reactors. E-111 will shut down on high vibration and alarm in the control room.

6.3 ETHYLENE FEED COMPRESSOR (C-111)

The compressor is an Ingersoll Rand, reciprocating, single stage, dual piston, double acting, design. C-111 operates with a 400 psig suction pressure and discharges at 650 psig with a maximum rate of 30,000 pounds per hour and minimum of 7500 pounds per hour at 25% speed. Below a 25% speed a recycle valve will open to control the discharge pressure. There are no unloaders or pockets on these compressors. The compressor is driven by a ³⁵⁰~~300~~

hp. electric motor that is variable frequency speed controlled from 25% (125 RPM's) to 100% (500 RPM's). The speed is controlled by the discharge pressure. The motors are totally enclosed water and air cooled. (T.E.W.A.C.). C-111 will shut down automatically on high vibration, low oil pressure, low suction pressure, high discharge or high motor temperature. (See Table 6.4 for settings).

TABLE INDEX FOR ETHYLENE PURIFICATION & COMPRESSION

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
6.1	C-111 loop controls
6.2	C-111 data and performance sheet
6.3	C-111 electric motor data sheet
6.4	C-111 trips & alarms
6.5	Purification beds capacity chart

FIGURE INDEX FOR ETHYLENE PURIFICATION & COMPRESSION

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
6.1	Ethylene purification & compression flow sheet
6.2	C-111 capacity/speed chart
6.3	C-111 crankcase
6.4	C-111 cylinder head
6.5	Regeneration basic flow sheet

ETHYLENE COMPRESSION & PURIFICATION CONTROLLERS

LOOP CONTROL #	PURPOSE	OPERATION
FIC 1004 Flow Ind. & Control	To control recycle ethylene gas back into the feed system.	By operating flow control valve FV1004
FIC 1123 Flow Ind. & Control	To control ethylene feed flow to reactor	By operating flow control valve FV1123
SIC 1126 Speed Ind. & Control	To control the speed of C-111 thus discharge pressure	By sensing a pressure change from PIC-1127A
PIC 1127A Press. Ind. & Control	To control discharge pressure on C-111 thru SIC-1126A	By sensing a pressure change in C-111 discharge it will operate SIC 1126.
PIC 1127B	To control discharge pressure of C-111 once C-111 has reached minimum RPM's	By operating recycle valve PV 1127

TABLE 6.1

INGERSOLL-RAND, GAS COMPRESSORS

— OPERATING CHARACTERISTICS AND GENERAL DATA —

COMPRESSOR TYPE: (2) 6½" & 6¼" X 9" HSE-1-NL2

CYLINDER DATA AND PERFORMANCE (U.S. CUSTOMARY UNITS)

Service	ETHYLENE FEED GAS COMPRESSORS					
Stage	1					
Cylinder or Liner I.D. (in.)	(2) 6½					
Stroke (in.)	9					
Cylinder Type	DA					
Cylinder Pattern Number	F-25900					
Liner Thickness (in.)	3/8					

Percent of Full Load	100					
Intake Pressure (psig)	376.3					
Intake Temperature (°F)	107					
Discharge Pressure (psig)	657					
Discharge Temperature (°F)*	172					
Piston Displacement (cfm)	306.25					
Capacity at Inlet (cfm)	249.83					
Dry Cubic feet per min. ref. 14.7 psiA & 60 °F	7082.3					
Dry Pounds Per Hour	31,400					
Safety Valve Setting (psig)	740					

BHP per Stage	309.3					
Total BHP	309.3					
RPM	505					
Barometric Pressure (psiA)	14.7					

* Discharge temperature is estimated as an adiabatic rise.

Key to abbreviations:

SA — Single Acting
FE — Frame End or Crank End
OE — Outer End
DA — Double Acting
TR — Tail Rod

TABLE 6.2 C-111 DATA SPECIFICATIONS

DO A 056762
CONFIDENTIAL

INGERSOLL-RAND
GAS COMPRESSORS

- OPERATING CHARACTERISTICS AND GENERAL DATA -

ELECTRIC MOTOR DRIVER

Make & Type FUJI ELECTRIC COMPANY

BHP 350 kW 261 RPM 150 to 500 Voltage 575

Phase 3 Frequency 60 Hz Power/Service Factor 1.0

Special Features TEWC, EXTERNAL COOLING FAN, CLASS 'F' INSULATION, 80° RISE BY
RESISTANCE OVER 40° AMBIENT RTD'S

LOW SPEED COUPLING (IF USED) THOMAS 550 CMR

HIGH SPEED COUPLING (IF USED) NONE

GEAR REDUCER MAKE & MODEL (IF USED) NONE

TABLE 6.3 MOTOR SPECIFICATIONS

C-111 ALARMS/SHUTDOWNS

CONDITION	ALARMS	SHUTDOWN
High vibration	Mils	Mils
Low oil pressure	15 psi	10 psi
Low suction pressure	300 psi	100 psi
High discharge temperature	120 °C	120 °C

TABLE 6.4

ABSORPTION BED CAPACITY CHART

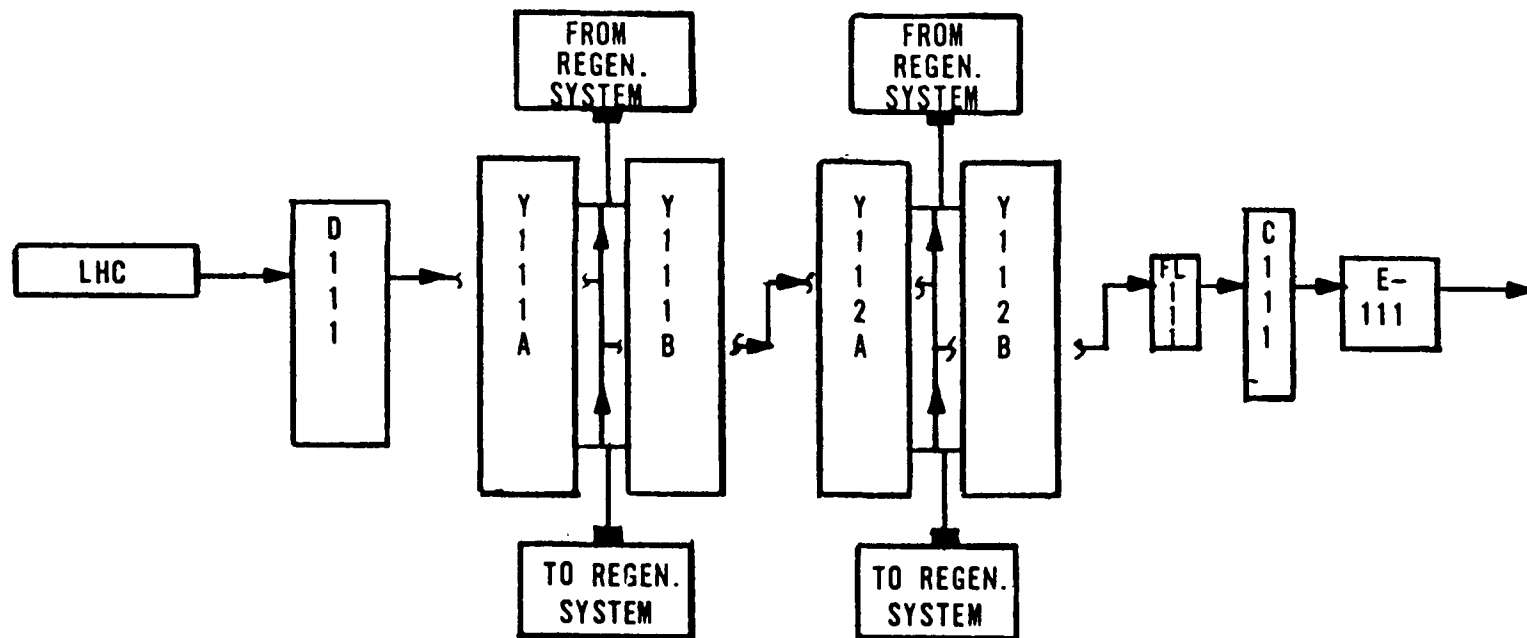
BED #	VOLUME EACH	WT. OF MEDIA EACH	TYPE OF MEDIA	SERVICE
Y-111 A/B	315 cu. ft.	14,500 lbs.	Grade 05 Silica Gel	Ethylene
Y-112 A/B	315 cu. ft.	13,500 lbs.	5A Molecular Seive	Ethylene
Y-211 A/B	285 cu. ft.	11,000 lbs.	13X Molecular Seive	Solvent
Y-611 A/B	285 cu. ft.	13,000 lbs.	Grade 05 Silica Gel	Solvent
Y-801	70 cu. ft.	3,300 lbs.	Grade 05 Silica Gel	Solvent
Y-802	70 cu. ft.	3,300 lbs.	Grade 05 Silica Gel	Solvent

NOTE: Bulk density of Grade 05 Silica Gel is 46 lbs. per cubic foot.

Bulk density of Type 13X Molecular Sieve is 38 lbs. per cubic foot.

Bulk density of Type 5A Molecular Sieve is 43 lbs. per cubic foot.

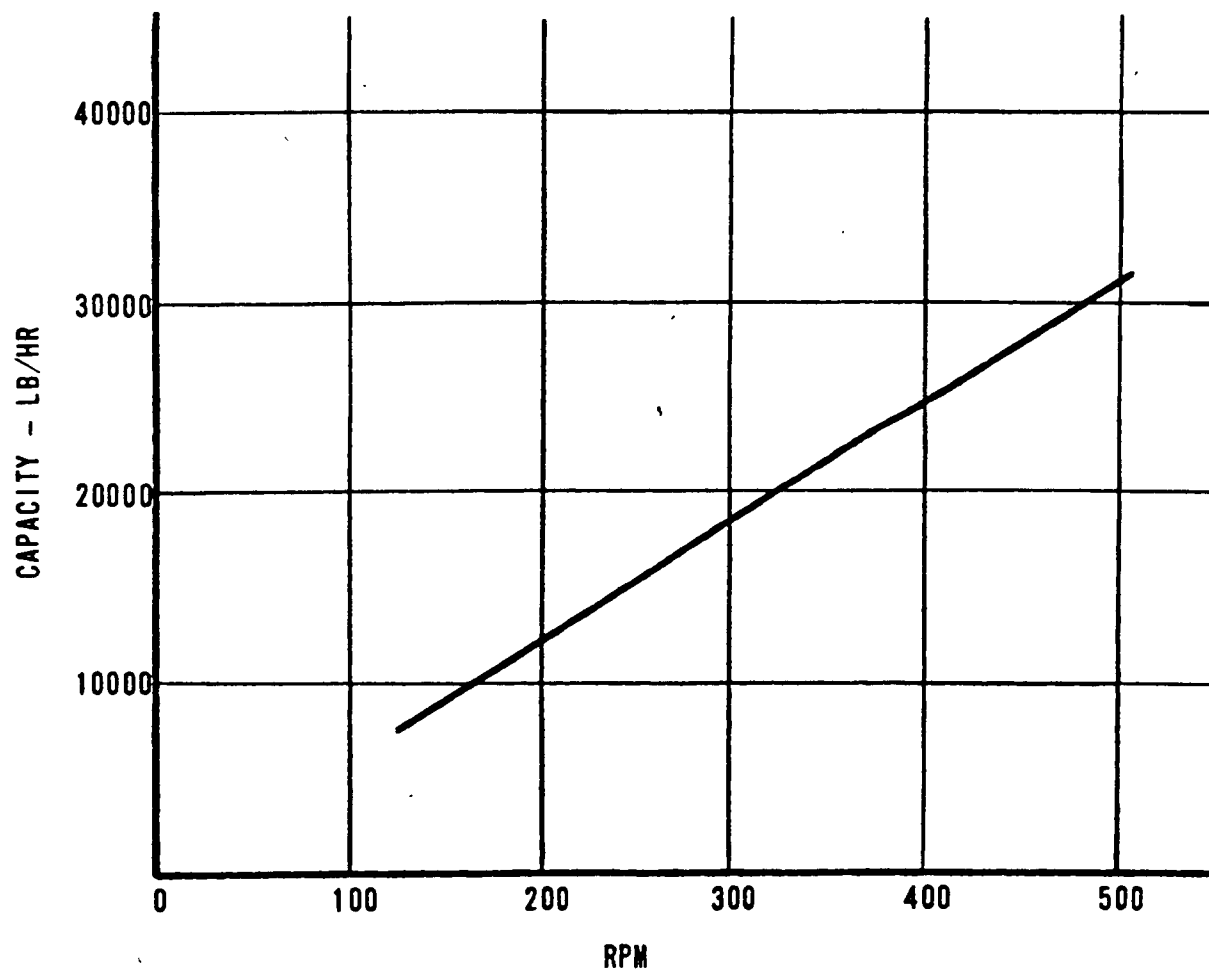
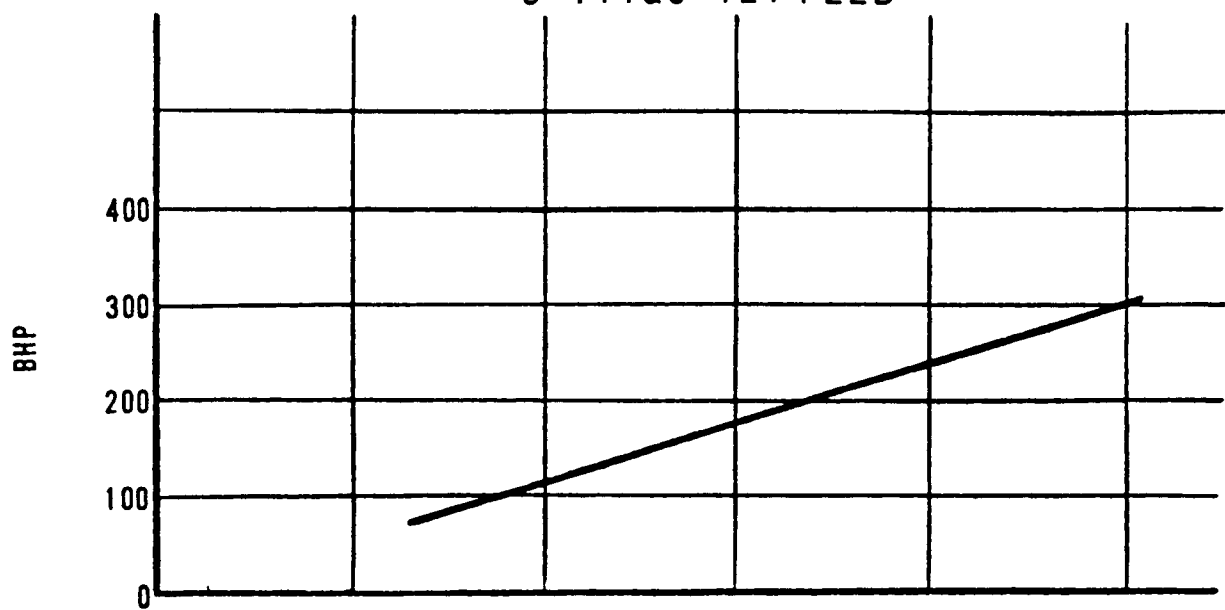
TABLE 6.5



INCOMING ETHYLENE PURIFICATION AND COMPRESSION

FIG. 6.1

EXPECTED PERFORMANCE
C-111&C-121 FEED



CAPACITY VS SPEED C-111

DO A 056767
CONFIDENTIAL

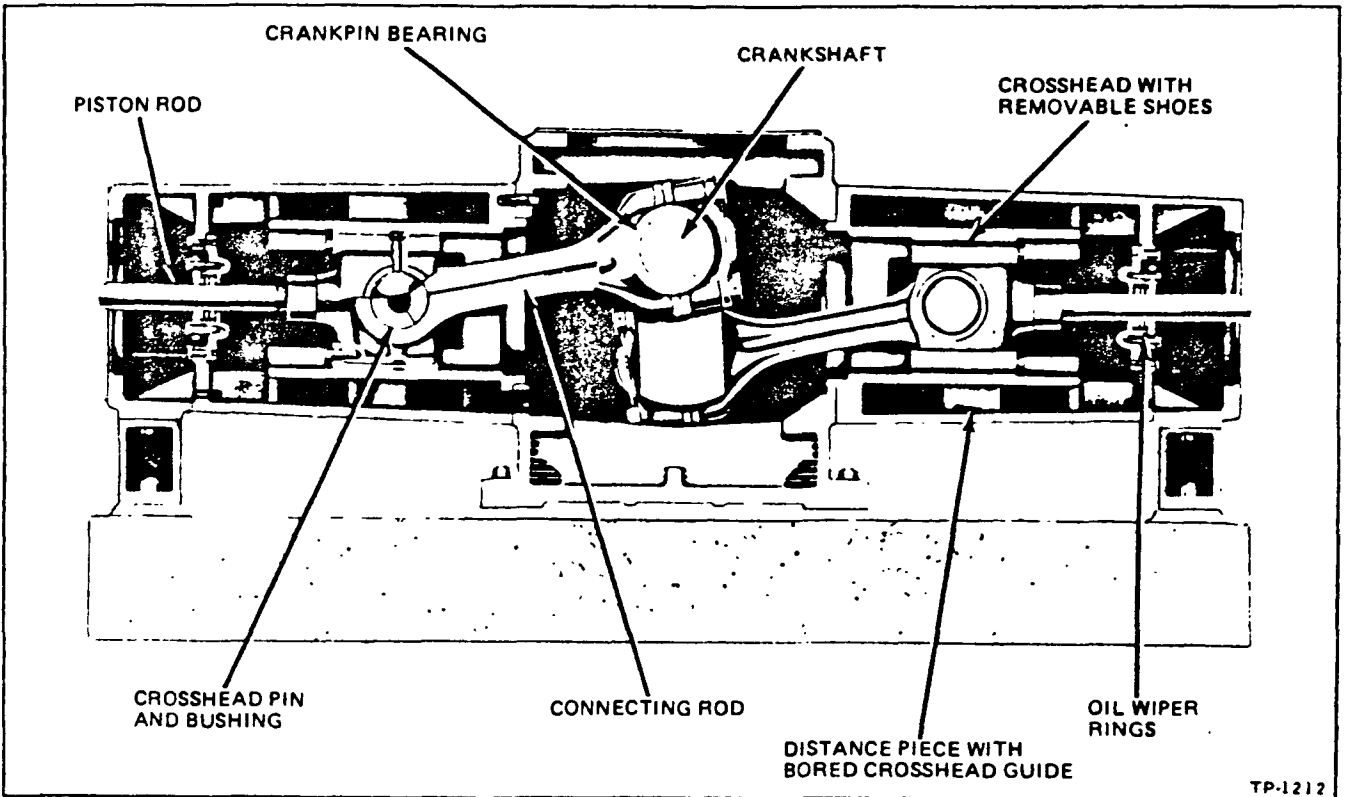


FIGURE 6.3 C-111 CRANKCASE

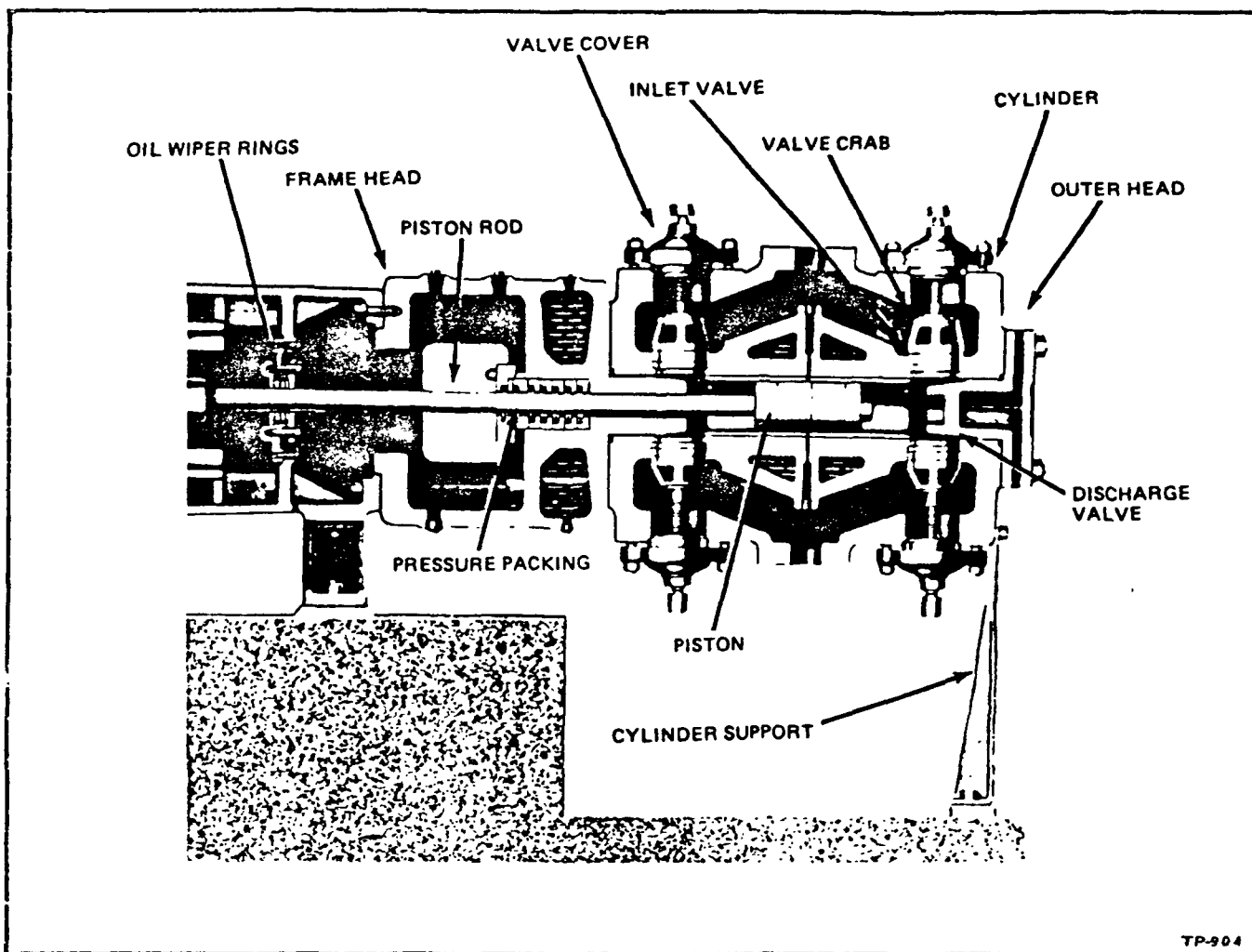
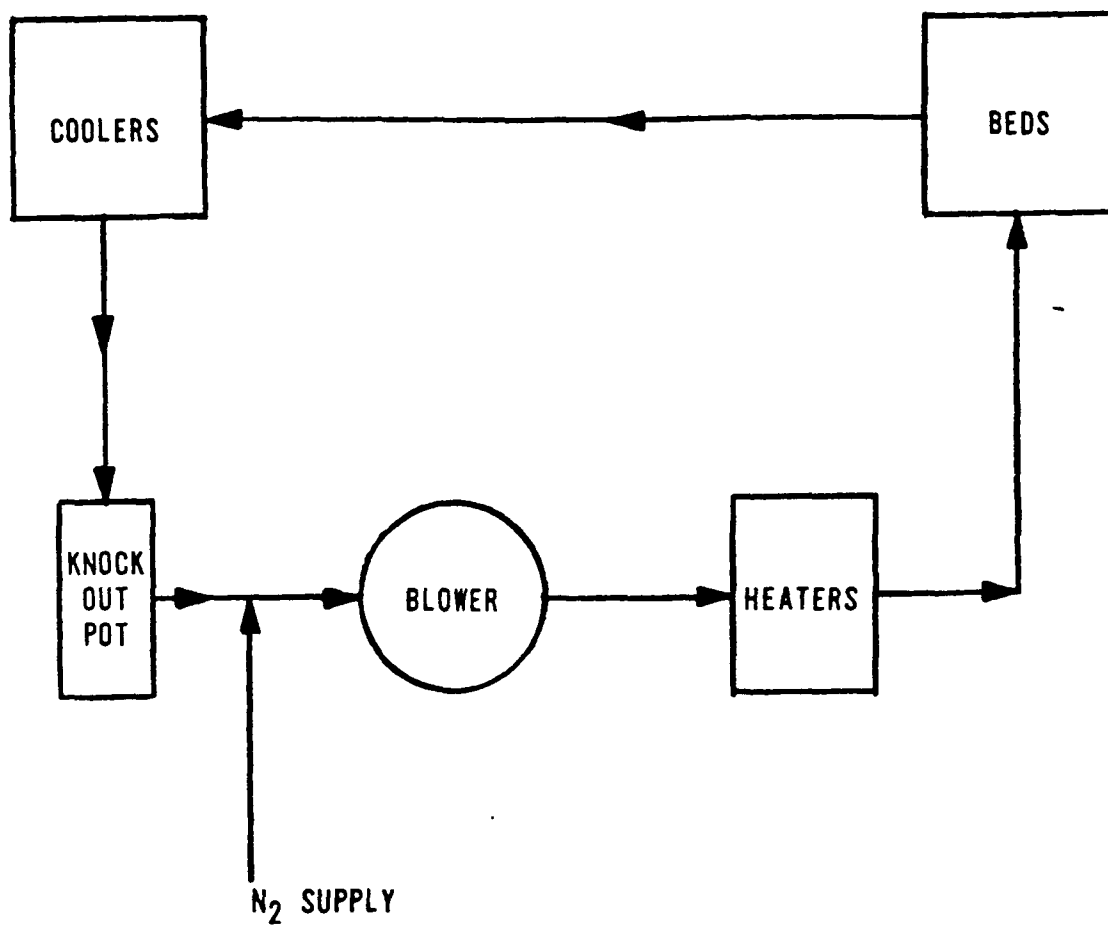


FIGURE 6.4 C-111 CYLINDER HEAD



TYPICAL FLOW PATH DURING REGENERATION

FIG. 6.5

7. CATALYST

The catalyst used in the Dowlex process is a Dow developed high efficiency catalyst. Under ideal conditions the process uses two pounds of titanium per 1,000,000 pounds of ethylene. This catalyst is made from four different chemicals; magnesium alkyl, triethyl aluminum, tetraisopropyl titanate, hydrogen chloride and is mixed in solvent.

7.1 CATALYST STORAGE

The chemicals used to make catalyst will react violently with air or water, therefore they must be stored under nitrogen pad. Magnesium alkyls are stored in D-301, which has three compartments; A, B, and C. Each compartment has level, pressure and temperature transmitters, with a high temperature alarm.

Magnesium alkyl is received by tank truck in a 10-20% solution. Each truck of magnesium alkyls is of a different concentration and the catalyst mix quantities depend on this concentration, so therefore it must be stored separately. This is the reason D-301 has three compartments.

D-301 is equipped with a pressure relief valve set to relieve at 102 psig to D-308 (See Section 7.3)

Triethyl aluminum is also stored under nitrogen pad in D-302. D-302 is equipped with a level, pressure, temperature transmitter, and a pressure relief valve set to relieve at 102 psig to D-303.

Triethyl aluminum is also received by tank truck as a 15% solution.

Titanate is received in 55 gallon drums. Titanate will decompose on contact with water so it is transferred to D-304 for storage which is also nitrogen padded. The titanate is diluted with solvent to prevent it freezing. D-304 pressure relief valve relieves to D-308 at 102 psig.

Hydrogen chloride is received in cylinders.

7.2 CATALYST MIX

Each component of the catalyst is carefully weighed and transferred by computer into D-305 for mixing. D-305 rests on load cells, which give the net weight of each component. There are level, pressure, and temperature indications for the mix tank.

Hydrogen chloride is weighed in D-300 then transferred to D-305. D-300 is designed for 1500 psig. Its PSV relieves to the atmosphere.

Titanate is weighed in D-309 then transferred to D-305. Magnesium alkyl, triethyl aluminum and solvent are weighed in D-305. D-309 relieves to D-308.

In the catalyst mixing procedure heat is generated by chemical reaction so D-305 is jacketed. Cooling tower water is used on the jacket to remove this heat.

The first step in the mixing procedure is to add hydrogen chloride to magnesium alkyl. This forms finely divided solid magnesium chloride which acts as the catalyst support. The catalyst at this point is pale-yellow in color. This step in the catalyst mixing process is where most heat is generated.

This heat must be removed before the next chemical is added, which is titanate. If the temperature is not below 30°C, the titanate will be deactivated. After the titanate is added, the catalyst is a titanate complex supported on the magnesium chloride and is tan-yellow in color.

The next step is to add triethyl aluminum which forms a titanate aluminum complex on the magnesium chloride support. At this point the catalyst

is complete and is tan in color.

To insure the catalyst is thoroughly mixed, D-305 is equipped with a 1 hp agitator. This agitator is started and stopped automatically by the computer and the motor current is monitored by the computer.

During the catalyst mixing procedure it is very important that the hydrogen chloride weights be as accurate as possible. If the catalyst has too little hydrogen chloride it will not run, the catalyst will age rapidly and will give very poor efficiency. If the catalyst has too much hydrogen chloride extra triethyl aluminum will be needed to make the catalyst work. This will cause lower reactor temperatures which cause lower production rates, or will cause catalyst plugging problems.

All catalyst components have flow control valves going to D-305. The pressure relief valve on D-305 is set to relieve at 120 psig to D-308.

After the catalyst has been mixed it is transferred to D-306 or D-307 hold tanks. Here the premixed catalyst is stored until it is needed in the process. To keep the catalyst mixed D-306 and D-307 are equipped with 2 hp agitators. The agitator amps are indicated on the TDC2000.

D-305, D-306, and D-307 are equipped with automatic block valves to allow mixing and transferring procedures to be carried out from the control room. These automatic block valves have limit switches to indicate if they are in the open or closed position. D-306 and D-307 have temperature and level indications.

The pressure relief valves on D-306 and D-307 are set to relieve at 120 psig to D-308.

When catalyst is needed in the process it is transferred from D-306 or D-307 to D-311 day tank. D-311 rests on load cells and is equipped with a $\frac{1}{2}$ hp agitator.

The pressure relief valve on D-311 is set to relieve at 120 psi and relieves to D-212 which is the dump tank for the reactors.

The catalyst is pumped from D-311 by Milton-Roy duplex variable speed pumps (P-311A, B, and C) to R-211 and/or R-212. Normally the P-311's are set up to pump to one reactor using two pumps with one as a spare. This depends on the catalyst efficiency and pump capacity.

The Milton-Roy duplex pumps are adjustable stroke and variable speed. The stroke adjustment is usually on maximum.

The speed of the P-311's is controlled by the reactor temperature.

A flow indicator is installed in the P-311's discharge line to show the catalyst flow to the reactor. The P-311's also have an air operated three way valve on the discharge for recycling back to D-311.

7.3 WASTE CATALYST

If for any reason the catalyst in D305, D306, D307, or D-311 is bad or gets contaminated it can be dumped to D308 which is the catalyst waste tank.

The pressure relief valves on D305, D306, and D307 relieve into a header that empties into D308. D308 is vented to the flare header. There is a three way valve on this line to isolate D308 from the flare header if necessary.

The waste catalyst in D-308 is killed by adding process water to the tank and then is pumped from D308 to D809 using P-308.

D-809 is used for waste solvent and bad catalyst.

7.4 SIDESTREAM CATALYST

The sidestream catalyst is very important to the process. This side-

stream catalyst is called triethyl aluminum or ATE. ATE is transferred from D-302 to D-312 which is on load cells. Triethyl aluminum is pumped from D-312 by Milton-Roy duplex variable speed pumps (P-312A, B, or C) to R-211 and/or R-212, normally one reactor R-211.

Triethyl aluminum is used to activate the premix catalyst. If the triethyl aluminum is added too soon the premix catalyst will age rapidly, therefore the discharge lines from the P-311's and P-312's combine just before entering the reactor.

The stroke adjustment on the P-312's are normally on maximum with the speed ratio controlled from the speed of the P-311's.

There is usually one P-312 running for each reactor with one as a common spare depending on the amount of triethyl aluminum needed and the pump capacity.

The pressure relief valve on D-312 is set to relieve at 170 psig, and relieves to D-212 the same as D-311.

The nitrogen pad and depad system on D-305, D-306, D-307, D-311, and D-312 allow the vessels to breathe during filling and transferring. Nitrogen pressure is used to make all chemical and catalyst transfers.

7.5 MILTON-ROY DISC DIAPHRAGM LIQUID END METERING PUMPS

The Milton-Roy diaphragm pump is a seal-less pump suitable for pumping small flows of slurries like the premixed catalyst or calcium stearate. The diaphragm is hydraulically balanced between the process liquid on one side and the hydraulic oil on the other side. The hydraulic oil takes the place of a mechanical connection between pump plunger and diaphragm.

In a disc diaphragm liquid end pump, the reciprocating pump plunger al-

ternately forces hydraulic oil against the diaphragm and then draws the oil back into the plunger bore. This action causes the diaphragm to flex between the limiting contour plates.

Each stroke of the plunger pulls the diaphragm toward the oil side contour plate so that process liquid flows into the displacement chamber through the suction ball-check valve. Each discharge stroke of the plunger pushes the diaphragm towards the process side contour plate to expel the process liquid from the displacement chamber through the discharge ball-check valve. On each suction stroke, the discharge ball-checks are seated, and on each discharge stroke, the suction ball-checks are seated. This mode of operation prevents back flow and ensures liquid movement from the suction port, through the displacement chamber, and out the discharge port. Precise hydraulic oil volume is maintained by an automatic air-bleed valve and a refill valve.

TABLE INDEX FOR CATALYST

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
7.1	Loop Controls for the Catalyst Pumps

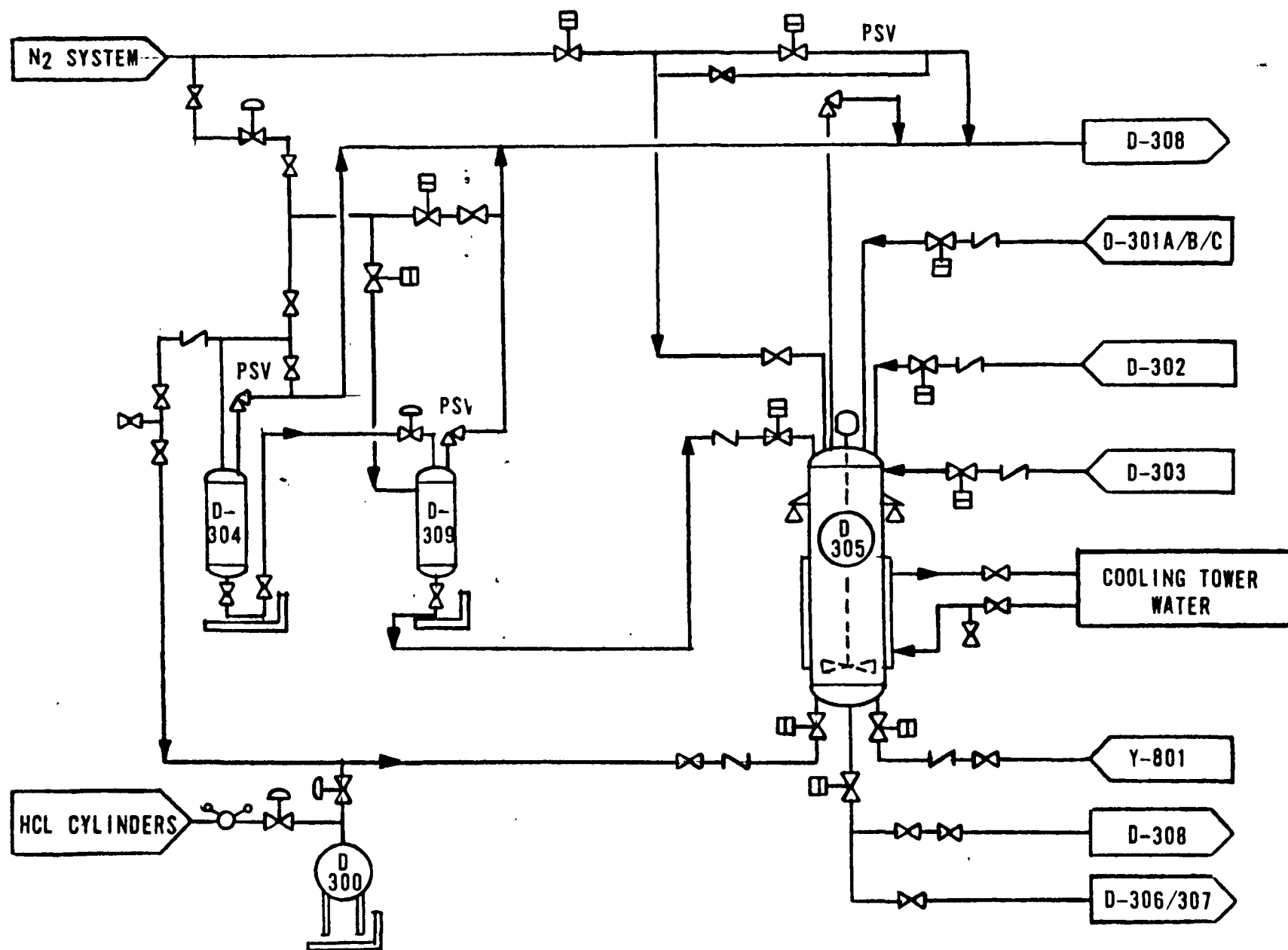
FIGURE INDEX FOR CATALYST

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
7.1	Catalyst Mix
7.2	Catalyst System
7.3	Agitator Data for A-306 & 307
7.4	Agitator Data for A-311 & 321
7.5	Agitator Data for A-305
7.6	Milton-Roy Diaphragm Pump

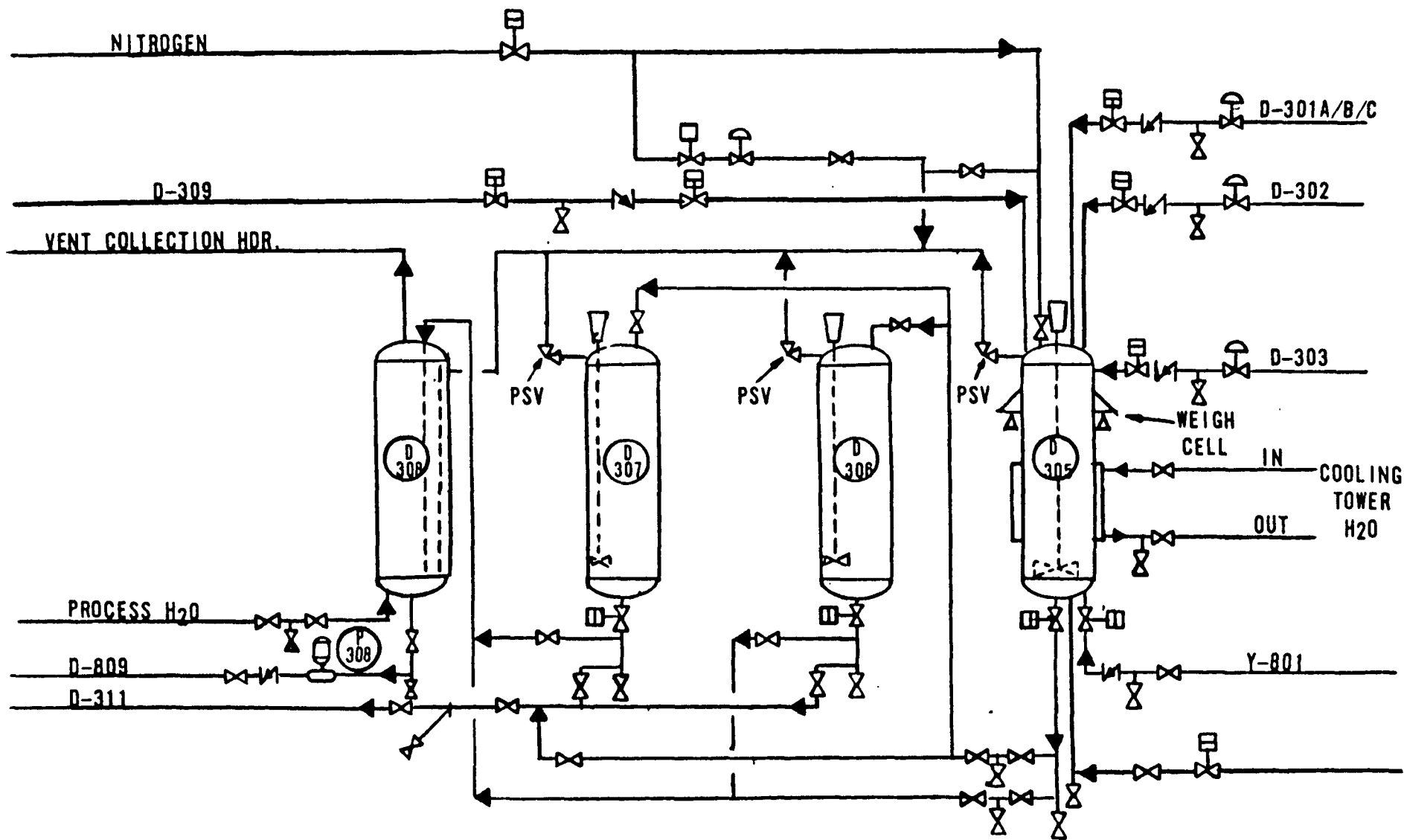
TABLE 7.1

LOOP CONTROLS FOR THE CATALYST PUMPS

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
TIC-2249	Temperature controller for R-212	Controls catalyst flow to R-212 by controlling the speed controller (SIC-3081) of P-311 A or B.
TIC-2275	Temperature controller for R-212	Controls catalyst flow to R-212 by controlling the speed controller (SIC-3090) of P-311 B or C.
FIC-3103	ATE flow controller for R-212 which is determined by the catalyst flow	Controls ATE flow to R-211 by controlling the speed controller (SIC-3108) of P-312 A or B.
FIC-3107	ATE flow controller for R-212 which is determined by the catalyst flow.	Controls ATE flow to R-212 by controlling the speed controller (SIC-3104) of P-312 B or C.



CATALYST MIX



CATALYST SYSTEM

FIG. 7.2

FIGURE 7.3

TAG NO.: ITEMS A306 & A307

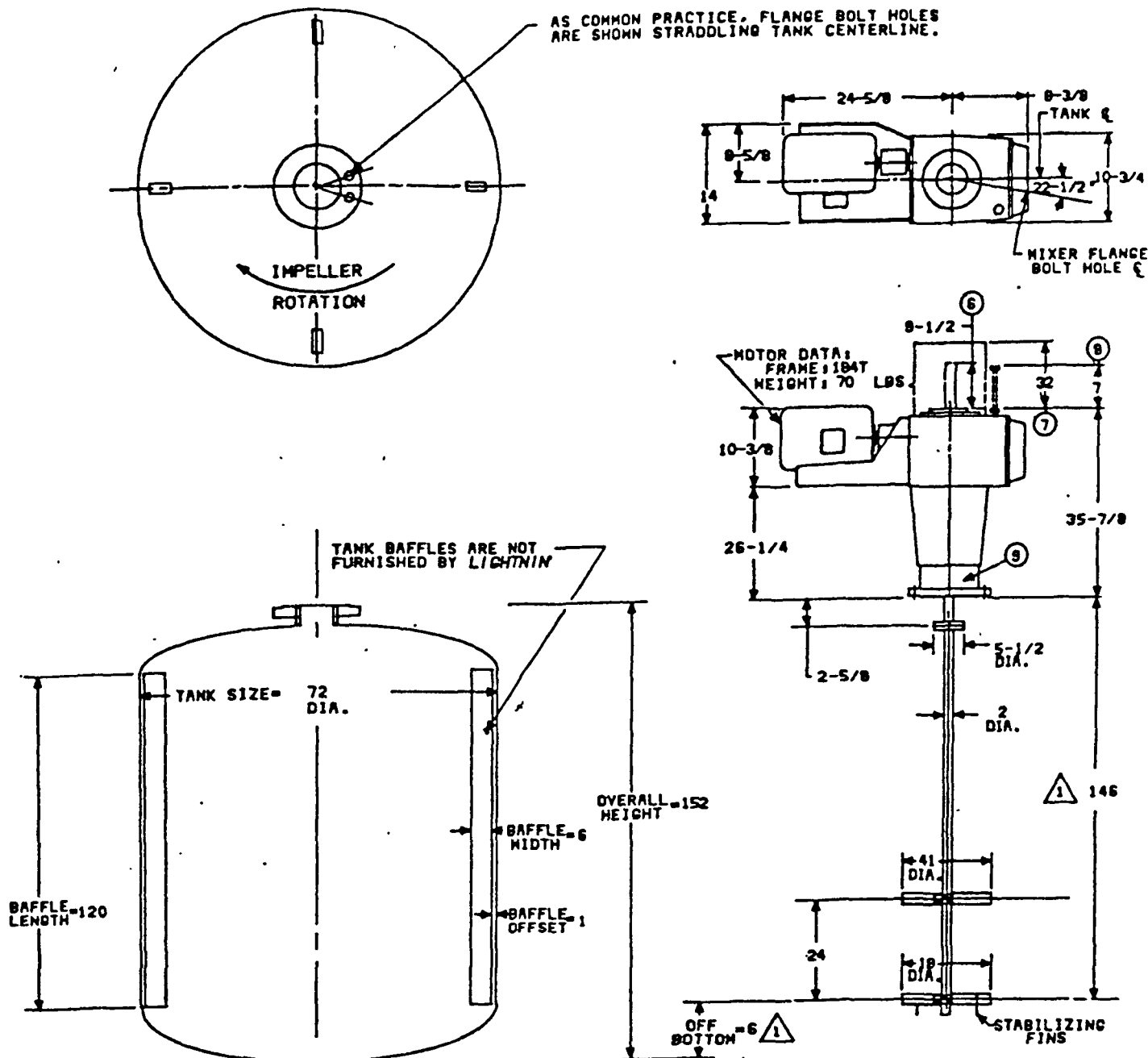
LIGHTNIN 71S 2 MIXER

PLATE S102B

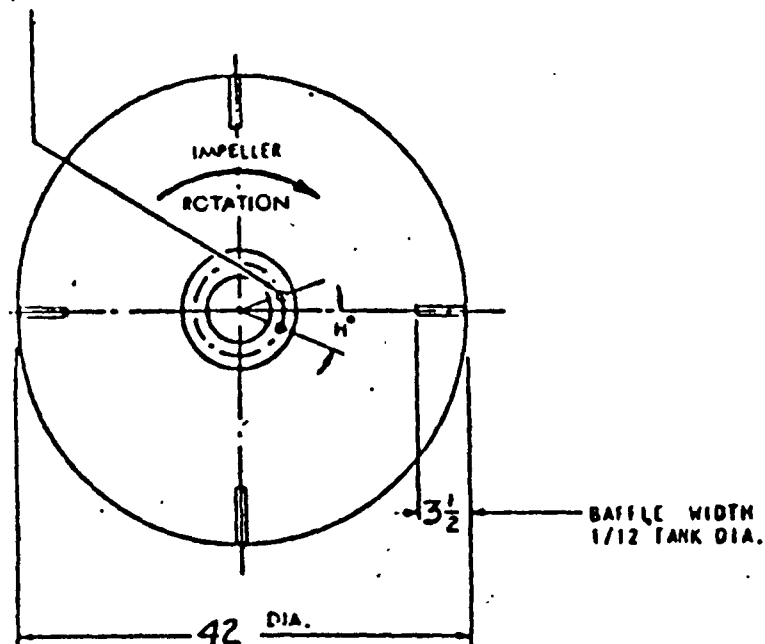
102

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NOZZLE DESIGN DATA	IMPELLER DATA	NOTES
VERTICAL DOWNWARD LOAD (POUNDS): 1,100 TORQUE (INCH-LBS.): 3,380 BENDING MOMENT (INCH-LBS.): 23,600 DESIGN LOADS ARE GREATER THAN ACTUAL LOADS BY A SUITABLE FACTOR, CONSISTENT WITH CONSTRUCTION CODES AND LIGHTNIN EXPERIENCE. MIXING EQUIPMENT CO. INC. DOES NOT WARRANT, GUARANTEE, OR ASSUME ANY RESPONSIBILITY FOR THE DESIGN OR CONSTRUCTION OF THE MOUNTING PLATFORM FOR THE MIXER.	TYPE: A200/A200 RPM: 56 QUANTITY OF BLADES: 4/4 KEYWAY ON SHAFT ALLOWS FOR THE FOLLOWING IMPELLER ADJUSTMENT IN 3" INCREMENTS; SEE NOTE 10	1. REFER TO INSTRUCTIONS FOR START-UP AND MAINTENANCE PROCEDURES, AND SAFE LIFTING PRACTICES. 2. ALL DIMENSIONS ARE IN INCHES. 3. MATERIAL OF MIXER PARTS IN THE TANK IS STEEL UNLESS OTHERWISE SPECIFIED. 4. TOTAL MIXER WEIGHT (LESS MOTOR) 624 POUNDS. 5. TANK MUST HAVE MINIMUM OPENING SIZE OF 9 DIAMETER TO PASS DISASSEMBLED MIXER PARTS. 6. CLEARANCE REQUIRED ABOVE MIXER AND ABOVE IMPELLER(S) TO PERMIT REMOVAL OF SEAL CARTRIDGE. 7. CLEARANCE REQUIRED FOR PULLER ASSEMBLY (OPTIONAL). 8. CLEARANCE REQUIRED FOR DIPSTICK REMOVAL. 9. MECHANICAL SEAL: STYLE: C CODE: T-3 PER OWC: IT-820 INLET & OUTLET CONNECTIONS TO SEAL LUBRICANT 1/8 NPT - COOLANT 1/4 NPT. 10. IMPELLERS ARE ADJUSTABLE ON A 48" CONTINUOUS KEYWAY.
UNIT MOUNTING FLANGE DATA 150 LB. ANSI (ASA) SERIES DRILLING SIZE: 8 O.D.: 13-1/2 NO. OF EQUI-SPACED BOLTS: 8 B.C.: 11-3/4 FLANGE THICKNESS FOR BOLTING: 2-3/4 BOLT DIA: 3/4 (MOUNTING BOLTS NOT FURNISHED BY LIGHTNIN)		Motor - 2 HP - 575 Volts DO A 056781 CONFIDENTIAL

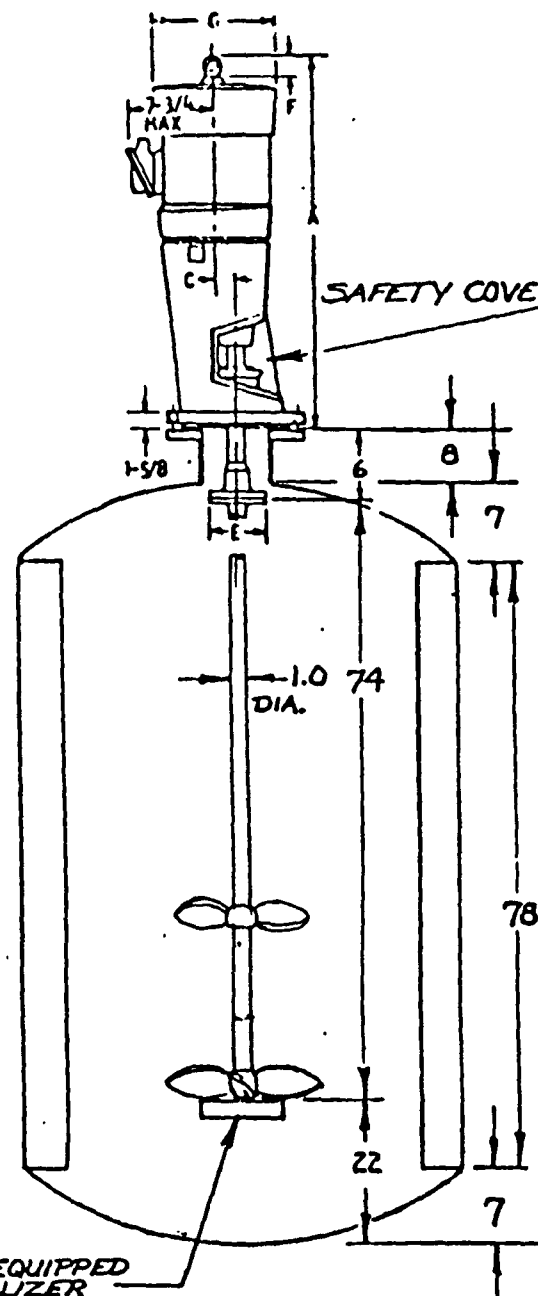
FLANGE DATA					
SIZE	O.D.	B.C.	NO. OF HOLES	SIZE OF BOLTS	H"
5	10	8-1/2	16	1 1/8	11 1/4
6	11	9-1/2			
18	25	22 3/4			

150 LB. ASA SERIES FLANGE DRILLING.
HOLES STRADDLE CENTERLINE AS SHOWN
(MOUNTING BOLTS FURNISHED BY CUSTOMER)



MODEL	HP	APPROX WT LBS	A	C	E	F	G		
N13GDS-25	1/4	110	28-3/8	1-3/8	3-7/8	2	8-1/2		
N13GDS-33	1/3	120							
N13GDS-50	1/2	155	29-3/8	1-5/8	4-3/4				
N13GDS-75	3/4	165				2-1/2	10-7/8		
N13GDS-100	1	230	33-1/4	1-7/8	4-3/4				
N13GDS-150	1-1/2	300	33-3/4						
N13GDS-200	2	350	34-1/4						
N13GDS-300	3	350	34-3/4						

IMPELLER EQUIPPED WITH STABILIZER



- ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
- ALL MIXER PARTS IN CONTACT WITH TANK CONTENTS ARE STEEL UNLESS OTHERWISE SPECIFIED
- PROPS ARE NOT TO BE RELOCATED FROM POSITION SHOWN
- UNIT IS FURNISHED WITH A DOUBLE MECHANICAL SEAL, TYPE T-3
- TANK BAFFLES NOT FURNISHED BY MIXING EQUIPMENT CO.
- IMPELLER R.P.M. 350
IMPELLER DIAMETER 9.4
- MINIMUM OPENING REQUIRED TO PASS IMPELLER DETACHED FROM SHAFT IS 9.0 DIAMETER
- SERIAL NO. 80/943096
- HEAVIEST MIXER PIECE: (MOTOR) APPROX. 60 LBS.

MIXING EQUIPMENT CO. INC.			
REV	DATE	BY	REVISION
1			
CERTIFIED BY			
FOR DOW CHEMICAL INTER'L			
MIXER MODEL <u>N33GDS-50</u>			
TAG NO <u>ITEMS A311 & A321</u>			
PO NO <u>72289-L5012</u>			
MIXING EQUIPMENT CO. INC.			
A UNIT OF GENERAL SIGNAL			
LIGHTNING			
INSTALLATION DRAWING			
198			
R.D.S.		943096A	
7-11-80			

DESIGN LOADS:

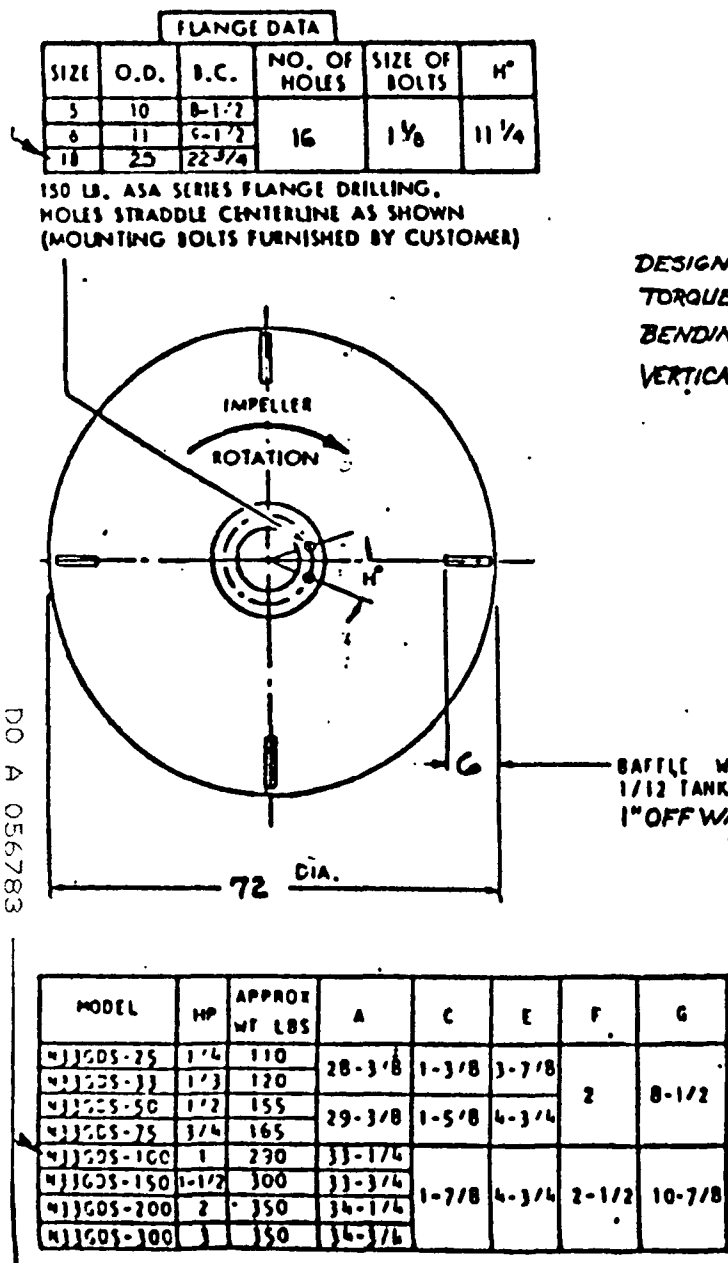
TORQUE - 200 IN. LBS.

BENDING MOMENT - 7700 IN. LBS.

VERTICAL DOWNWARD LOAD - 550 LBS.

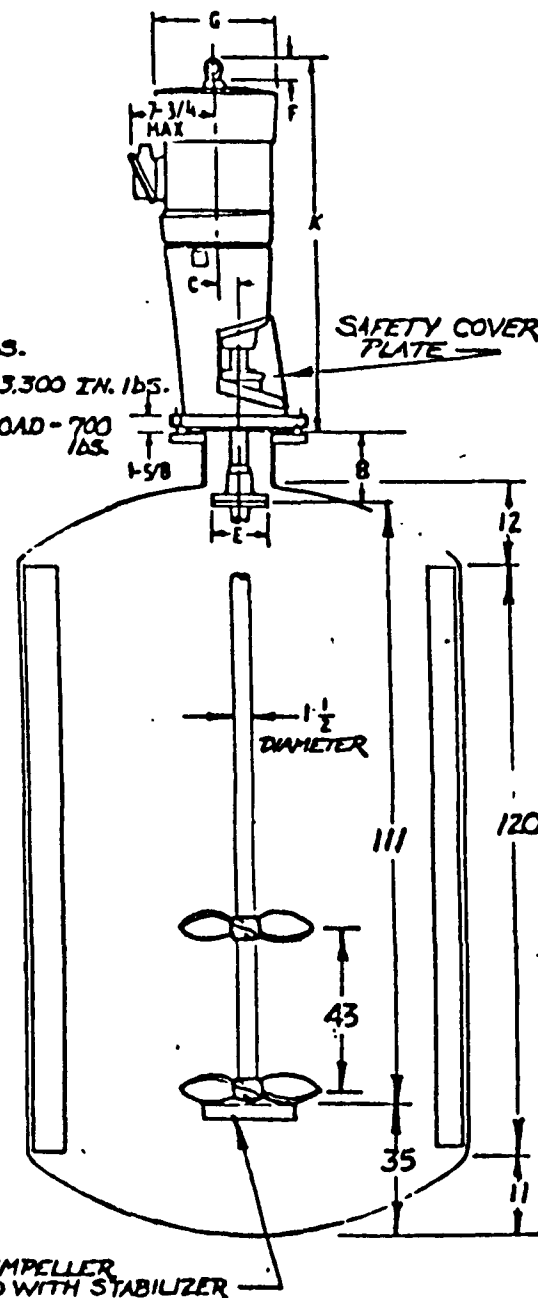
FIGURE 7.4
CONFIDENTIAL
DO A 056782

DO A 056783
CONFIDENTIAL



DESIGN LOADS:
TORQUE - 550 IN. lbs.
BENDING MOMENT - 13,300 IN. lbs.
VERTICAL DOWNWARD LOAD - 700 lbs.

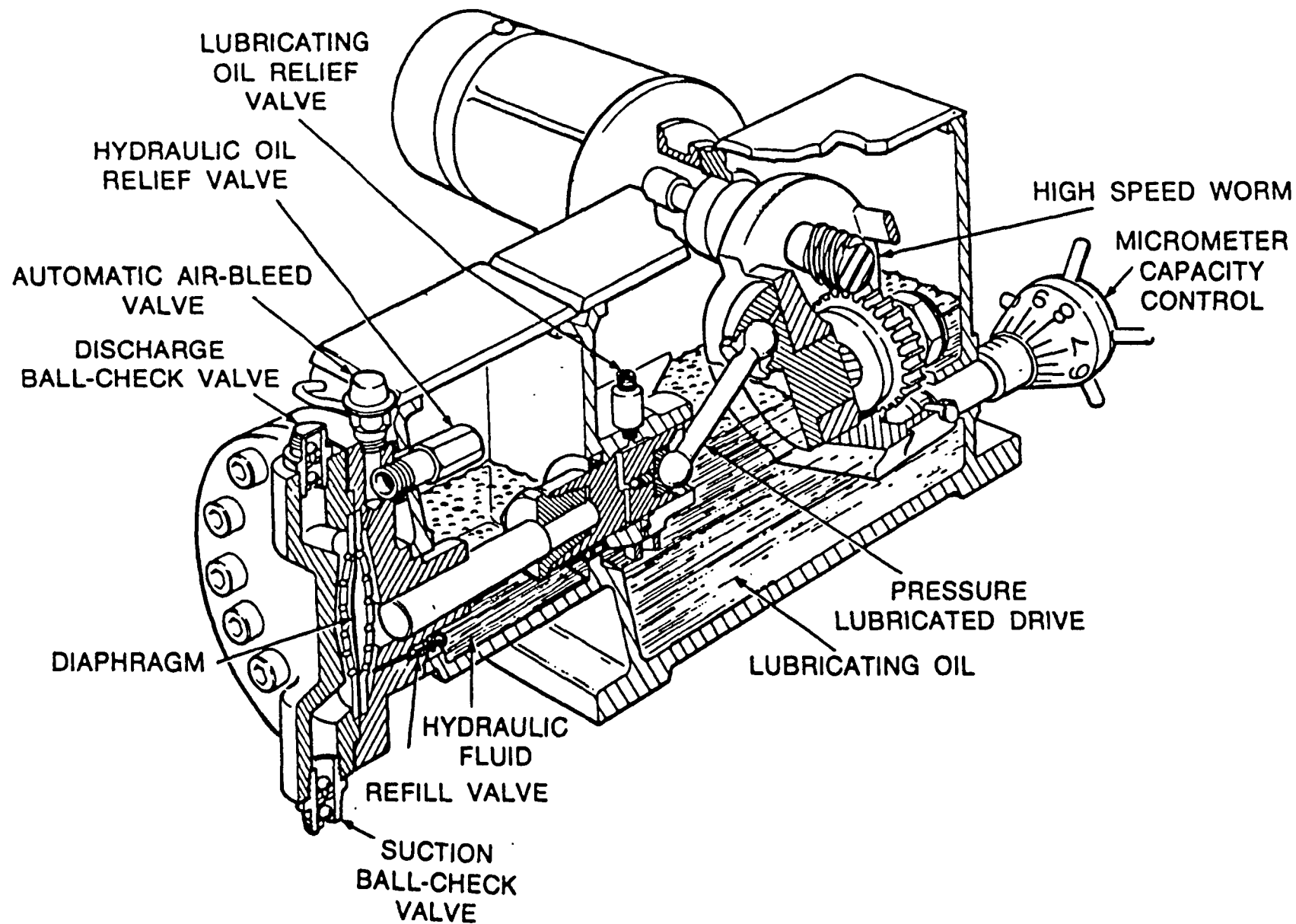
LOWER IMPELLER
EQUIPPED WITH STABILIZER



1. ALL DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED
2. ALL MIXER PARTS IN CONTACT WITH
TANK CONTENTS ARE STEEL
UNLESS OTHERWISE SPECIFIED
3. PROPS ARE NOT TO BE RELOCATED
FROM POSITION SHOWN
4. UNIT IS FURNISHED WITH A DOUBLE
MECHANICAL SEAL, TYPE T-3
5. TANK BAFFLES NOT FURNISHED BY
MIXING EQUIPMENT CO.
6. IMPELLER R.P.M. 230
IMPELLER DIAMETER 14.2
7. MINIMUM OPENING REQUIRED TO
PASS IMPELLER DETACHED FROM
SHAFT IS 13.0 DIAMETER
8. SERIAL NO. 80/943095
9. HEAVIEST MIXER PIECE:
MOTOR - APPROX. 70 LBS.

MIXING EQUIPMENT CO. INC.			
REV	DATE	BY	CHKD BY
1			
CERTIFIED BY			
FOR DOW CHEMICAL INTER'L			
MIXER MODEL <u>NJ3GDS-100</u>			
TAG NO <u>ITEM A305</u>			
PO NO <u>72289-LS012</u>			
REF DRG			
MIXING EQUIPMENT CO. INC.			
A UNIT OF GENERAL SIGNAL			
LIGHTNING			
INSTALLATION DRAWING			
R.D.S.	7-10-60	943095A	198

FIGURE 7.5



DO A 056784
 CONFIDENTIAL

FIGURE 7.6

Milroyal Disc Diaphragm Liquid End

8.0 REACTION

We have two identical reactors on each train, R-211 and R-212. The reactors are 10' diameter spheres with a 4500 gallon capacity. Each reactor runs liquid full and is continuously stirred by an agitator with four pitched blades. The agitator turns at ~~80~~⁸⁴ RPM's and is driven by a 200 hp electric motor. Assisting the agitator for better mixing there are five evenly spaced baffles contoured to the walls of the reactor. The reactor is temperature controlled at 200°C by catalyst flow to the reactor. The reactors are pressure controlled at 450 psi by a pressure control valve that drops the pressure to 20 psi in the first devolatilizer.

R-211 and R-212 have emergency isolation valves on the feed into the reactors, and the polymer in and out of the reactors. These valves will be operated from the control room.

R-211 and R-212 have nine temperature indications and a high temperature alarm. The temperature control point comes from a temperature transmitter located at the top of the reactor. The temperature transmitter has high and low temperature alarms.

The pressure control point for R-211 is located at the top of the reactor and has a high and low pressure alarm.

8.1 REACTANTS AND CONTROLS

Ethylene from LHC at 400 psi is compressed to 650 psi and flow controlled to the reactor. Prior to entering the reactor, ethylene is mixed with solvent (ISOPAR E) at 600 psi and cooled from 50°C to 10°C in a cooling water exchanger (E210) and chilled water exchangers (E211 A/B). The ethylene is mass flow controlled to the reactor based on production. The flow is compensated for

temperature and pressure changes in the ethylene feed stream so pounds per hour do not change if on computer. The solvent is ratio controlled (about 5 pounds solvent per pound of ethylene) to adsorb the heat of reaction. 85% of the ethylene is converted in the first reactor, 7% is converted in the second reactor with no additional feed flows. Conversion is controlled at 92-93% by the solvent/ethylene ratio; to increase conversion add more solvent. This takes out more heat, and more catalyst is added to maintain the reactor temperature, this extra catalyst increases the conversion.

(See Table 8.1 for various cause-effect relationships.)

8.2 DUAL REACTORS

Some products require a 'dual' reactor set up. On dual reactor runs, additional feed and catalyst are added to the second reactor (R-212). A 10% portion of low melt index material is made in R-212 and a 90% portion of high melt index material in R-211. This allows us to make a broad molecular weight distribution. Reactor flows on dual reactor runs are in the bottom of R-212 and out the top to R-211 bottom for 10% of the production. The remaining 90% of ethylene and solvent enters R-211 along with R-212 product. The top off of R-211 goes to E-511. (See Fig. 8.1)

8.2 CATALYST

Pre-mix catalyst and ATE are ratio controlled by variable speed Milton Roy duplex pumps to control reactor temperature at 200°C. The ATE is used to activate the pre-mix catalyst. ATE to pre-mix catalyst ratio is very important for good catalyst efficiency. Too much or not enough ATE will bring the catalyst efficiency down. The computer will constantly adjust the ATE ratio to get maximum catalyst efficiency.

8.4 MELT INDEX

Hydrogen is mass flow controlled into the ethylene stream to the reactor for melt index control. The hydrogen stream is compensated for temperature and pressure changes so pounds per hour hydrogen does not change. More hydrogen produces a higher melt index. Less hydrogen produces a lower melt index. We have dual line viscosity probes on the outlets of both reactors. The viscosity probes show if the polymer is getting harder or softer. A downward trend on viscosity would indicate softer polymer or higher melt index. An upward trend on viscosity would show a harder polymer or lower melt index. Hydrogen concentration in the ethylene is analyzed by an on-stream gas chromatograph.

The hydrogen to the reactor has a wide range of flows for different melt indexes. We have 3 different size flow meters and two different size control valves for more accurate flow control of hydrogen. (See Fig. 8.8.)

8.5 DENSITY

Octene is flow controlled into the solvent stream before entering the reactor for density control. More octene produces a lower density. Less octene produces a higher density. Octene is used for linear low density polyethylene that has a density range from 0.915 to 0.935. However lower and higher densities can be produced and still be classified as linear low density polyethylene. Propylene instead of octene is used for intermediate density (.930 to .945) and high density polyethylene (.945 to .970). Fig. 8.2 shows the density control scheme. Figures 8.3 and 8.4 show the relationships between density, percent octene and melt index.

8.6 REACTOR JACKET AND BLOWDOWN

The reactors are jacketed for heating and cooling of the reactor walls. 235 psi steam is used to keep the reactor warm when the train is down. Cooling tower water is used to help absorb some of the heat of reaction when the train is running. The jacket is equipped with a PSV that relieves to the atmosphere at 275 psi.

Each reactor has two PSV's that relieve at 750 psig into D-212 where polymer is separated from ethylene and solvent vapors. (See Fig. 8.3) Polymer falls to the bottom with vapors going out the top into the flare header. To keep polymer from going out the top with vapors, quench water spray nozzles are used. D-212 also has a PSV that relieves to the atmosphere at 102 psig. D-212 is 235 psig steam jacketed to flash off vapors and keep poly molten so it can be padded out the bottom of D-212. A pancake blind would have to be installed in the vent line to do this. N₂ lines tie into the top of both reactors so they can be padded out for maintenance. Both R-211 and R-212 can be padded out the bottom to D-511. There are flow alarms on each reactor safety valve discharge line to detect leaks.

8.7 REACTOR SEALS

The seal on the reactor agitator shaft is a double mechanical seal. (See Fig. 8.6) Mineral oil at 20 psi to 50 psi above reactor pressure is supplied to the top of the seal through a level controlled seal oil pot. The seal pot is supplied from D905 and P907 (Section 23.2). The pressure on the seal pot is maintained by a N₂ cylinder with a pressure regulator. (See Fig. 8.7) We have a low pressure alarm and a high flow alarm on the seal oil pot. We have a combustible gas alarm near the seal to detect leakage to the outside. If

the seal starts leaking to the inside we can by-pass the seal oil pot and use high pressure solvent from the P-211's. There is a flow indication on this solvent so the amount can be included in the solvent to ethylene ratio calculation.

See Fig. 8.8 - Agitator Data

See Table 8.2 - Reactor Control Loops.

TABLE INDEX FOR REACTOR SECTION

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
8.1	Cause Effect Chart
8.2	Reactor Control Loops
8.3	A-211 Data
8.4	Emergency Dump System

FIGURE INDEX FOR REACTOR SECTION

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
8.1	Dual Reactor Flows
8.2	Density Control Scheme
8.3	Relationships Between Density
8.4	Percent Octene and Melt Index
8.5	Reactor Blow Down
8.6	A-211 Seal Diagram
8.7	Seal Oil Pots

TABLE 8.1 - CAUSE EFFECT CHART

INCREASE	WOULD CAUSE	GO UP - GO DOWN
Hydrogen	melt index	go up
Octene %	density	go down
Solvent/ethylene ratio	melt index	go up
Solvent/ethylene ratio	conversion	go up
Solvent/ethylene ratio	catalyst efficiency	go down
Melt Index	density	go up
Melt Index	I_{10}/I_2 (MWD)	go down
Melt Index	viscosity	go down
Density	I_{10}/I_2 (MWD)	go down
ATE Premix ratio	catalyst efficiency	or go down go up
Temperature	melt index	go up

TABLE 8.2
REACTOR CONTROL LOOPS

<u>LOOP</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC-2227	Flow control solvent to reactor.	Ratio controlled with ethylene to absorb heat.
FIC-1123	Ethylene flow control to the reactor.	Flow control ethylene for production rate.
FIC-2214	Flow control H ₂ to the reactor.	Flow control H ₂ for melt index.
FIC-8039	Flow control octene to the reactor.	Flow control for density.
PIC-2248	Reactor pressure control.	Let's down pressure into D-511.
TIC-2249	Reactor temperature control.	Controls speed of catalyst pumps, P-311 A or B.
TIC-2275	R-212 temperature control.	Temperature control on dual reactor runs. P-311 B or C speed.
LIC-2301	Control level in D-213 A.	Seal oil pot level control on R-211.
LIC-2306	Control level in D-213 B.	Seal oil pot level control on R-212.

MIXING EQUIPMENT CO., INC.

BOX 1370 135 MT. READ BLVD. ROCHESTER, N. Y. 14602

A UNIT OF GENERAL SIGNAL

LIGHTNIN'

MIXERS AND AERATORS

0243016				DOW CHEMICAL CO.			
DOW CHEMICAL USA				PLANT 86			
P. O. BOX 150				SHIP TO PLAQUE MINE, LOUISIANA 70764			
PLAQUE MINE, LOUISIANA 70764				ATTN: M. E. BOURGEOIS			
TAG: ITEMS A211, 212, 221 & 222							
ORDER NO.		REQ. NO.		ORDER NO.		REQ. NO.	
72289-15012				72289-15012			
INVOICE DATE		TERMS NET 30 DAYS F. O. B. ROCHESTER, N. Y.		VIA PREPAY & ADD RYDER			
		20% DWGS. MAILED		LIGHTNIN' ORC 944526			
		80% SHIPPED					
MODEL 781S200		C.O. #		DATE:		INSTALLATION DATA	
SERIAL NO. 09445261-4						UNIT SIZE 781 EXACT RATIO 21.2	
MOTOR OR DRIVE RELIANCE		FRAME SIZE 447T		HORSEPOWER 200		UNIT WGT. LESS MOTOR	
VOLTS 575		CYCLES 60		R.P.M. 1800			
PHASE 3		FURNISHED BY LIGHTNIN'		ENCLOSURE XP			
				MOUNTED BY		IMPELLER	
						NOMINAL SPEED 1800 84	
						OFF BOTTOM 60"	
						SPACING	
						MIN. TAKE OFF MIN. REQ. D.	
						*TANK DIA. 120"	
						OVERALL HEIGHT 132"	
						DRAWING	
						BAFFLES	
						QUANTITY 5	
						LENGTH SS	
						WIDTH 18"	
						OFF WALL DISTANCE	

73

SPECIFICATION

SCHEDULED SHIPMENT DATE → 12-1-80

TABLE 8.3

TABLE 8.4

1) EMERGENCY DUMP SYSTEM

- a. When to use --- The Emergency Dump System is primarily designed for use in extreme emergencies when the plant is in imminent danger of severe damage and where this damage can be minimized by emptying any or all of the following vessels: R-211, R-212, R-221 and R-222. Operation of the system will be authorized by the shift supervisor.

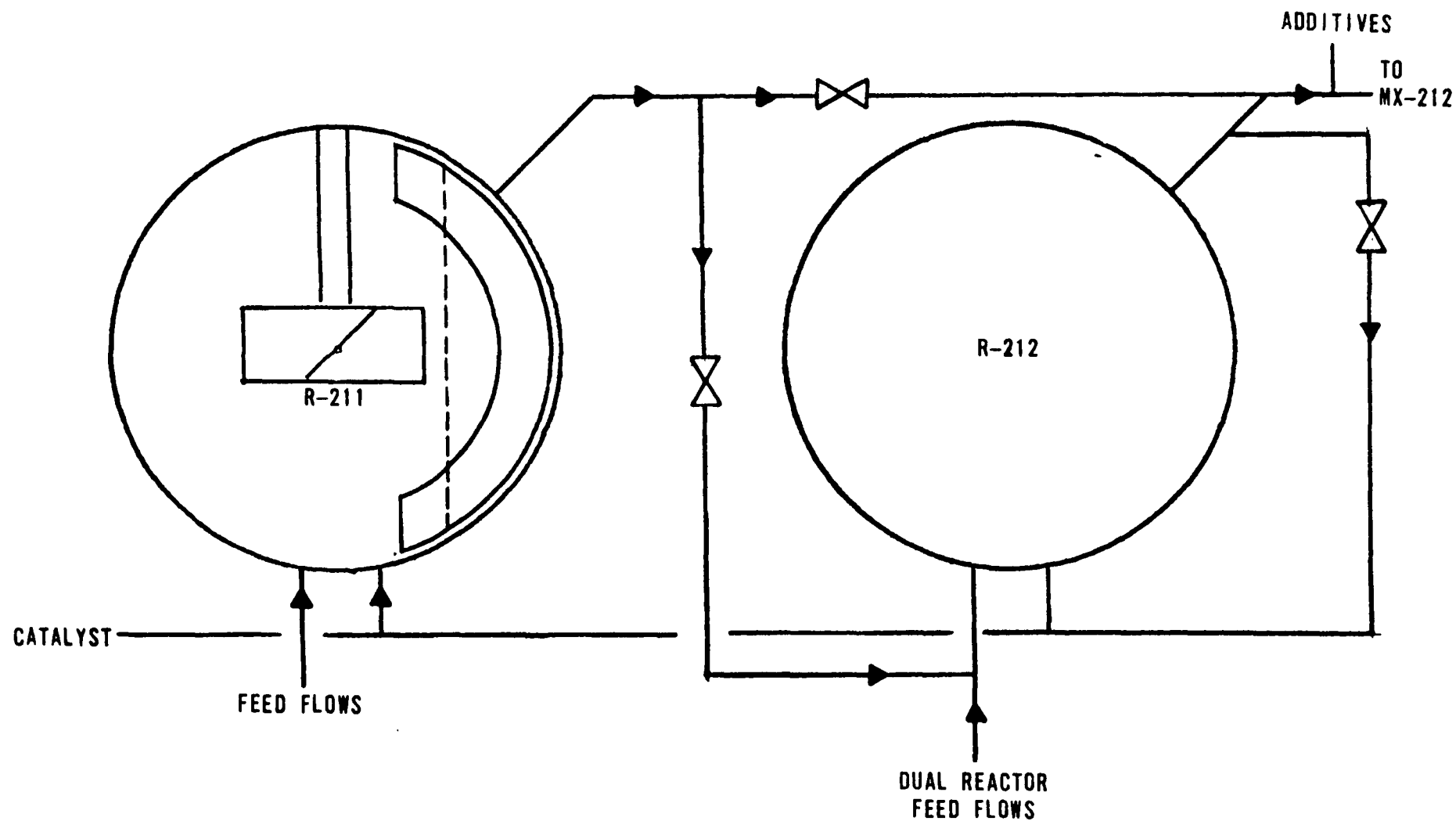
These emergencies are defined as:

1. Genuine pressure rise significantly above the pop valve set pressure.
 2. A massive reactor leak where other normal control systems will not reduce the leak to a satisfactory level.
- b. How to operate --- Turn the appropriate valves on the dump system panel to the "Open" position. The quench water valve to D-212 and D-222 will have to be opened manually.

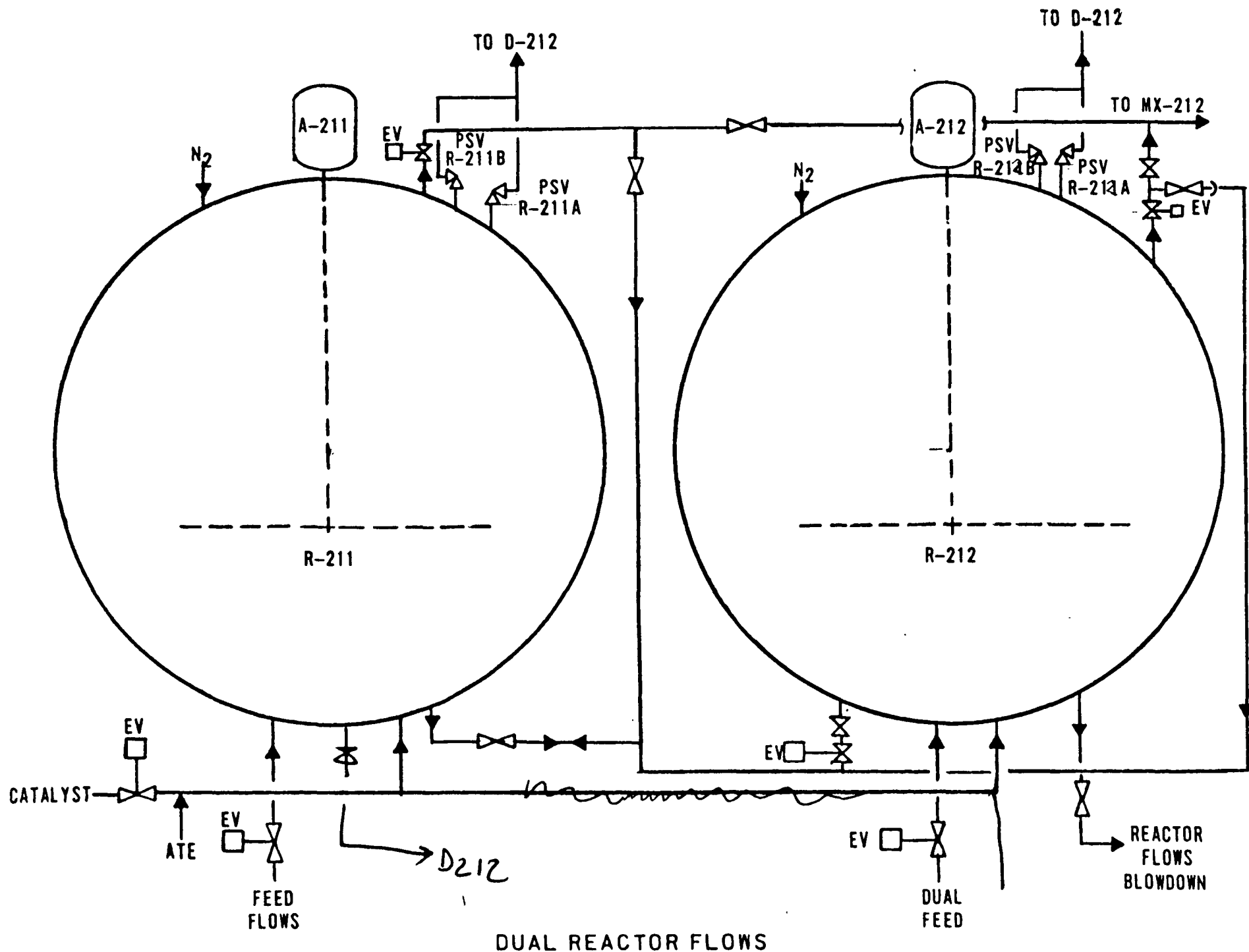
As soon as practical after activation of the system, the dump lines that were used should be purged with either steam, or nitrogen. This is to minimize cleanup problems and should not be attempted until it can be done safely.

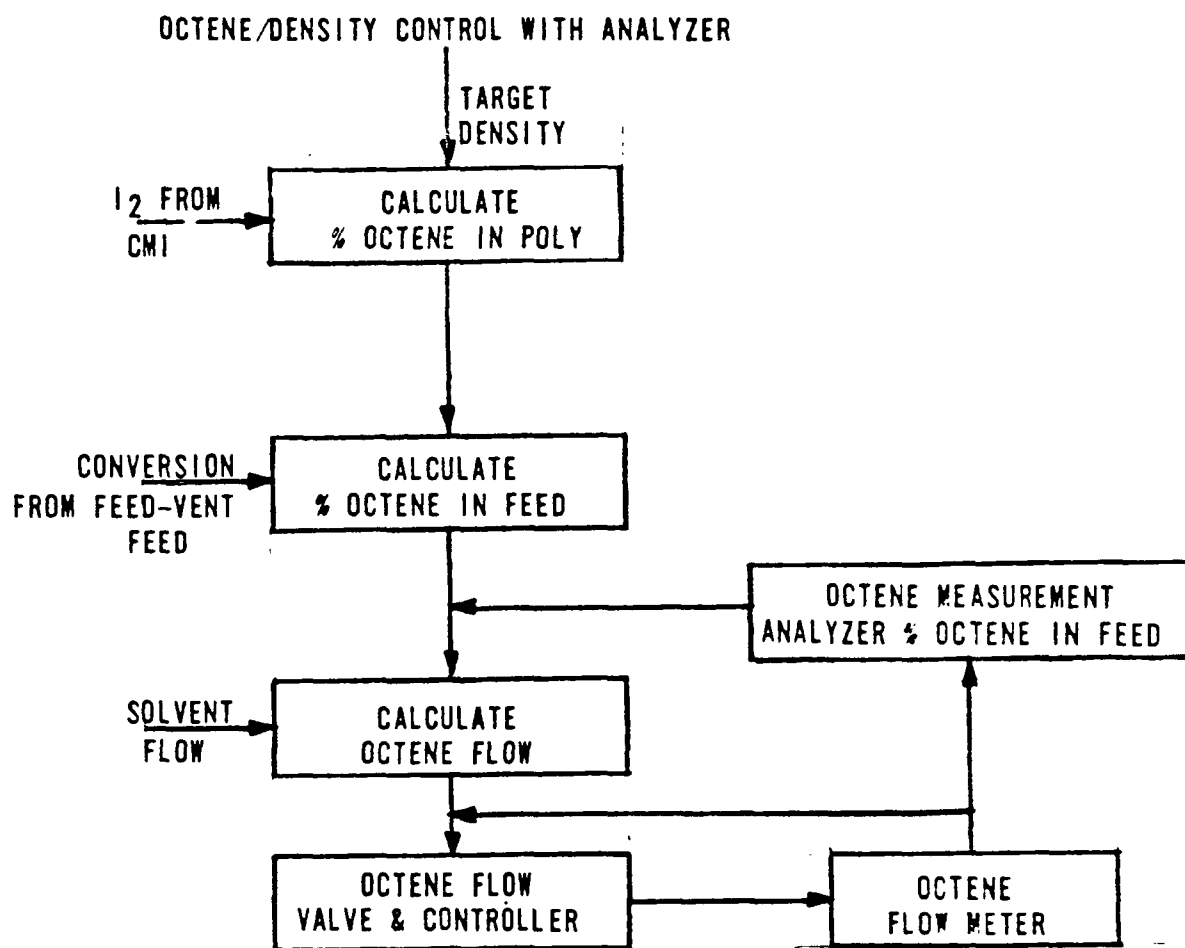
After the emergency is over it will be necessary to clean out the tanks. The shift supervisor will initiate the clean-out procedures after he has inspected them and satisfied himself that it is safe to work in the area.

When there is an emergency requiring dumping any of the above mentioned vessels, the emergency horn will be sounded.



REACTORS





DENSITY CONTROL SCHEME

FIG. 8.2

100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2

ME INDEX

935

930

925

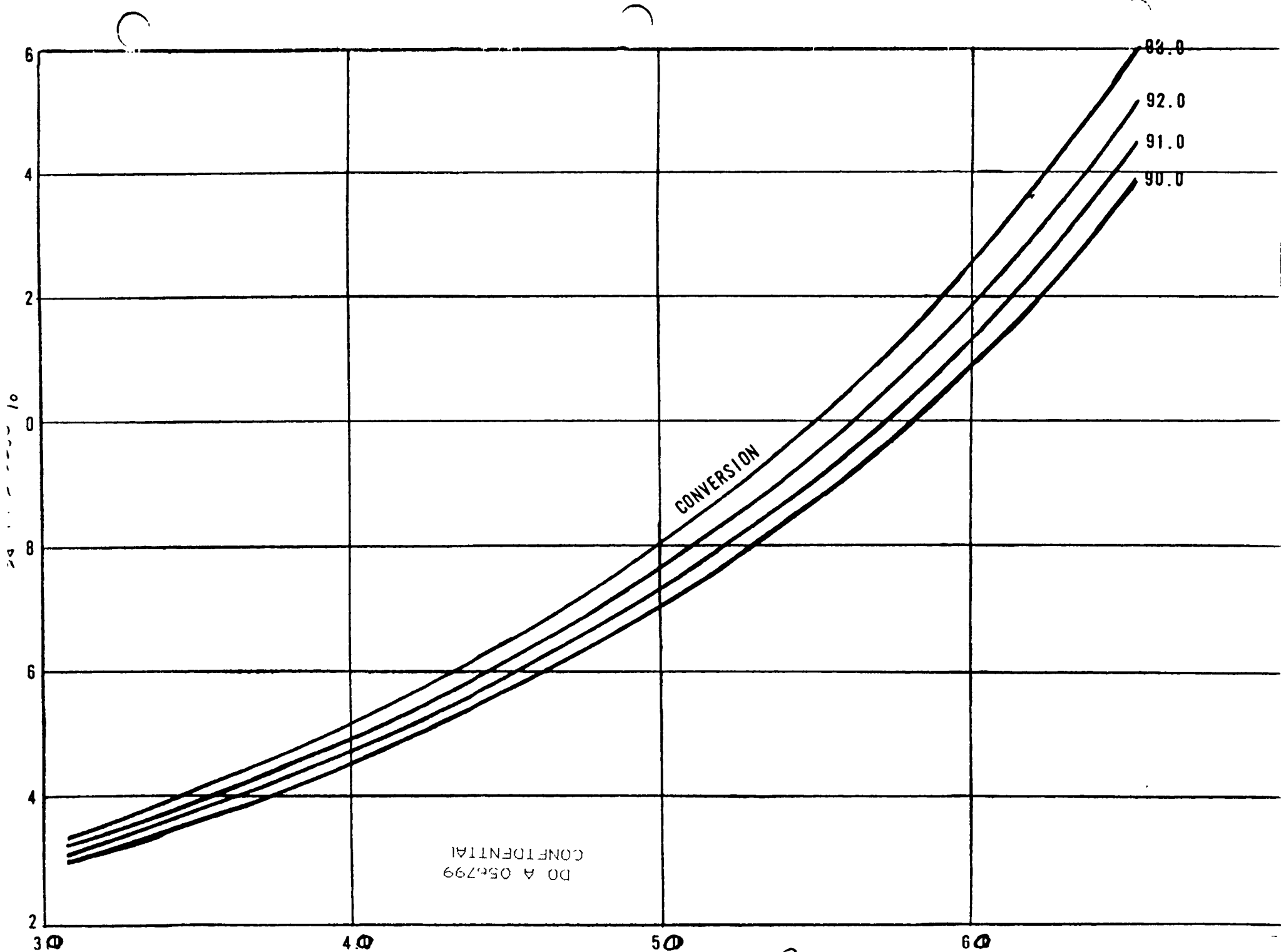
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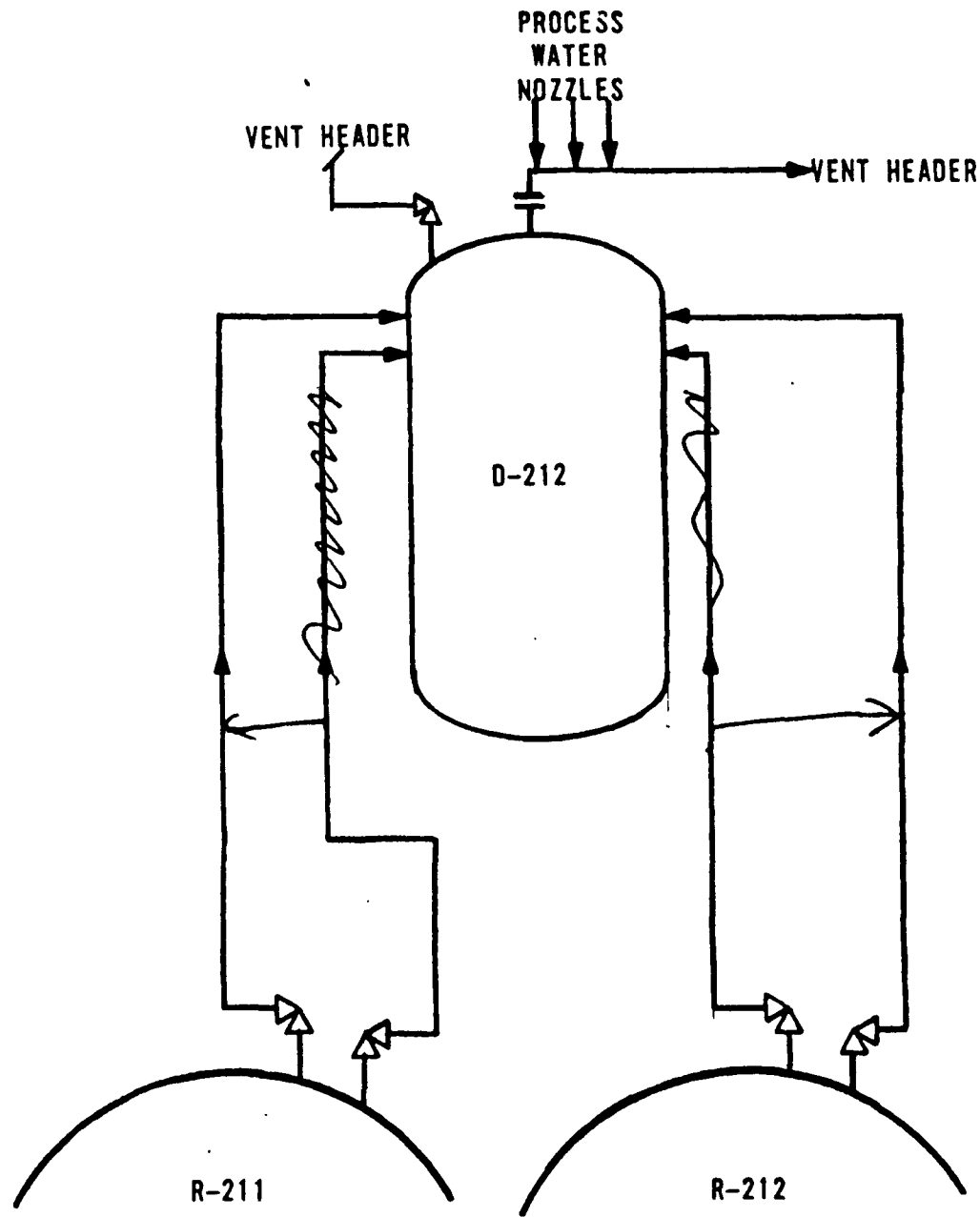
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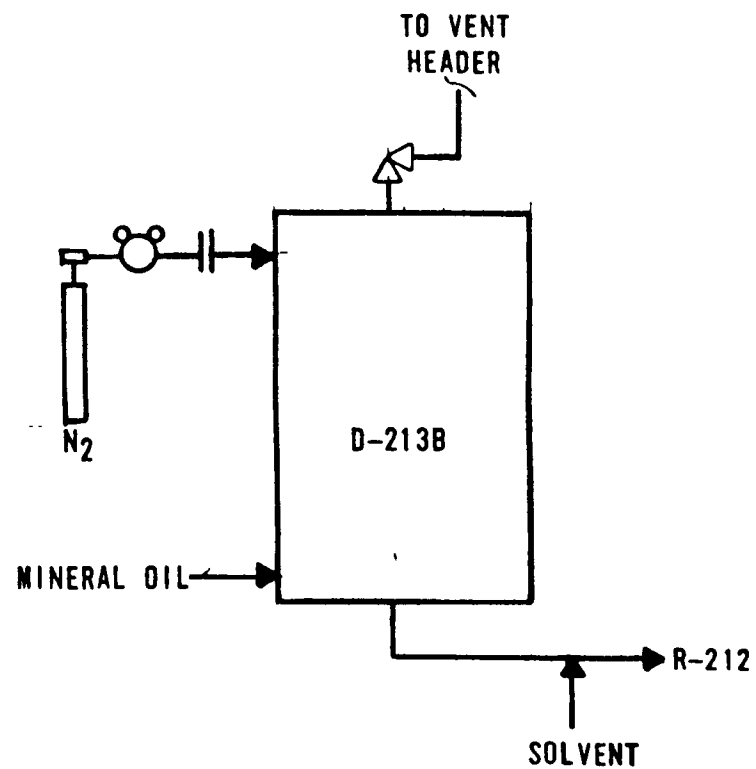
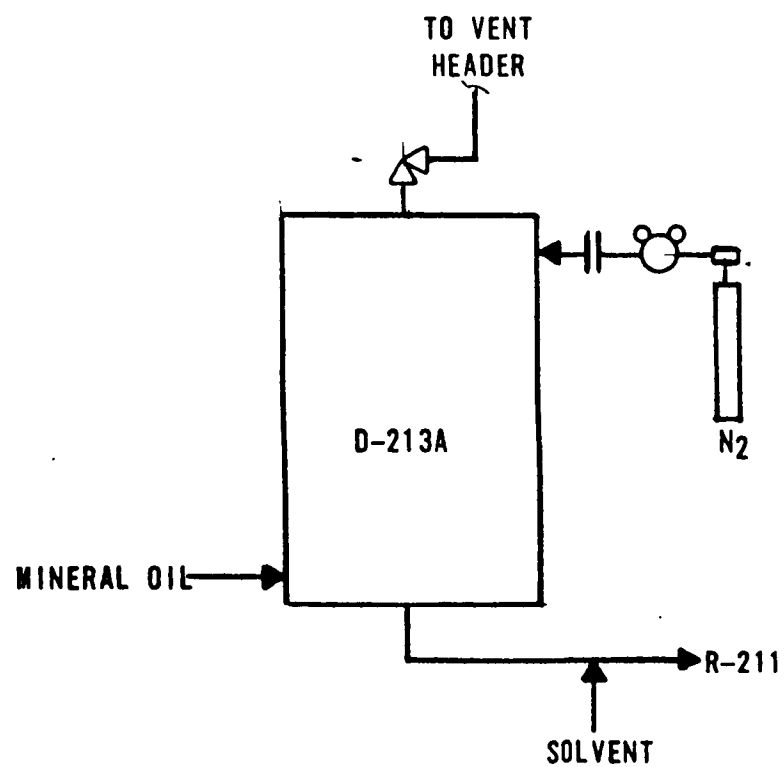
TGA
2-12-80

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REACTOR PSV BLOW DOWN DRUM



SEAL OIL POTS FOR REACTORS

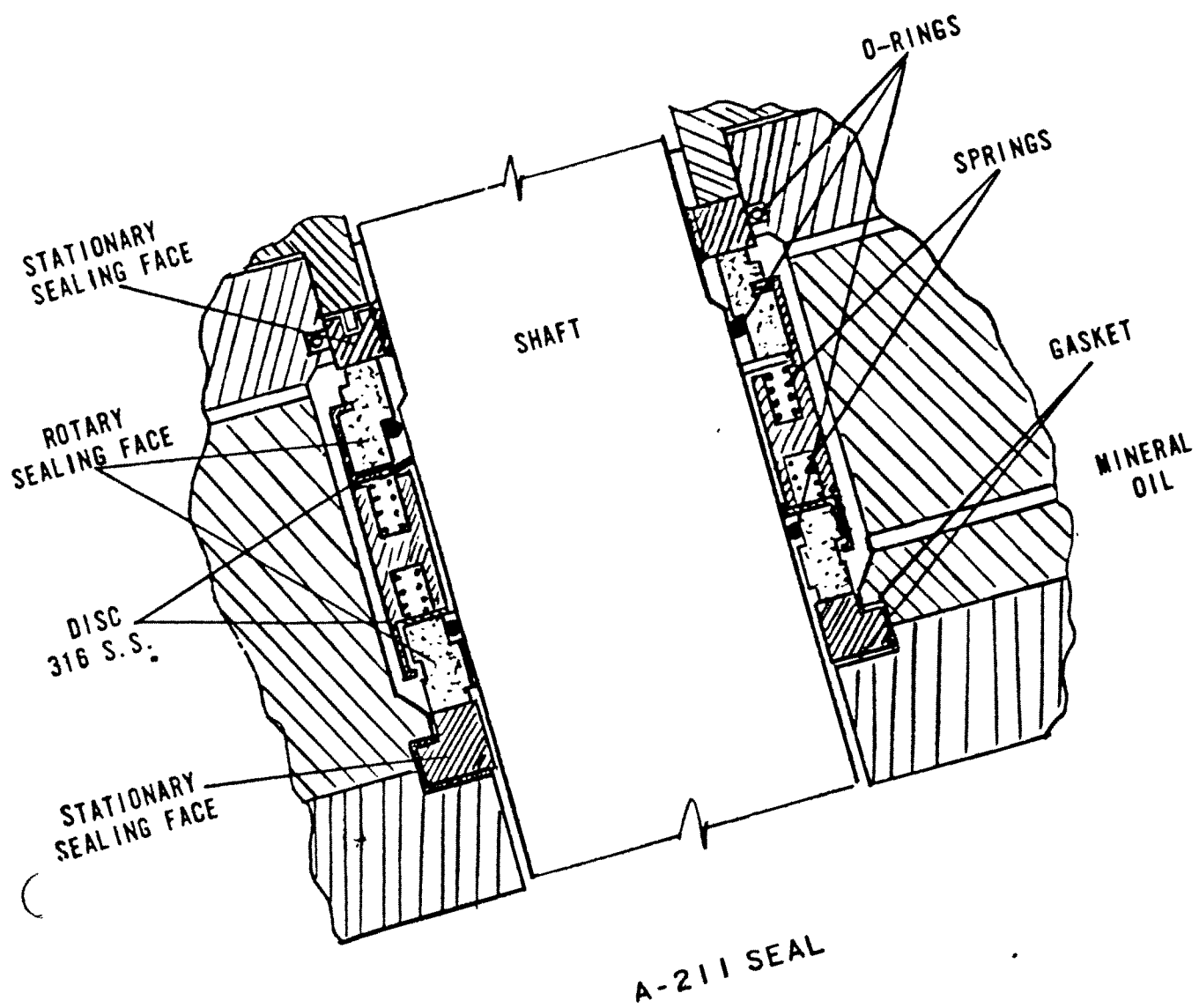


FIG. 8.6

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9. CALCIUM STEARATE

Calcium stearate is pumped into the polymer stream after it leaves the reactor to neutralize the active catalyst components. A static mixer in the main polymer line improves the mixing of the calcium stearate and polymer solution.

The calcium stearate stops the polymerization reaction. It also inhibits the formation of hydrochloric acid. (See Section 5).

Calcium stearate is a powder and is slurried with solvent before it is metered into the product. The solvent is used only as a carrier for the calcium stearate. Irganox 1010 is an additive we mix with calcium stearate to help keep the polymer from degrading.

9.1 MIX TANKS

We have two mix tanks common to both trains. (D-401 and D-402) Each tank is continuously stirred by an agitator. The agitator turns at 56 RPM and has one impeller with four pitched blades. It is driven by a 2 hp electric motor. The motor has a high and low amp alarms. The mix tanks have a regulator to keep nitrogen pressure on the vessels. N₂ will have to be depadded to the flare when adding solvent and calcium stearate. The tanks are protected by a PSV that relieves to the flare at 150 psig. Each tank has a recirculation pump, P-401 and P-402. The seal flush for these pumps comes from P-611 or P-621. Both tanks have high and low level alarms. See Fig. 9.1 A-401 & A-402 Data.

9.2 DAY TANKS

The day tank is continuously stirred by an agitator that has two impel-

lers with 3 pitched blades. The agitator turns 350 RPM and is driven by a 1 hp electric motor. The agitator has high and low amp alarms. The day tank has a N₂ pad and has a PSV that relieves to the flare at 150 psi. D-411 has a pressure relief regulator that relieves to the flare when transferring into the tank. D-411 has high and low level alarms.

See Fig. 9.2 - A-411 and A-421 Data.

See Fig. 9.1 - Calcium Stearate Control Loops.

9.3 MIXING

Solvent from Y-611 or Y-621 is pumped through a totalizing valve-meter into mix tanks D-401 and D-402. The meter measures gallons and will automatically close when the desired amount of solvent is added. 2300 pounds of calcium stearate is used to mix one batch, giving a concentration of 12 weight percent. We receive calcium stearate in 2200 pound tote bins. The calcium stearate is transferred from the tote bin to the mix tank by a variable speed belt conveyor with 4400 pounds per hour capacity. There is a diverter valve and two automatic slide valves at the end of the conveyor to select which tank to unload to. Each tote bin will be weighed prior to transferring to the mix tanks. Irganox 1010 is mixed with calcium stearate in high and low concentrations depending on product specifications. Low Irganox will be 100-300 PPM and high Irganox will be 400-800 PPM concentration in the polymer. This means 1.6% to 5% Irganox concentration in D-401. We receive Irganox in 110 pound fiberpacks. We will dump fiberpacks of Irganox into a hopper at the end of the belt conveyor to transfer Irganox to the mix tanks. Calcium stearate is transferred to the day tank D-411 remotely by operator command. D-411 is on weigh cells where calcium stearate is weighed and pumped into the polymer stream by variable

speed Milton-Roy duplex pumps, P-411 A/B. Approximately 11 pounds of 12% calcium stearate slurry per 1000 pounds of polymer is added at 750,000 catalyst efficiency and depends on catalyst efficiency. This rate is controlled by a computer calculation based on the amount of premix catalyst used.

There is a three-way automatic valve on the discharge of P-411 A and B which can be lined up to the static mixer, MX212, or to recirculate back to D-411.

A high pressure solvent line from P-211's exists to flush the P-411's if needed.

TABLE INDEX FOR CALCIUM STEARATE

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
9.1	Calcium Stearate Control Loop

FIGURE INDEX FOR CALCIUM STEARATE

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
9.1	A-401 and A-402 Agitator Data
9.2	A-411 and A-421 Agitator Data

TABLE 9.1

CALCIUM STEARATE CONTROLLERS

<u>LOOP</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC-3134	Flow of calcium stearate to MX212.	Speed of P-411.

INSTALLATION DATA FOR **LIGHTNIN®** 71S 2 MIXER

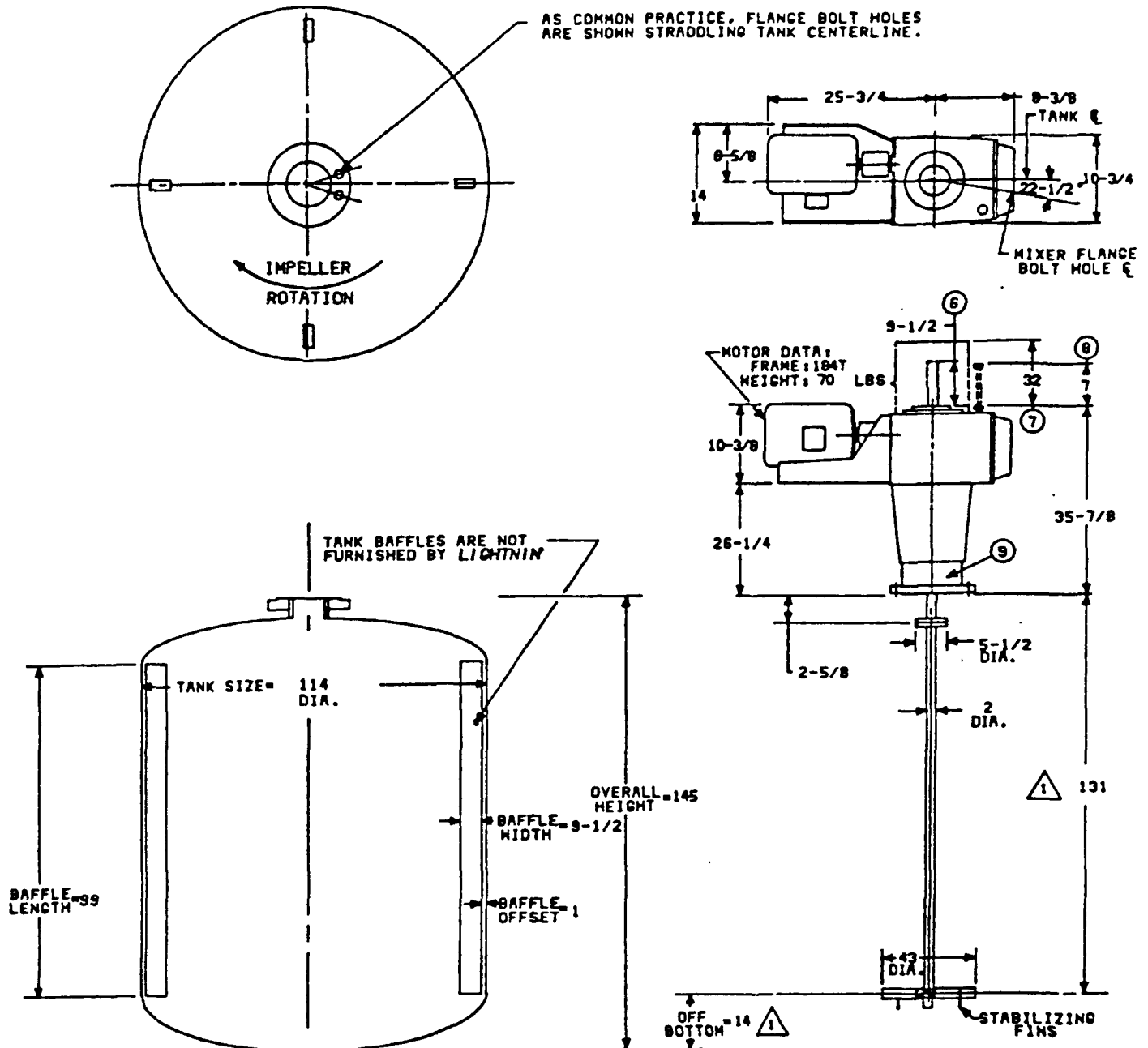
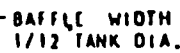


PLATE 51028	NOZZLE DESIGN DATA VERTICAL DOWNWARD LOAD (POUNDS): 1,100 TORQUE (INCH-LBS.): 3,380 BENDING MOMENT (INCH-LBS.): 23,600	IMPELLER DATA TYPE: A200 RPM: 56 QUANTITY OF BLADES: 4 KEYWAY ON SHAFT ALLONS FOR THE FOLLOWING IMPELLER ADJUSTMENT IN 3" INCREMENTS: LOWER IMPELLER: 18" UPWARD.	NOTES 1.REFER TO INSTRUCTIONS FOR START-UP AND MAINTENANCE PROCEDURES, AND SAFE LIFTING PRACTICES. 2.ALL DIMENSIONS ARE IN INCHES. 3.MATERIAL OF MIXER PARTS IN THE TANK IS STEEL UNLESS OTHERWISE SPECIFIED. 4.TOTAL MIXER WEIGHT(LESS MOTOR) 622 POUNDS. 5.TANK MUST HAVE MINIMUM OPENING SIZE OF 12-3/4 DIAMETER TO PASS DISASSEMBLED MIXER PARTS. 6.CLEARANCE REQUIRED ABOVE MIXER AND ABOVE IMPELLER(S) TO PERMIT REMOVAL OF SEAL CARTRIDGE. 7.CLEARANCE REQUIRED FOR PULLER ASSEMBLY (OPTIONAL). 8.CLEARANCE REQUIRED FOR DIPSTICK REMOVAL. 9.MECHANICAL SEAL: PER OMG: IT-820 STYLE: C CODE: T-3 INLET & OUTLET CONNECTIONS TO SEAL LUBRICANT 1/8 NPT - COOLANT 1/4 NPT. 10.UNIT IS FURNISHED WITH A LOAD LIMITER COUPLING.
138	DESIGN LOADS ARE GREATER THAN ACTUAL LOADS BY A SUITABLE FACTOR, CONSISTENT WITH CONSTRUCTION CODES AND LIGHTNIN EXPERIENCE. MIXING EQUIPMENT CO. INC. DOES NOT WARRANT, GUARANTEE, OR ASSUME ANY RESPONSIBILITY FOR THE DESIGN OR CONSTRUCTION OF THE MOUNTING PLATFORM FOR THE MIXER.		
© 1979	UNIT MOUNTING FLANGE DATA 150 LB. ANSI (ASA) SERIES DRILLING SIZE: 8 O.D.: 113-1/2 NO. OF EQUI-SPACED BOLTS: 8 B.C.: 11-3/4 FLANGE THICKNESS FOR BOLTING: 2-3/4 BOLT DIA: 3/4 (MOUNTING BOLTS NOT FURNISHED BY LIGHTNIN) Motor - 2 HP - 575 Volts		

FIGURE 9.1

VERTICAL DOWNWARD LOAD - 350 LBS.

150 LB. ASA SERIES FLANGE DRILLING.
HOLES STRADDLE CENTERLINE AS SHOWN
(MOUNTING BOLTS FURNISHED BY CUSTOMER)



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10. DEVOLATILIZATION AND VACUUM SYSTEM

10.1 DEVOLATILIZATION

The polymer, solvent, and ethylene solution is heated to 260°C in E-511 with Dowtherm vapor. The polymer solution flows through the tube side of E-511. Dowtherm enters E-511 shell side, is condensed, flows into a knock out drum, D-519 where liquid is level controlled back to the Dowtherm furnace feed drum, D-500 (See Fig. 10.1). The pressure drops from 450 psi to 20 psi before entering D-511. (First devolatilizer) The polymer enters the side of D-511 tangentially which causes a spiral effect to help keep polymer from being carried overhead with the vapors. About 98% of the solvent is vaporized and flows out the top of D-511 to the bottom of T-611 (Wax Column Scrubber). D-511 is level controlled to the second devolatilizer (D-512) by a variable speed gear pump P-511. D-511 will hold about 2 hours of production. The reactors will not have to be shutdown because of minor problems in the pelletizer area. P-511 is a 34" inlet and 12" outlet. P-511 speed is from 2 RPM to 20 RPM and pumps 6000 pounds per hour to 40,000 pounds per hour of polymer. P-511 is designed for 4000 psig. The capacity and pressure will depend on melt index. The gear teeth fill efficiency, that is, the fraction of the teeth filled with polymer goes down with decreasing melt index and with increasing speed. The capacity is therefore not directly proportional to speed.

If the discharge line is restricted, to protect pump and piping we have high discharge pressure and high gearbox torque shutdowns, other shutdowns on P-511 are high level in D-512. Low temperature on P-511 discharge line prevents P-511 startup. Polymer enters D-512 through a plate heat exchanger E-512, where polymer is heated to 260°C with Dowtherm liquid. E-512 has hori-

zontal plates with vertical Dowtherm tubes (See Fig. 10.2). Poly enters the top of E-512 and flows across the plates and out the outside of the plates into D-512.

D-512 runs under 5 millimeters of mercury absolute pressure. The remaining solvent is vaporized out of the top of D-512 into the vacuum system. Both D-511 and D-512 are jacketed with spiral pipe welded to the outside shell of the devolatilizers and heated with liquid Dowtherm. Dowtherm flow path to the jackets is the same on both devolatilizers. Dowtherm enters P-511 and P-512 housing through a devolatilizer temperature control valve into the bottom of the jacket of the devolatilizers and out the top of the jacket to the Dowtherm return header. Both D-511 and D-512 have PSV's on the jackets which relieve to the Dowtherm storage drum D-502. D-512 is level controlled manually by a variable speed gear pump (P-512) to the pelletizer. The level indicators on D-511 and D-512 are lead shielded devices that project radiation across the devolatilizer to read the level. Level can also be estimated by various temperature indications inside the devolatilizer.

Both D-511 and D-512 have low, high, and high-high level alarms. If you get a high-high level alarm, shut down the reactors, before you overflow the devolatilizers.

The flanges on D-512 vacuum system are ring joint flanges with a nitrogen purge. Nitrogen is used to keep air out of system in case of a leaking flange. Air causes specks and gels (due to oxidation) in the finished product and causes polymer to build up on the walls of the devolatilizer.

10.2 DEVOLATILIZER LEVEL INDICATIONS

Each devolatilizer has two radiation sources that project 1000 micro

curies. Each source is mounted to the outside wall of the devolatilizer in a safety source holder. The radiation outside of the source holder will not exceed 2 MR/hr at 12 inches.

Each devolatilizer has two strip radiation detectors located on the opposite side of the devolatilizer radiation sources. As the polymer level rises the amount of radiation picked up by the detector decreases giving a level reading.

See Fig. 10.5 - D-511 Level Indicator

See Fig. 10.6 - D-512 Level Indicator

10.3 VACUUM SYSTEM

The vapors out of D-512 are cooled by three exchangers in series. E-513A uses cooling tower water, E-513B uses chilled water, and E-514 uses freon refrigeration. Freon from C-911 is pumped into the bottom of E-514 where it is vaporized and returns. We have a high temperature alarm on the outlet of E-514 to C-911. E-514 is level controlled with Freon for maximum cooling. The solvent enters D-514 where liquid and vapor are separated. We have high and low level alarms on D-514. The liquid is level controlled to D-515. Solvent from D-515 is used to lubricate and provide the 'liquid ring' on vacuum pumps. The non-condensable vapor (mainly N₂) is pulled out of the top of D-514 by a booster blower B-512. B-512 A and B are M. D. rotary positive displacement, V-belt driven by a 10 hp electric motor that turns 1750 RPM. The blower turns 3115 RPM and is capable of pulling 1100 cubic feet a minute of non-condensables. On the outlet of the blower we have high temperature and high pressure alarms. The vapor enters Nash vacuum pumps VP-512 A or B. VP-512 A and B and V-belt driven by a 60 hp electric motor that turns 1800 RPM. (See Fig.

10.7 and 10.8 - Nash Vacuum Pump). The vacuum pumps are capable of pulling less than 5 millimeters of mercury absolute pressure. The vacuum pumps are two stage pumps with two suction inlets and one discharge. When the velocity is high through the pump the first stage does all the work. When the velocity is low, the second stage "kicks" in and helps the first stage to pull a higher vacuum. N_2 is regulated to D-512 through a needle valve to keep a small flow through the vacuum pumps so they don't cavitate. Solvent from D-515 is cooled with chilled water in E-515 and Freon in E-516 and flow controlled for seal coolant and the liquid seal ring on the vacuum pump. This solvent flow is automatically shut off when the pump is shutdown. The vacuum pumps discharge into D-515. The liquid in D-515 is level controlled to T-611. Vapor goes out the top of D-515 into the flare header. We have a high pressure and high temperature alarm on the vapors out of D-515. We also have an oxygen analyzer on D-515 so we can tell if we have any air leaks into the system. (See Fig. 10.6 and 10.4 for a simplified diagram of the vacuum system.)

See Table 10.1 - Devolatilization Control Loops

See Table 10.2 - Vacuum System Control Loops

10.4 FREON COMPRESSOR

We have a packaged refrigeration unit (Model #RWB 40). The unit has its own factory mounted and wired control panel. The compressor is a positive displacement helical rotary screw compressor directly connected to a 125 hp, 1200 rpm electric motor. The compressor is capable of operating between 10% and 100% of capacity.

Freon vapor from the suction (D-913) will enter the compressor at _____ psi and _____°C. Lubrication is achieved by pumping oil into the suction of the compressor with the freon vapor. The oil pump is a positive displacement gear type oil pump driven by a 3 hp, 1200 rpm electric motor. The unit has dual oil pumps. An electric heater located inside the discharge drum (D-911) heats the oil to operating temperature (_____°C) for start-up.

Freon R-22 is used as the refrigerant. (See Table 10.4 for Freon R-22 data.) The freon and oil are compressed to _____ psi at _____°C in C-911. The discharge of C-911 enters D-911, the oil separator/reservoir. D-911 is a 3 stage separator. The freon/oil separation is assisted by coalescing-type oil mist eliminators. The oil is temperature controlled at _____°C by a cooling tower water exchanger. The oil is then filtered and pumped to the suction of C-911 for lubrication and to the hydraulically actuated single slide valve for suction pressure control.

The freon flows out the top of D-911 to E-911 where it is condensed with chilled water and gravity flows into D-912, the liquid vapor flash drum. The liquid freon is filtered and is flow controlled to E-514 and E-516 (solvent coolers on vacuum system). E-514 and E-516 are level controlled with liquid freon. The vaporized freon flow back to C-911 suction drum, D-913. A recycle line from D-912 (liquid flash drum) to D-913 (C-911

suction drum, with a pressure regulator will allow high discharge ____ psi to bleed back into the suction drum.

See Table 10.3, C-911 Shut Downs.

See Figure 10.10 and 10.11, Freon and Oil Flows.

TABLE INDEX FOR DEVOLATILIZATION AND VACUUM SYSTEM

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
10.1	Devolatilization Control Loops
10.2	Vacuum System Control Loops
10.3	C-911 Shutdowns
10.4	Freon 22 Data
10.5	Radiation Level Indicators

FIGURE INDEX FOR DEVOLATILIZATION AND VACUUM SYSTEM

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
10.1	E-511 Diagram
10.2	E-512 Diagram
10.3	Simplified Drawing Vacuum System
10.4	Simplified Drawing Vacuum System
10.5	D-511 Level Indicator
10.6	D-512 Level Indicator
10.7	Nash Vacuum Pump
10.8	Nash Vacuum Pump
10.9	Diagram C-911
10.10	Freon Flow
10.11	Oil Flow on Freon Compressor

TABLE 10.1
DEVOLATILIZATION CONTROL LOOPS

<u>LOOP</u>	<u>PURPOSE</u>	<u>OPERATION</u>
LIC-5093	D-511 level control.	Controls speed of P-511.
LIC-5059	D-519 level control.	Controls flow of Dowtherm into the Dowtherm return header from D-519.
TIC-5088	Control D-511 jacket temperature.	Control Dowtherm flow to jacket.
TIC-5126	Control D-512 jacket temperature.	Control Dowtherm flow to jacket.
FIC-5138	Temperature control Dowtherm on E-512.	Controls flow of Dowtherm to E-512.

TABLE 10.2
VACUUM SYSTEM CONTROL LOOPS

<u>LOOP</u>	<u>PURPOSE</u>	<u>OPERATION</u>
LIC-5176	Level control E-514 shell side.	Control Freon flow to E-514.
LIC-5181	Level control D-514.	Controls solvent flow from D-514 to D-515.
FIC-5222	Flow control solvent to vacuum pump	Controls solvent flow to liquid seal ring & seal coolant to VP-512 A&B.
LIC-5238	Level control E-516 shell side.	Controls Freon flow to E-516.
LIC-5253	Control D-515 level.	Level controls solvent flow from D-515 to T-611.

TABLE 10.3

C-911 SHUTDOWNS

			<u>CONTROL SETTINGS</u>
1 - High	Discharge Pressure		275 psig
2 - Low	Suction Pressure		10 psig
3 - Low	Oil Pressure Differential		20 psig
4 - High	Discharge Temperature		220° F
5 - High	Oil Temperature		150° F
6 - High	Oil Temperature		60° F

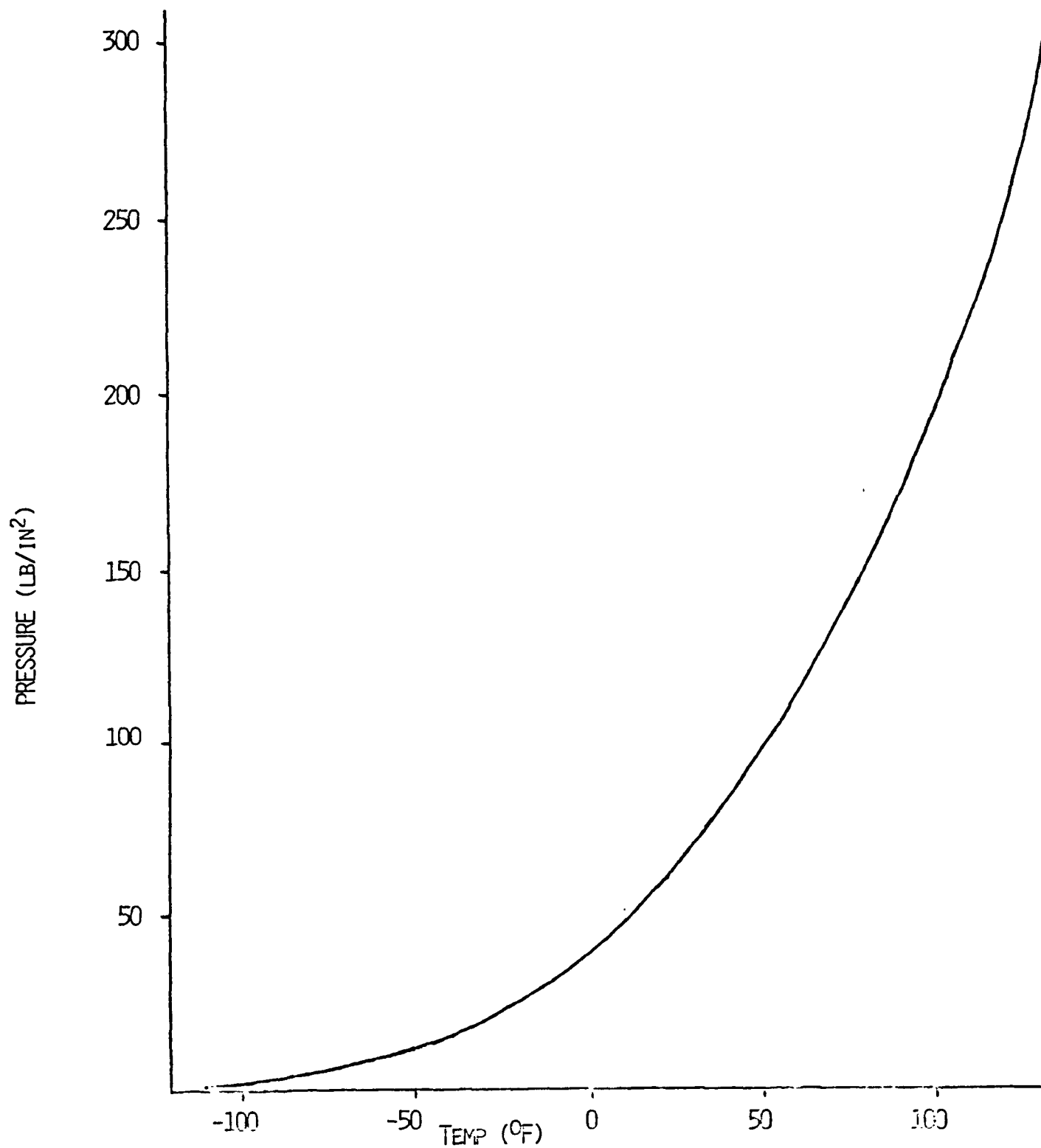


TABLE 10.4 TEMPERATURE VERSUS PRESSURE PLOT FOR FRECN 22

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TABLE 10.5

RADIATION SAFETY

DEVOLATILIZER LEVEL INDICATORS

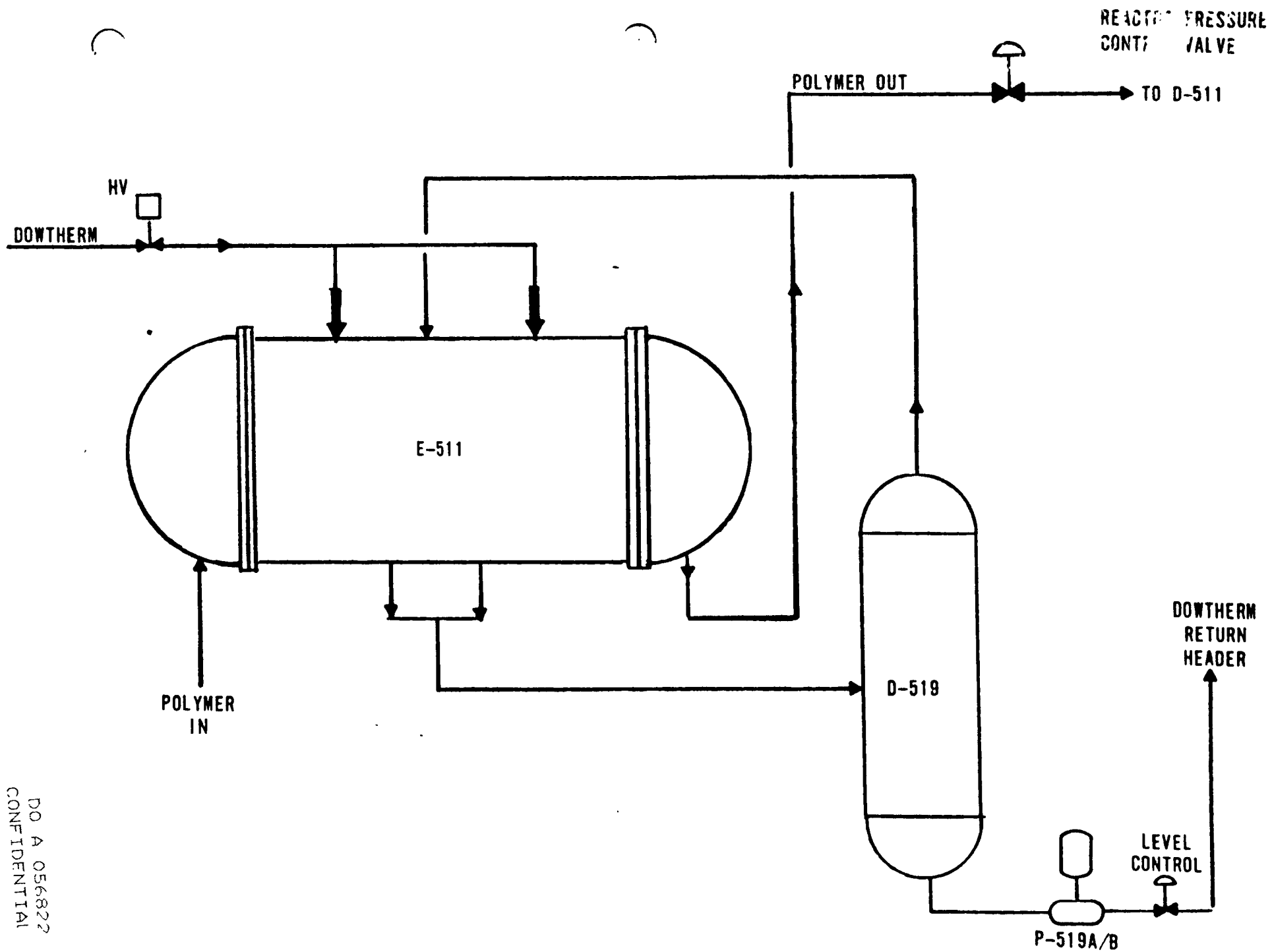
A. Routine

1. Within sixty days after installation and semi-annual intervals thereafter, an inspection of all devices containing radioactive material shall be conducted by the Radiation Safety Committee to determine the general physical condition of the device, proper shutter operation, and adequate posting of radiation caution signs.

B. Personnel Protection

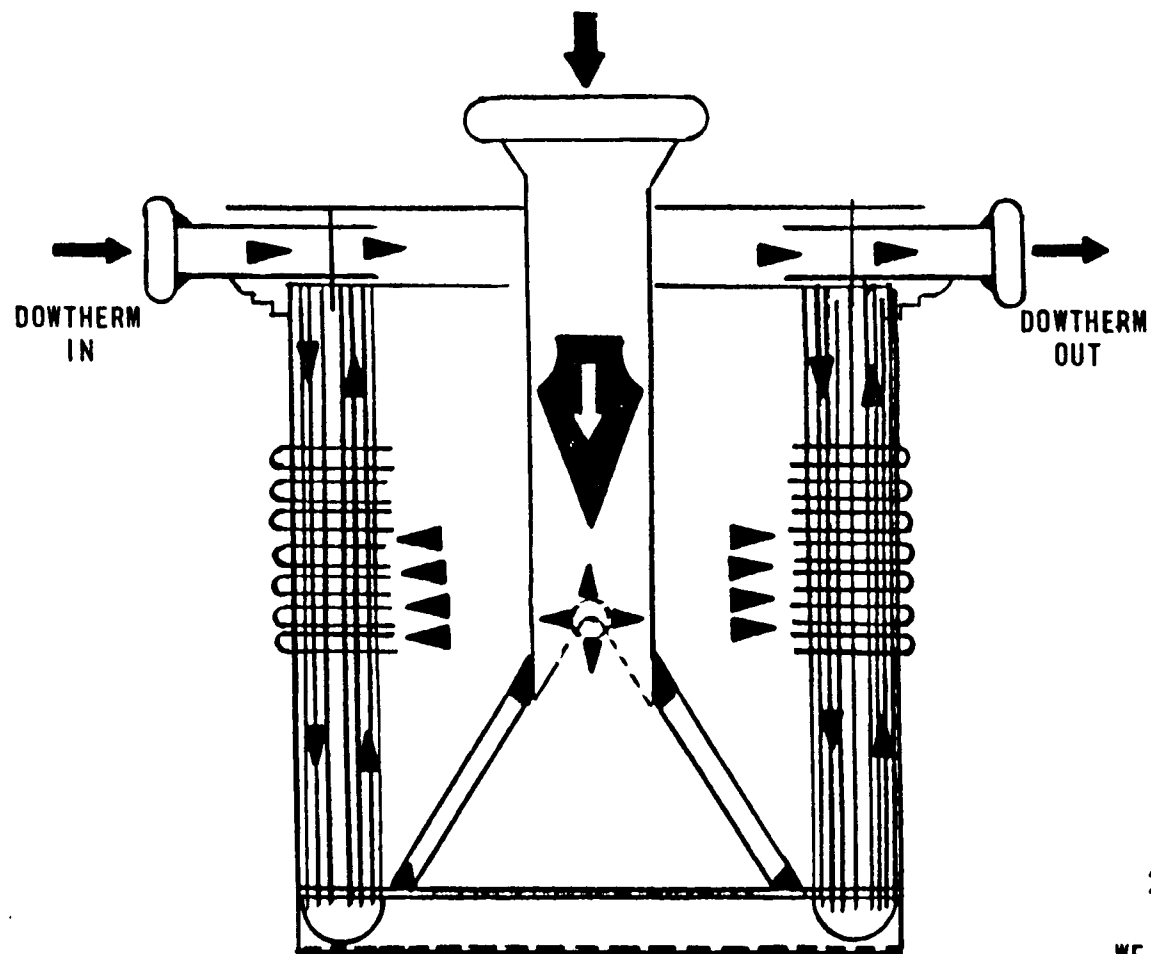
1. The source holder should be sealed locked and red tagged in the off or closed position when:
 - a. The radiation device is physically moved away from the vessel including instation, relocation or storage.
 - b. When individuals are working on or adjacent to a device during periods of shut down.
 - c. Whenever an individual enters a vessel on which a device is located.
 - d. Whenever a vessel or line is empty and an individual is working around the exterior of a vessel.

Our Radiation Safety Officer is: Henry Hopper
 Phone #1877
 Radio Page #8787-321



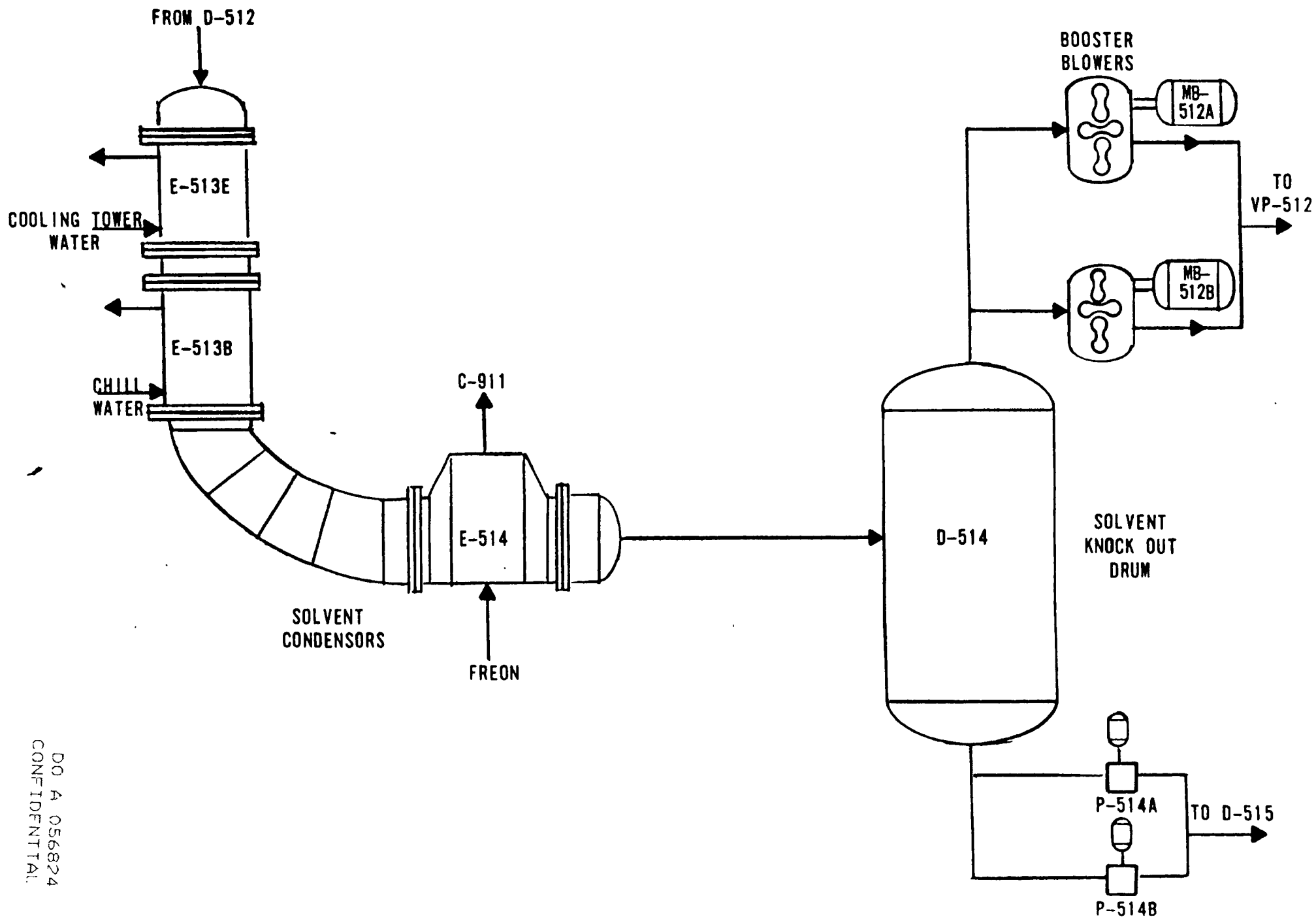
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FIG 10 1



26,000 PLATES
508 TUBES
WEIGHT 31,000 LBS.

E-512



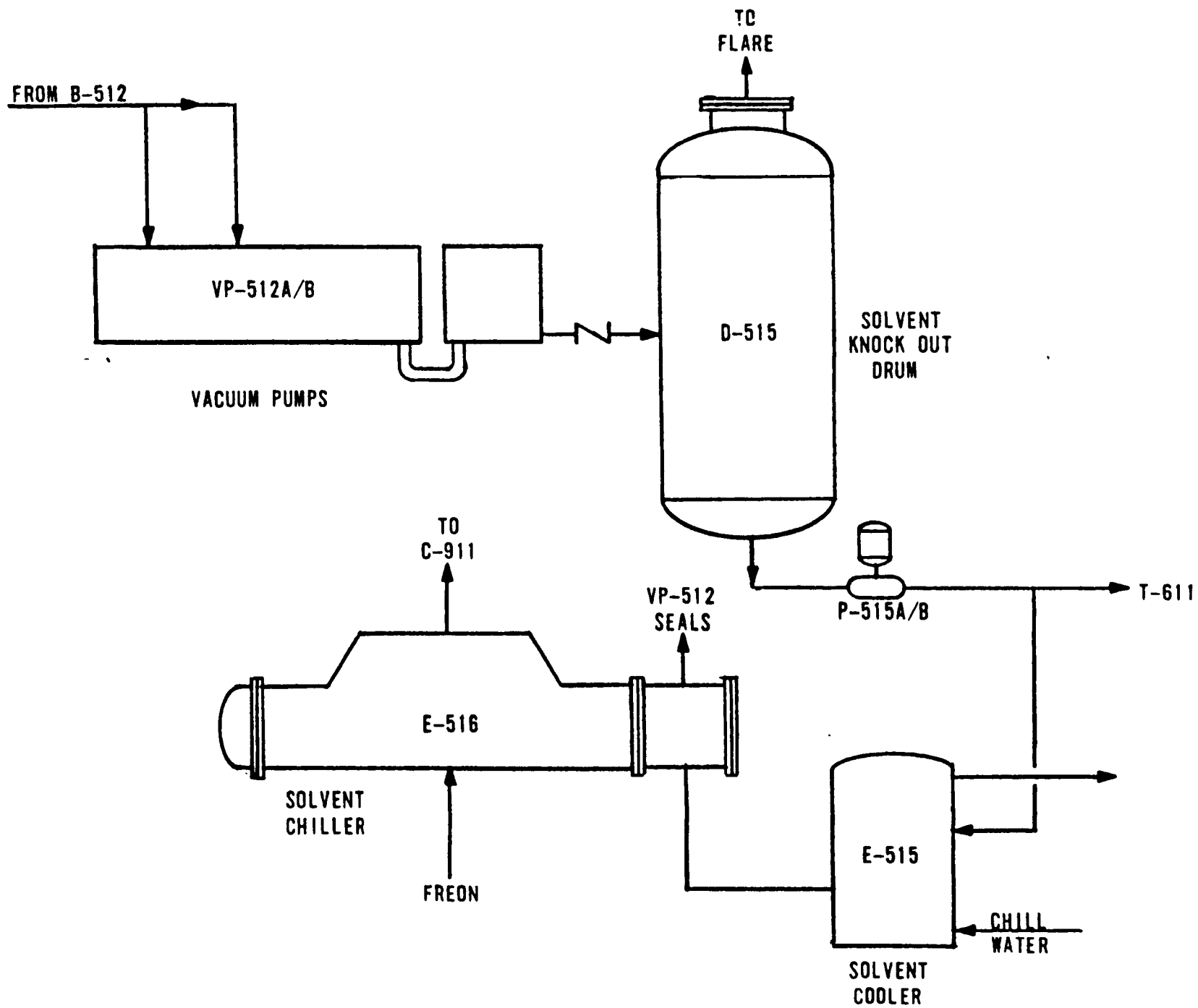
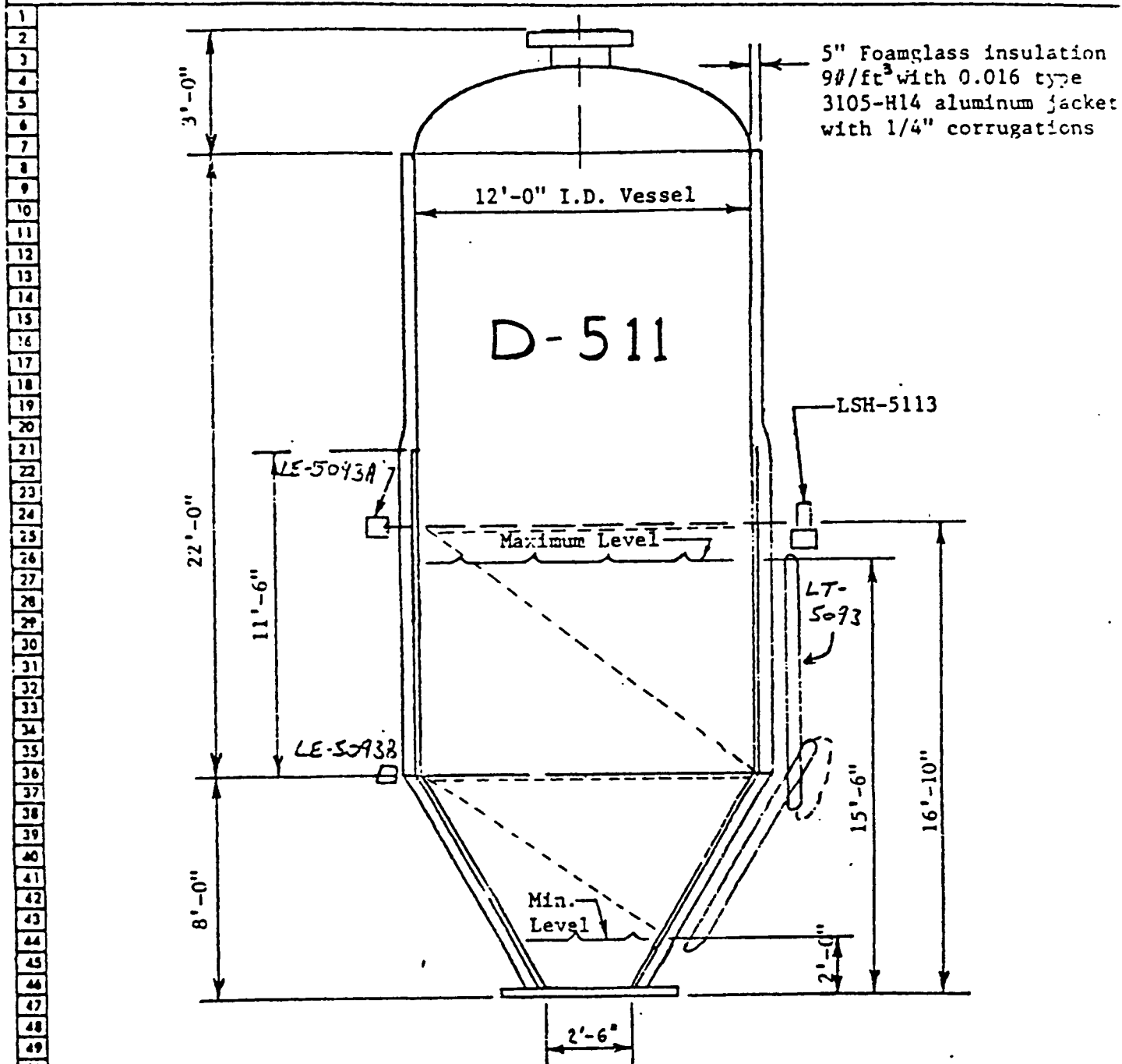


FIG. 10.4

FIGURE 10.5

PLANT 85	FILE/JOB NO. LA72269
LOCATION Louisiana Division	BLDG. NO.
MANUFACTURER	NO. UNITS
	B/M NO.
	P. O. NO. 56052B-72269-1



Notes:
(See next page)

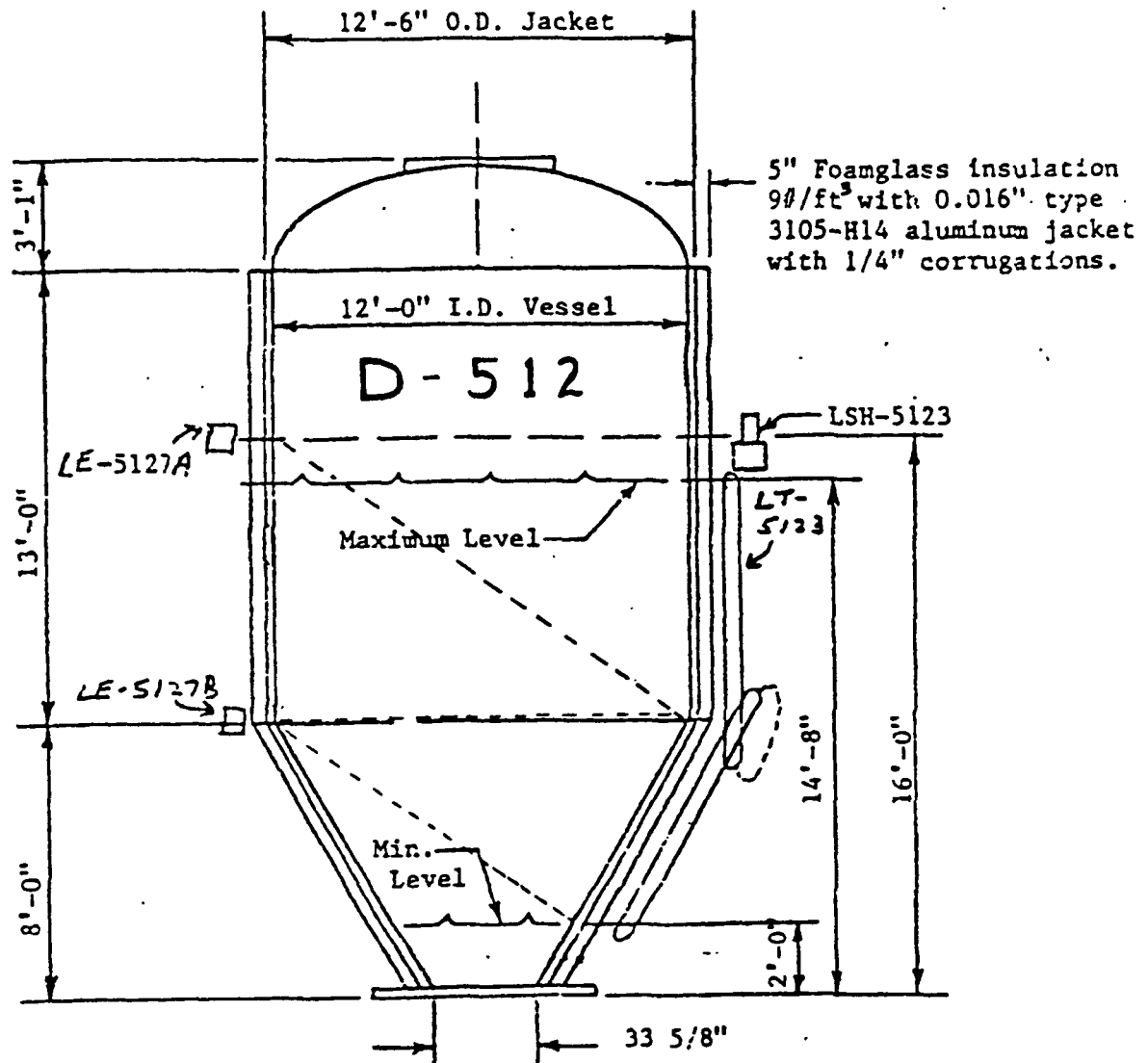
DO A 056826
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SPEC BY CPS	THE DOW CHEMICAL COMPANY	81-151/251	EQUIP. NO. D-511/521
CHECKED	SERVICE		
APP'D	Radiation Level Instruments		
REVISION DATE	1/24/65		

SPECIFICATIONS

FIGURE 10.6

PLANT	86	FILE/JOB NO.	LA72239
LOCATION	Louisiana Division	BLDG. NO.	CHARGE NO.
MANUFACTURER	Ohmart	NO. UNITS	B/M NO.
		P. O. NO.	S6052-72239

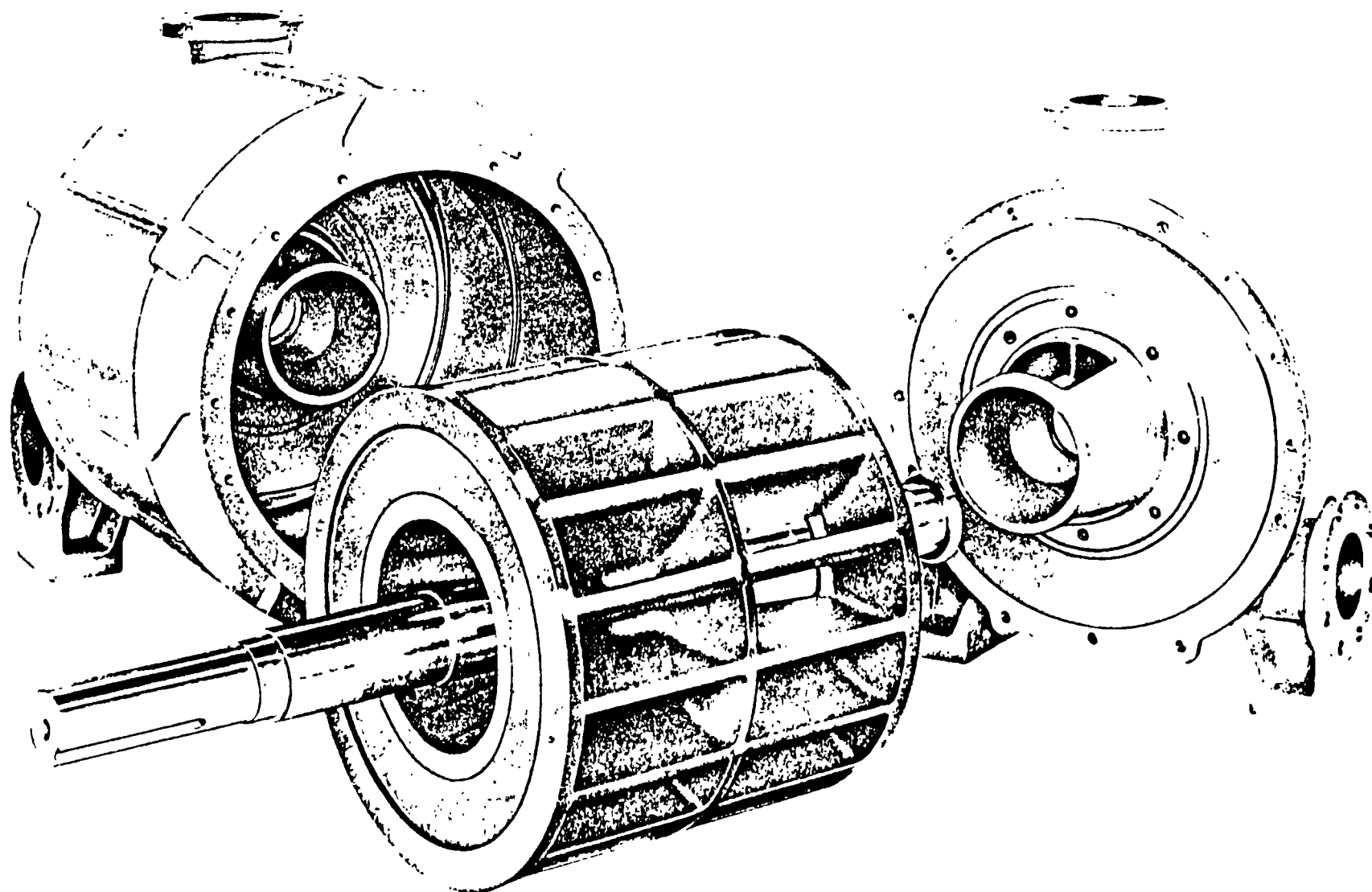


Notes:

- Vessel wall is SA-516-70 steel 5/8" thick on both the cone and straight side. The jacket is 4" SCH 40 SA106B half pipe on 5 1/4" pitch.
- Vessel contents molten polyethylene 0.92 specific gravity. Jacket contents Dowtherm A 0.81 specific gravity.
- Operating temperature vessel contents 482°F, jacket 572°F.
- Level devices will be mounted 8" from jacket wall. Vendor shall supply details of supports required on vessel.

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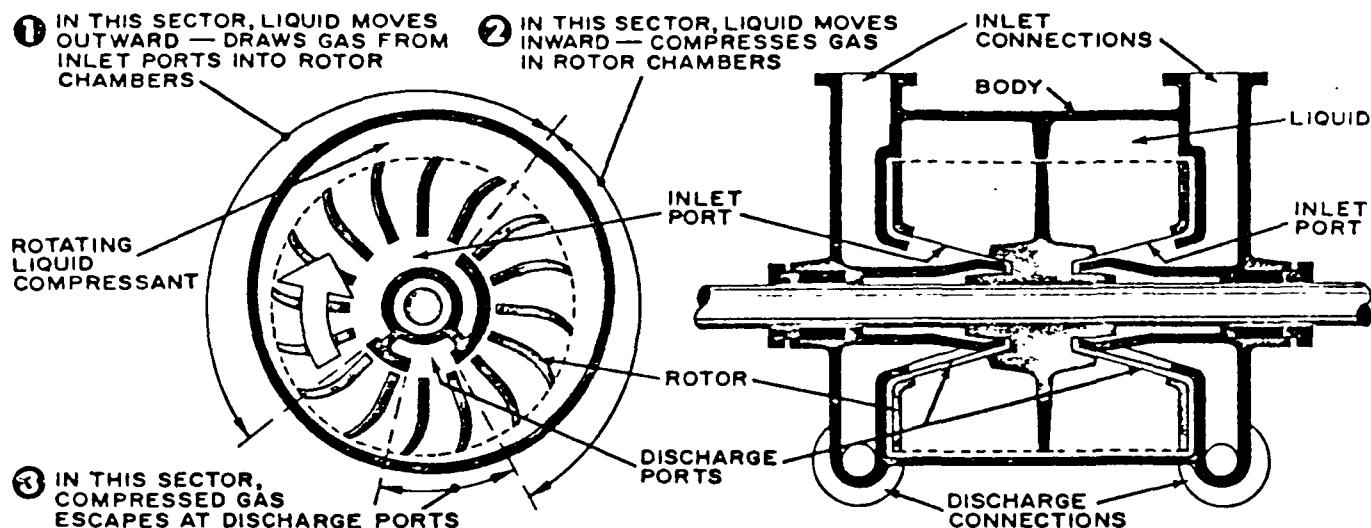
SPEC. BY	CPS	THE DOW CHEMICAL COMPANY			EQUIP. NO.
CHECKED		SERVICE			D-512/522
APP'D		Radiation Level Instruments			SPECIFICATIONS
DATE		REVISION	DATE	A	RAM 12-7-85
				B	
				C	
					SPEC.



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Jash® Type CL Vacuum Pump/Compressor

FIGURE 10.7



Functional schematic of Nash unit.

HOW IT WORKS

Disassembled view shows physical appearance of rotor, body and ported cones indicated on schematic.

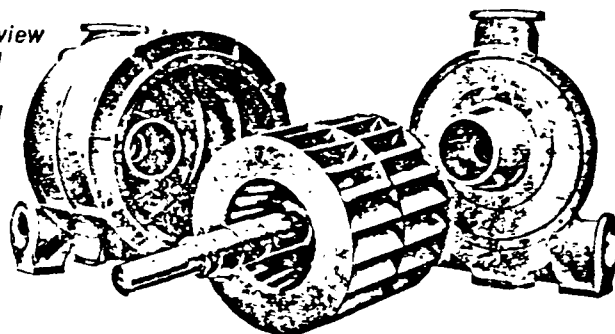


FIGURE 10.8

The Nash compressor or vacuum pump has only one moving part — a balanced rotor that runs without any metal-to-metal rubbing contact. Such simplicity is possible because all functions of mechanical pistons or vanes are actually performed by a rotating band of liquid compressant. While power to keep it rotating is transmitted by the rotor, this ring of liquid tends to center itself in the cylindrical body. Rotor axis is offset from body axis. As the schematic diagram shows, liquid compressant almost fills, then partly empties each rotor chamber during a single revolution. That sets up the piston action. Stationary cones inside the rotor blades have ported openings that separate gas inlet and discharge flows.

ABOUT LIQUID COMPRESSANTS

A portion of the liquid compressant flows through the Nash vacuum pump or compressor while it is operating. The liquid, which is discharged along with the compressed gas, is usually taken out by a separator in the discharge line.

Liquid compressant that accumulates in the separator may be discarded, and make-up liquid may be introduced to replace it. In a closed-circuit system, liquid compressant may be cooled in a heat exchanger and recirculated through the system.

Condensibles in the gas stream condense into the liquid compressant. The accumulation may be discarded — as in the case of water vapor condensed out of humid air.

Condensed liquid may also be recovered — as in the case of solvents drawn off during a drying operation.

Flow rate of the liquid compressant into a Nash vacuum pump or compressor is usually adjusted by a hand valve setting in combination with one or more fixed orifices. In a recirculated system, the Nash unit itself supplies pressure to maintain liquid flow. In a once-through system, the liquid should be supplied at a moderate, fairly constant pressure.

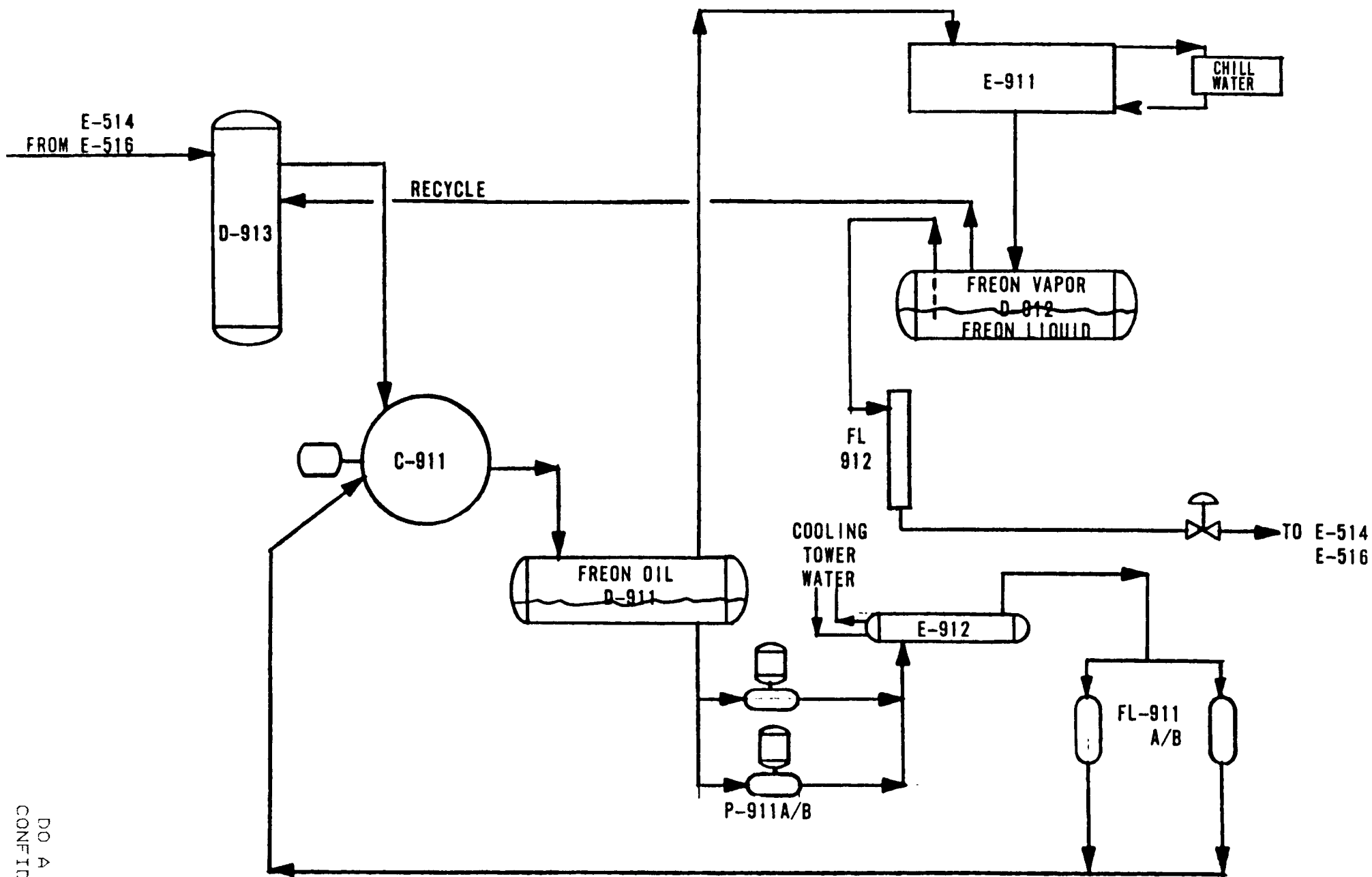
Water is the most common liquid compressant — an obvious choice, for example, if the gas being compressed or evacuated is air.

A number of other compressants are used in various chemical processing applications. The choice can

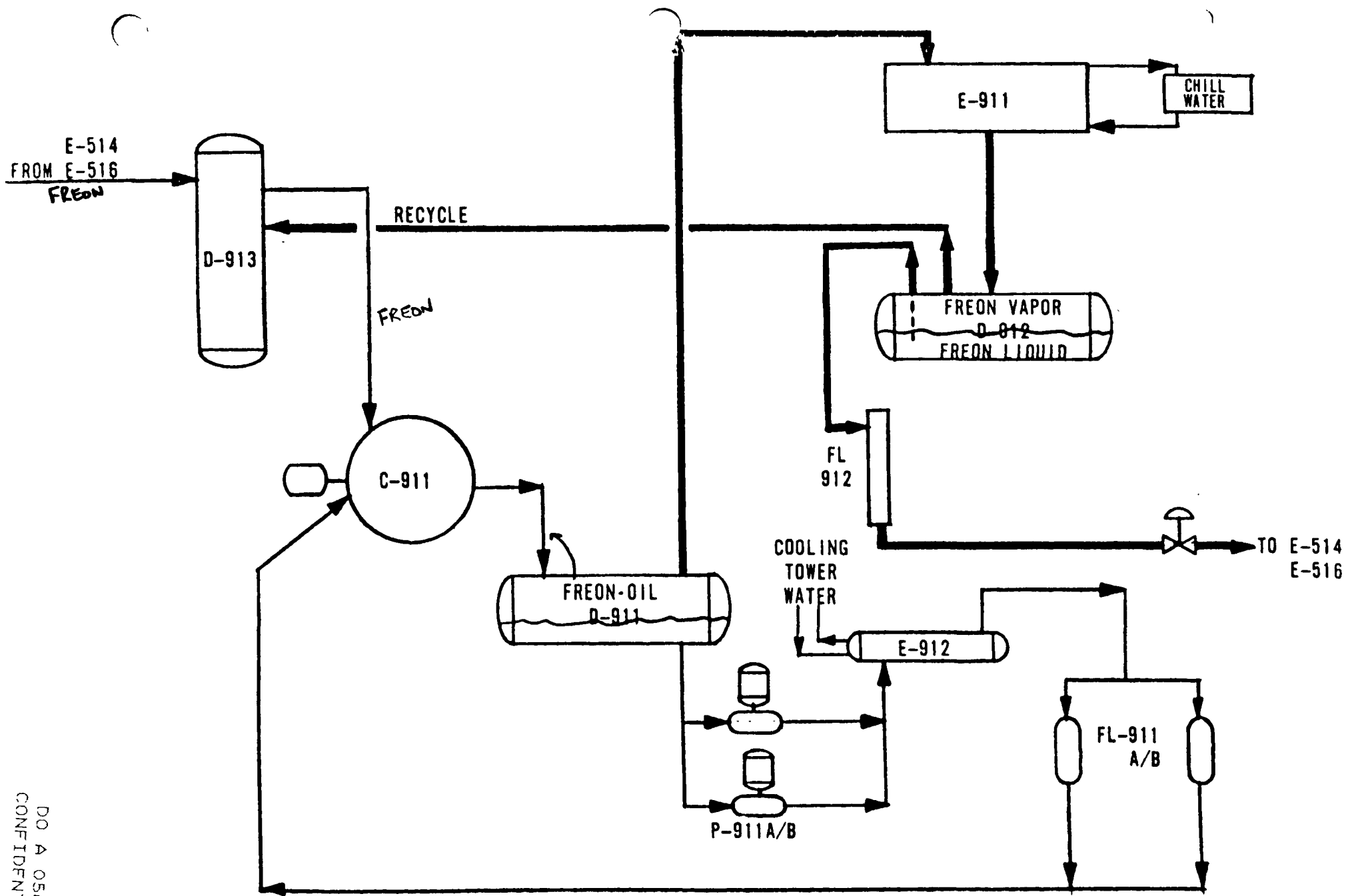
become a rather complex engineering problem. Nash applications engineers have a mass of operating data on file, and they can advise you about liquid compressants that have proved successful with a wide variety of gases.

Some of the considerations are compatibility with the gas, protection of equipment from corrosion, compatibility with any vapors to be condensed, vapor pressure, specific heat, specific gravity, viscosity and — of course — availability at a reasonable cost.

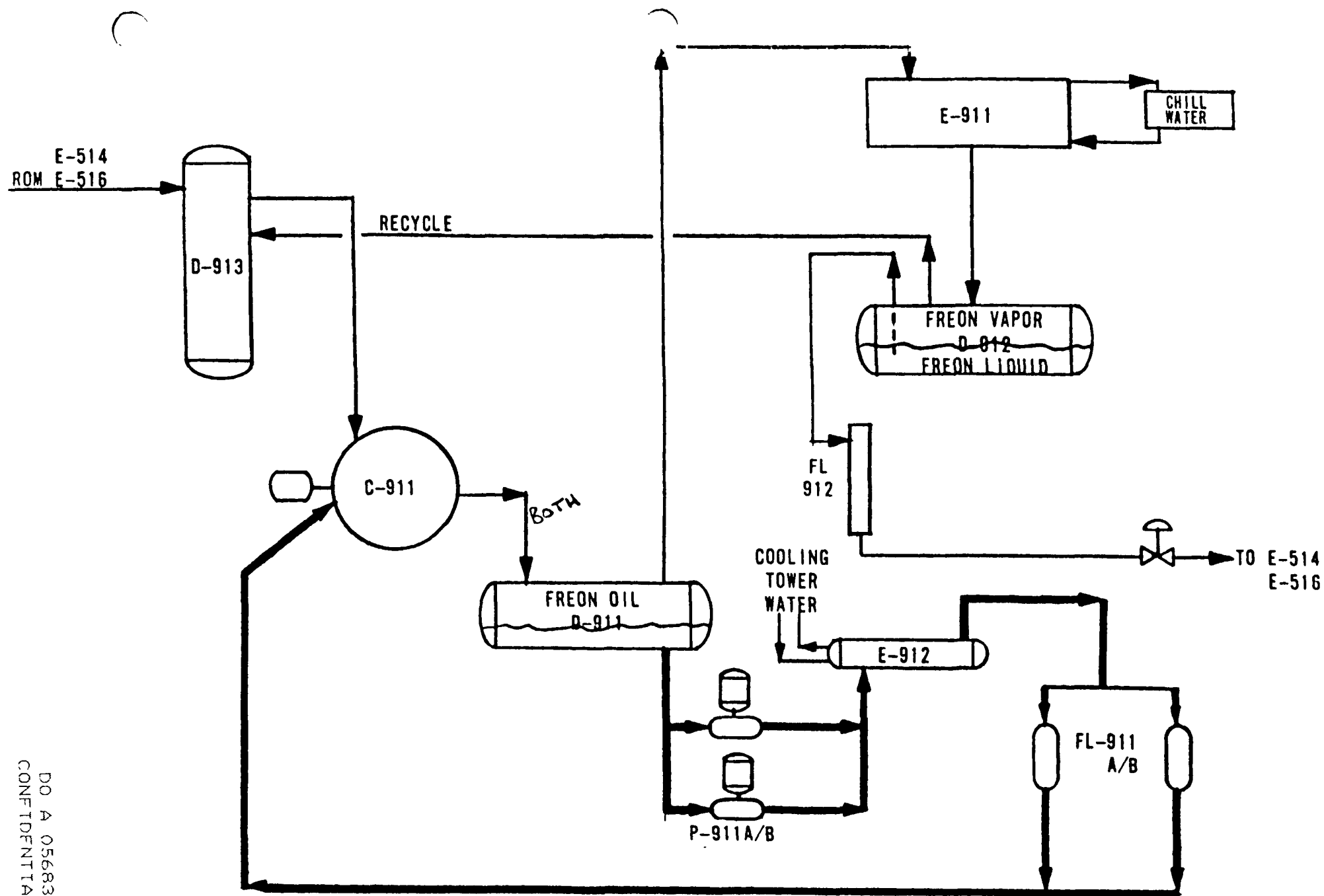
A combination of processing advantages can often be gained by selecting the best liquid compressant for a particular job, and this freedom of choice is one of the basic benefits that the Nash principle affords.



C-911



FREON FLOW FREON COMPRESSOR



OIL FLOW FREON COMPRESSOR

11. SOLVENT RECOVERY AND PURIFICATION

The recovery and purification of the solvent after it has been through the system is an important part of the plant operation.

11.1 RECOVERY

This portion of the plant is used to separate entrained polymer from the solvent (T-611), partially condense and cool the solvent while producing 15 psig steam in E-611, finish condensing the solvent in E-612, separate the ethylene from the solvent D-611, and mix in octene with the solvent. In normal operation solvent and unreacted ethylene vapors from D-511 enter the bottom of the scrubber column, T-611, where the vapors rise up through two sets of Monel Pall ring beds. The rings are kept wet by liquid solvent being pumped over them from D-611 using the P-611 A/B pumps through a flow control valve and also by P-613 A/B that takes suction from the bottom of T-611 for recirculation of the solvent. T-611 bottoms is level controlled through the control valve on the discharge of the pumps P-611 A/B.

A portion of the "bottoms" from T-611 is also pumped out by P-614 A/B through filters (FL-614) back to D-511. These filters help to reduce "specks" in the polymer. The P-614 A/B pumps take their suction from the discharge of the P-613 A/B pumps. Reboiler, RE-611, attached to the side of T-611, is a 235# steam heat exchanger that helps maintain the temperature and level in the bottom of T-611. Example: if the level in T-611 was too high, the reboiler (RE-611) steam control valve will start toward its open position to boil out more solvent from T-611. If the level continued to rise, the solvent flow from P-611 would cut back.

The clean solvent and ethylene vapor exits the top of T-611 and enters

the tube side of E-611. Condensate is being pumped into the shell side of E-611 for the cooling of the solvent with the condensate being boiled off as 15 psig steam.

The condensate level in E-611 is controlled by a control valve and has a direct relation between level and amount of steam being produced. The steam pressure is controlled by the condensate level.

Some of the condensate is blown down to the condensate storage tank (D-908) through a flow control valve to prevent an accumulation of solids in the shell side of E-611.

The 15 psig steam, generated in E-611, is utilized for tracing, to operate the ARU's, and for building heat.

If the steam pressure becomes too high the header will be vented through a pressure control valve to a fin-fan cooler E-908, on D-908 the condensate storage drum.

From E-611, the solvent and ethylene flow to an air cooled exchanger (E-612) for further cooling then to D-611. E-612 has a high vibration shut-down switch.

Octene analyzers are located at various points in the solvent flow path to analyze percent octene in the solvent. Octene is added, through a control valve, just down stream of the Y-611 A/B beds to compensate for what was consumed in the reactor. It is possible also to add octene to the suction of the P-612 A/B pumps. D-611 separates the liquid (solvent) from the vapor (ethylene) with the solvent being pumped out by P-612 A/B to E-617.

11.2 PURIFICATION

This portion of the plant includes D-611, the solvent-ethylene separation

tank, pumps P-612 A/B, filters FL-611 A/B, E-617, a cooling tower water exchanger, the silica gel beds Y-611 A/B, and the molecular sieve beds Y-211 A/B.

In normal operation solvent is pumped from D-611 by P-612 A/B through E-617, which will cool the solvent to a lower temperature so that any polymer still remaining in the solvent will come out of solution and can be removed in the FL-611 filters. The FL-611 filters are the cartridge type which are in a single removable bundle.

After passing through the filters the solvent flow through Y-611 (silica gel beds) then through Y-211 A/B (molecular sieve) and on to the suction of the P-211 A/B/C and back into the reactor to start the cycle over again.

P-211's are high speed Sundyne centrifugal pumps that rotate at 11,400 RPM with a capacity of 230 GPM at 650 psig discharge pressure. Normally two pumps will run at a time with one spare. A "Lark" three way check/bypass valve on the discharge of each pump maintains a minimum flow through them by sending some solvent back to D-611.

Y-611's have a recirculation line from the outlet of the beds back to D-611 to maintain a constant flow through them. This recirculation is flow controlled.

An important point is the level control of D-611. If a low level is reached in D-611 solvent will be made up from D-811, which is the solvent/monomer storage tank, through a control valve on the discharge of the P-811 A/B pumps. On the other hand, if the level in D-611 is too high a control valve on the discharge of P-612 A/B will dump solvent back to D-811. For monitoring the effectiveness of the Y-611's and the Y-211's, water analyzers have been installed before and after the beds. The water concentration is monitored by the computer.

11.3 SOLVENT SILICA GEL BEDS (Y-611 A/B)

The solvent silica gel beds Y-611 A/B are designed to reduce water impurities from 100 PPM to 2 PPM. Other unknown impurities are also removed. Flow direction is downward during absorption and all phases of regeneration. Temperature of the bed is designed to reach 260°C during the heating cycle.

Thermowells are located at the top, middle, and bottom of each bed which are monitored by the TDC 2000. During absorption the high temperature alarm is 100°C but during the heating and cooling cycle the high temperature alarm is 300°C. Regeneration will be supervised by the computer.

Any liquid that is removed in regeneration will be in the knockout pot YD-611. YD-611 is level controlled and will blow down any liquid to D-809 which is the waste solvent tank.

The nitrogen regeneration system for these units operate the same as for the Y-111's and the Y-112's. Padding out of the beds before regeneration is to D-611.

11.4 SOLVENT MOLECULAR SIEVE BEDS (Y-211 A/B)

The solvent molecular sieve beds are designed to reduce water impurities from 90 PPM to 2 PPM. Other unknown impurities are also removed. Flow direction is downward during absorption and all phases of regeneration. Temperature of the bed is designed to reach 290°C during the heating cycle.

Thermowells are located at the top, middle, and bottom of each unit which are monitored by the TDC 2000. During absorption the high temperature alarms is 100°C but during heating and cooling the high temperature alarm is 300°C.

The nitrogen regeneration system for these units operates the same as for the Y-111's and Y-111's. Padding out of the beds is to D-611.

Figures 11.1 and 11.2 are block diagrams of solvent recovery and purification.

TABLE INDEX FOR SOLVENT RECOVERY AND PURIFICATION

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
11.1	Control Loops For Recovery

FIGURE INDEX FOR SOLVENT RECOVERY AND PURIFICATION

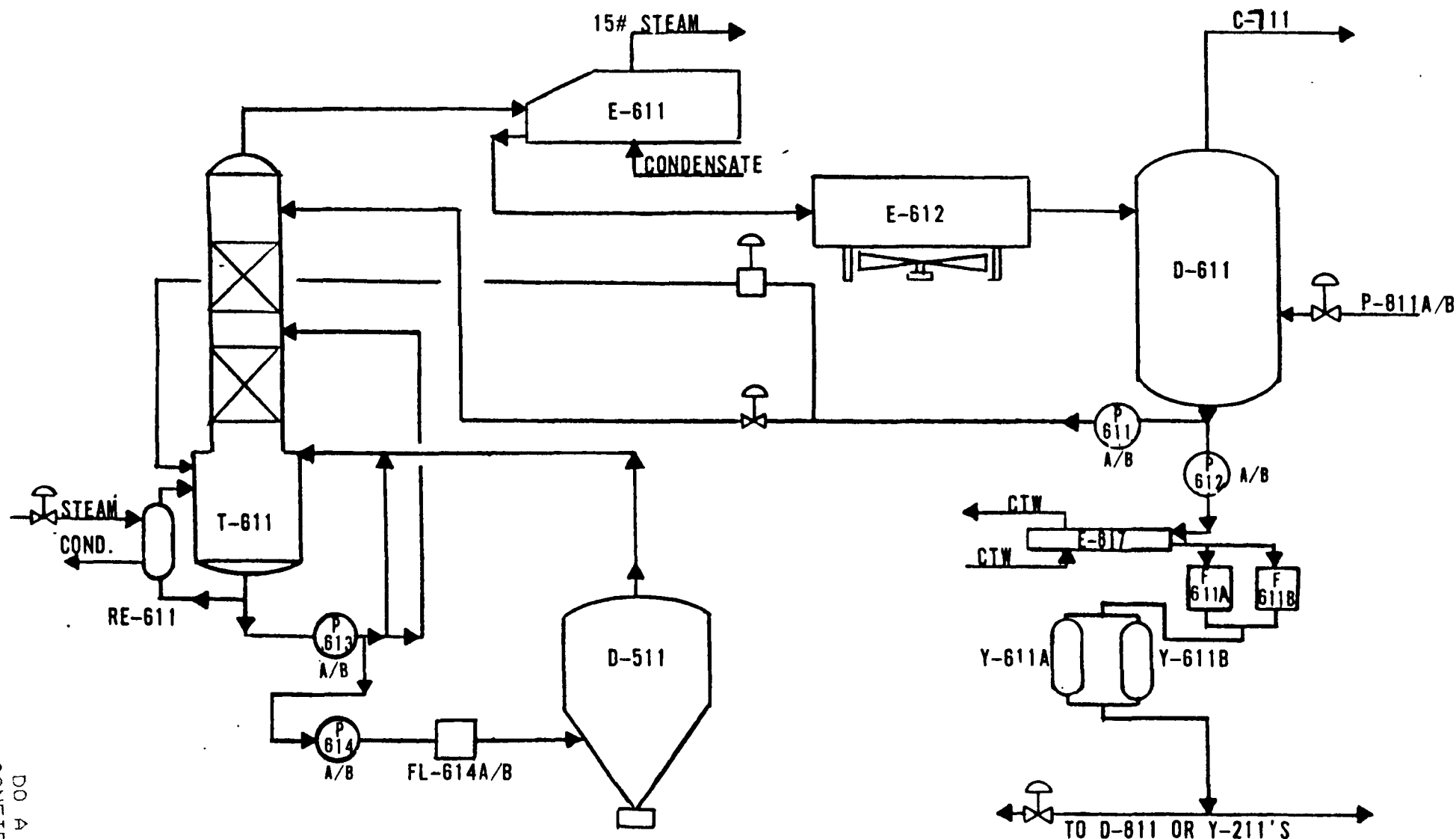
<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
11.1	Flow Path from T-611 to Y-611
11.2	Flow Path from Y-211 to E-211B

TABLE 11.1
CONTROLLERS SOLVENT RECOVERY

<u>LOOP NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
LIC-2195 Level Indica- tion & Control	To control the level in knock out pot YD-211	By opening blow down valve LV-2195 to the waste solvent tank D-809.
FIC-2214 Flow Indica- tion & control	To control the flow of hydro- gen to the ethylene feed stream.	By opening one of the two flow control valves FV-2214A or FV-2214B.
FIC-2227 Flow Indica- tion & control	To control the flow of sol- vent feed to the reactor.	By operating FV-2227. NOTE: the flow of solvent is dependent on the heat gener- ated in reactor.
FIC-6000 Flow Indica- tion & control	To flow control amount of sol- vent back to D-511 through FL-614's.	By operating the flow control valve FV-6000.
FIC-6002 Flow Indica- tion & Control	To flow control the amount of solvent being pumped by P-613 A/B to T-611 Rashing Bed.	By operating flow control valve FV-6002.
LIC-6009 Level Indica- tion & Control	To control ~~the~~ the level in T-611.	By operating ⁶⁰¹⁶ FV- ~~6009~~ on the discharge of the P-611's and controlling the steam valve ~~FV~~ -6009 on RE-611. LV
LIC-6036 Level Indica- tion & Control	To level control D-611	By opening a valve on discharge of P-811's to raise level LCV- 6036B and to open a valve dis- charge of P-612's to D-811 LCV-6036.

CONTROLLERS SOLVENT RECOVERY

<u>LOOP NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
LIC-6028 Level Indica- tion & Control	To control level/steam pres- sure in E-611.	By operating LV-6028 a control valve on the discharge of the P-908 A/B.
FIC-6027 Flow Indica- tion & Control	To maintain a blowdown flow on shell side of E-611 to prevent a sludge build up.	By operating FV-6027 a blow- down valve to D-908.
FIC-6063 Flow Indica- tion & Control	To maintain a minimum flow on the Y-611 A/B to D-611	By operating flow control valve FV-6063 during periods of low flow through the Y-611 A/B beds
LIC-6075 Level Indica- tion & Control	To blowdown the knock out pot on YD-611 regenerate system	By operating level control valve LV-6075 to D-809 the waste solvent tank.
FIC-8038 Flow Indica- tion & Control	To flow control the amount of octene being added to system.	By operating flow control valve FV-8038. The set point of this controller is deter- mined by the octene analyzers in the system.



SOLVENT RECOVERY

FIG. 11.1

12. ETHYLENE RECYCLE COMPRESSION

This portion of the Dowlex process is used to compress the unreacted ethylene from the reactors after it has passed through the devolatilization and solvent purification systems. The compressed ethylene is then sent back to the Light Hydrocarbon plant for cleanup.

Unreacted ethylene gas is separated from the liquid solvent in D-611 and flows overhead to D-711. From there, the ethylene flows through the compressor first stage suction knockout bottle, into and out of the first stage of the compressor, into the first stage discharge bottle, through E-711 which is the discharge cooler and into D-712. At this point, the ethylene is at 89 psig. Any liquid accumulated in the bottom of D-711 is pumped to D-809 using D-711.

From D-712, the ethylene flows into and out of the second stage of the compressor, into the second stage discharge bottle, through E-712 and into D-713. At this point, the ethylene is at 265 psig. From D-713, the ethylene flows into and out of the third stage of the compressor, into the third stage discharge bottle, then to the ethylene recycle line. At this point the ethylene is at about 733 psig which is high enough pressure to get into the recycle line to the Light Hydrocarbon plant. This pressure will vary depending on the LHC system pressure.

Each stage of the compressor has a discharge bottle and the purpose of these suction and discharge bottles is to dampen the pulsations caused by the reciprocating compressor and to remove condensed solvent.

The liquid level in D-711 is level controlled by a level controller and P-711 which comes on and shuts off automatically depending upon the level. The liquid level in D-712 and D-713 is level controlled by a level control valve. The liquid in D-712 and D-713 is padded out using their drum pressure,

to D-711. If there were a malfunction in this system or a large surge of liquid, a high level switch on D-711 will trip the recycle compressor (C-711).

The first stage suction bottle is drained continually to D-711.

D-711 pressure is primarily controlled by the speed of C-711.

If the pressure in D-711 gets too high a control valve in the inlet line from D-611 will open relieving the pressure to the vent collection system. This would occur after the compressor is at maximum speed. If the pressure gets too low a control valve in the outlet line from C-711 will open allowing ethylene in. This would occur when the compressor is at minimum speed. A third suction pressure controller set lower than the other two, controls ethylene from D-111 to D-711. If the pressure gets too low a low pressure switch will trip C-711.

D-711 is equipped with high and low pressure and high and low level alarms. There is also level pressure and temperature indications.

D-712 and D-713 are equipped with a high level alarm and pressure, level and temperature indications.

The exchangers E-711 and E-712 are used to reduce the temperature of the ethylene after it has heated up due to compression of the gas in the first and second stages. The third stage discharge does not have a cooler. Cooling tower water is used as a coolant in E-712 and E-713.

A portion of the recycled ethylene can go back into the system at D-111 and the remainder goes to the Light Hydrocarbon plant.

12.1 C-711

C-711 is an Ingersoll-Rand reciprocating compressor. It is direct coupled

to by a 350 hp AC motor with variable frequency speed control. The minimum speed is 125 RPM and maximum speed is 500 RPM. C-711 is designed to pump 4600 pounds of ethylene per hour with 10 psig first stage inlet pressure.

There are three stages to C-711, first stage, second stage, and third stage. On the discharge of all three stages there is a pressure and temperature indication, with a high temperature alarm, and a high temperature switch that will shut C-711 down should each stage discharge temperature exceed the maximum operating temperature of 120°C.

C-711 has a low pressure shut down on the lube oil system for crankcase. The compressor cylinders, have a force feed lubrication system. This is to avoid damage to the compressor due to excessive heat.

The discharge pressure of C-711 is determined by the pressure of the Light Hydrocarbon's ethylene recycle system. To keep C-711 from exceeding its designed pressure a safety relief valve is installed in the discharge line. A discharge pressure control valve is used to maintain a differential between both C-711 and C-721 and the line to LHC. This valve will prevent back flow.

In order to reduce ethylene losses to the atmosphere and for ecological and safety reasons, the packing gland vent line for each stage is vented back to the first stage suction. The distance pieces are open to the atmosphere.

The compressor itself is water cooled including the cylinders, packing areas, end pieces, and the oil cooler with cooling tower water.

In case there is any problem C-711 can be shut down from the control room but must be started in the field. There is a high vibration switch that will shutdown C-711 as well.

TABLE INDEX FOR ETHYLENE RECYCLE

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
12.1	Loop Controls
12.2	C-711 Data and Performance
12.3	C-711 Electric Motor Data and Characteristics
12.4	C-711 Trips and Alarms

FIGURE INDEX FOR ETHYLENE RECYCLE

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
12.1	C-711
12.2	Ethylene Recycle Compression Flow
12.3	C-711 Expected Performance
12.4	C-711 Crankcase
12.5	C-711 Compression Cylinder

TABLE 12.1

LOOP CONTROLS FOR THE ETHYLENE RECYCLE SYSTEM

LOOP CONTROL NUMBER	PURPOSE	OPERATION
PIC-7003	Pressure controller for D-711.	Increase or decrease speed of C-711 to control pressure on D-711.
PIC-7020B	Control of low suction pressure.	Opens allowing discharge flow into D-711.
PIC-7024	Secondary pressure controller for D-711.	Opens allowing ethylene into D-711 after C-711 has reached low speed.
PIC-7024	Secondary control for high suction pressure.	Opens allowing ethylene to the vent collection header after C-711 has reached high speed.
LIC-7036	Level controller for D-712.	Opens or closes allowing liquid back to D-711 depending on level.
LIC-7042	Level controller for D-713.	Opens or closes allowing liquid back to D-711 depending on level.

TABLE 12.2

INGERSOLL-RAND

- OPERATING CHARACTERISTICS AND GENERAL DATA -

GAS COMPRESSORS

COMPRESSOR TYPE: 16" & 7½" & 4-3/4" X 9" 2HSE-3

CYLINDER DATA AND PERFORMANCE (U.S. CUSTOMARY UNITS)

Service	RECYCLE ETHYLENE COMPRESSORS					
Stage	1		2		3	
Cylinder or Liner I.D. (in.)	16		7½		4 3/4	
Stroke (in.)	9		9		9	
Cylinder Type	DA		DA		DA	
Cylinder Pattern Number	N-22121		F-25900		F-26174	
Liner Thickness (in.)	½		½		3/8	

Percent of Full Load	100		100		100	
Intake Pressure (psig)	10.05		84.9		253.5	
Intake Temperature (°F)	107		107		107	
Discharge Pressure (psig)	89.1		264.7		733	
Discharge Temperature (°F)*	261		220		228	
Piston Displacement (cfm)	1039.02		213.73		84.11	
Capacity at Inlet (cfm)	671		162.1		56.77	

Dry Pounds Per Hour	4635		4635		4635	
---------------------	------	--	------	--	------	--

BHP per Stage	148		98		96	
Total BHP	342					
RPM	500					
Barometric Pressure (psiA)	14.7					

* Discharge temperature is estimated as an adiabatic rise.

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INGERSOLL-RAND.
GAS COMPRESSORS

- OPERATING CHARACTERISTICS AND GENERAL DATA -

ELECTRIC MOTOR DRIVER

Make & Type FUJI ELECTRIC COMPANY OF AMERICA

BHP 350 **kW** 261 **RPM** 150 to 500 **Voltage** 575

Phase 3 **Frequency** 60 Hz **Power/Service Factor** 1.0

Special Features EXTERNAL COOLING FAN, CLASS F INSULATION, 80°C RISE BY

RESISTANCE OVER 40°C AMBIENT, STATOR RTD'S, SOLEPLATE

LOW SPEED COUPLING (IF USED) THOMAS 550 CMR

HIGH SPEED COUPLING (IF USED) NONE

GEAR REDUCER MAKE & MODEL (IF USED) NONE

TABLE 12.3

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TABLE 12.4

C-711 TRIPS

1. Vibration trips at _____ g.
2. C-711 low oil pressure trips at 20 psi.
3. High discharge temperature's trips at 120°C. (1st, 2nd, and 3rd stages)
4. Low suction pressure trips at 3 psi.
5. D-711 high level trips at 85%.
6. MC-711 high temperature trips at 125°C.
7. MC-711 high current trips at _____ amps.

C-711 ALARMS

1. D-711 high and low level.
2. C-711 low oil pressure.
- 3.
- 4.
5. High discharge temperature on all three stages.
6. C-711 low suction pressure.
7. D-711 pressure high and low.
8. C-711 high and low speed.
9. MC-711 high temperature.
10. MC-711 high cooling water level.
11. D-712 high level.
12. D-713 high level.

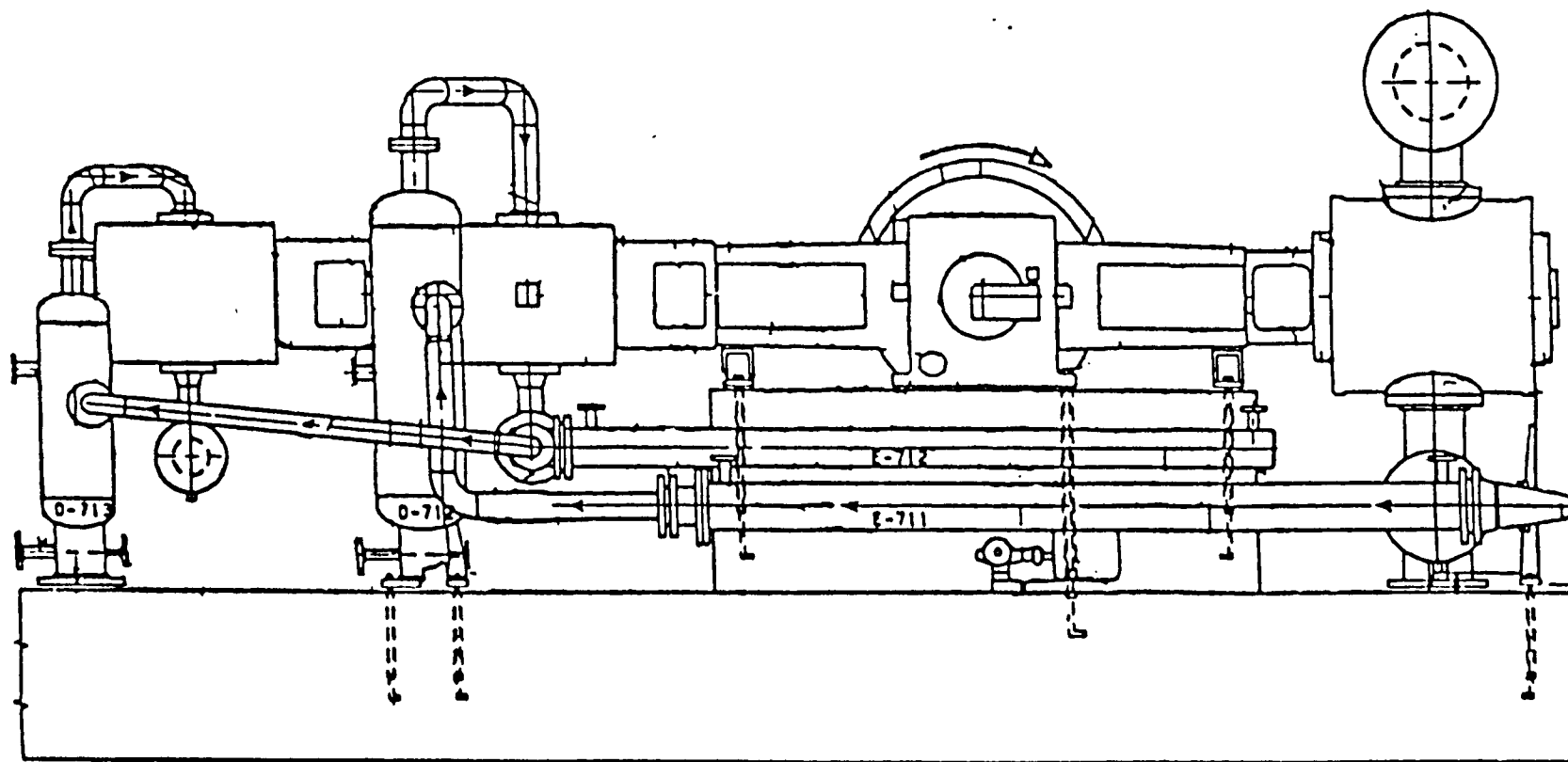
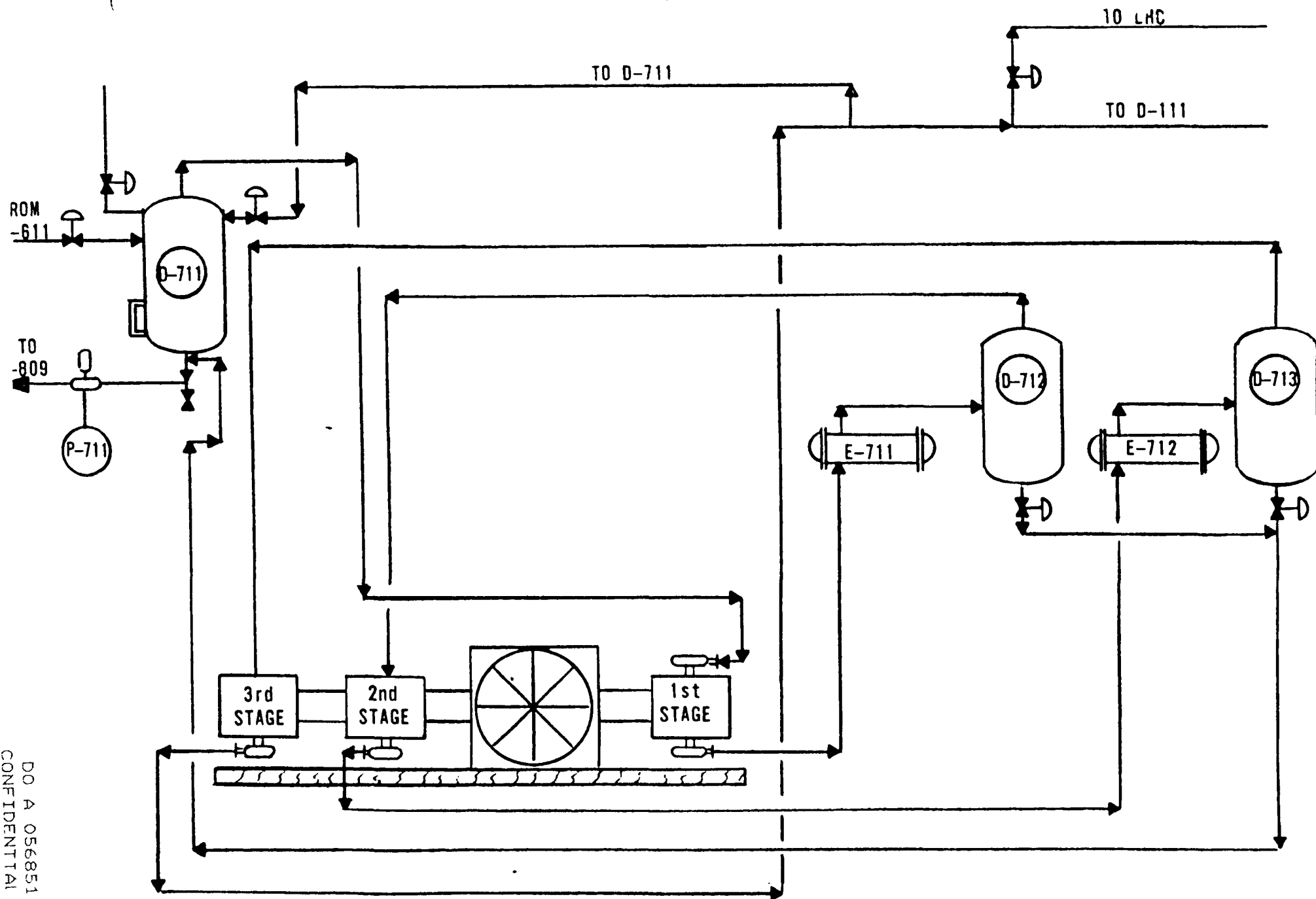
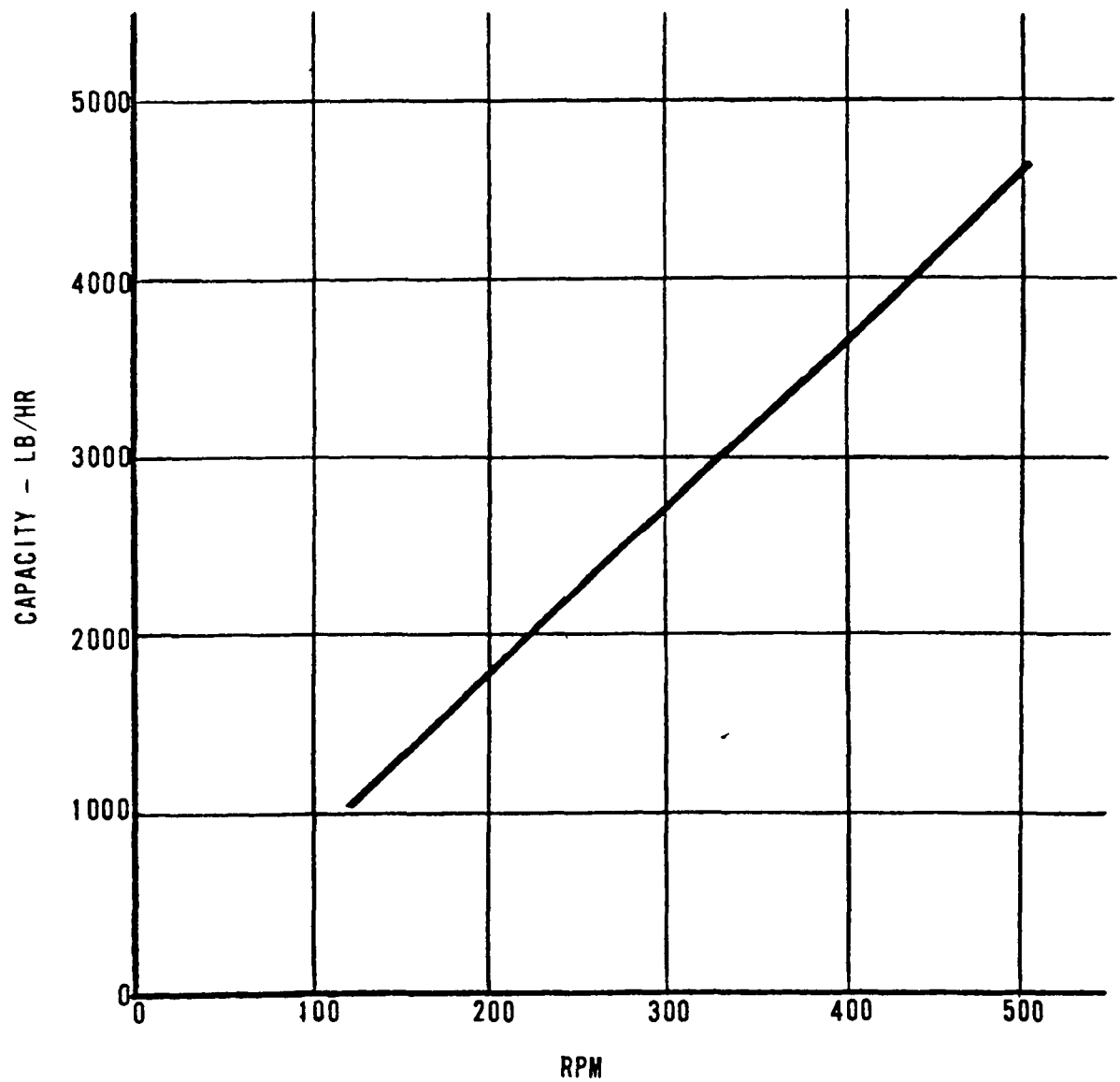
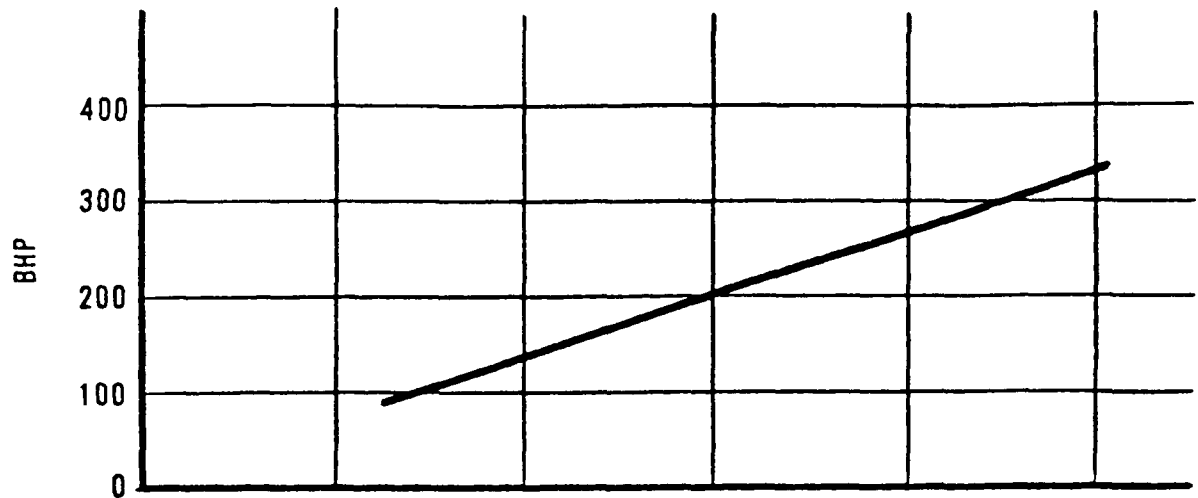


FIGURE 12.1 C-711



ETHYLENE RECYCLE COMPRESSOR

EXPECTED PERFORMANCE
C-711&721 RECYCLE



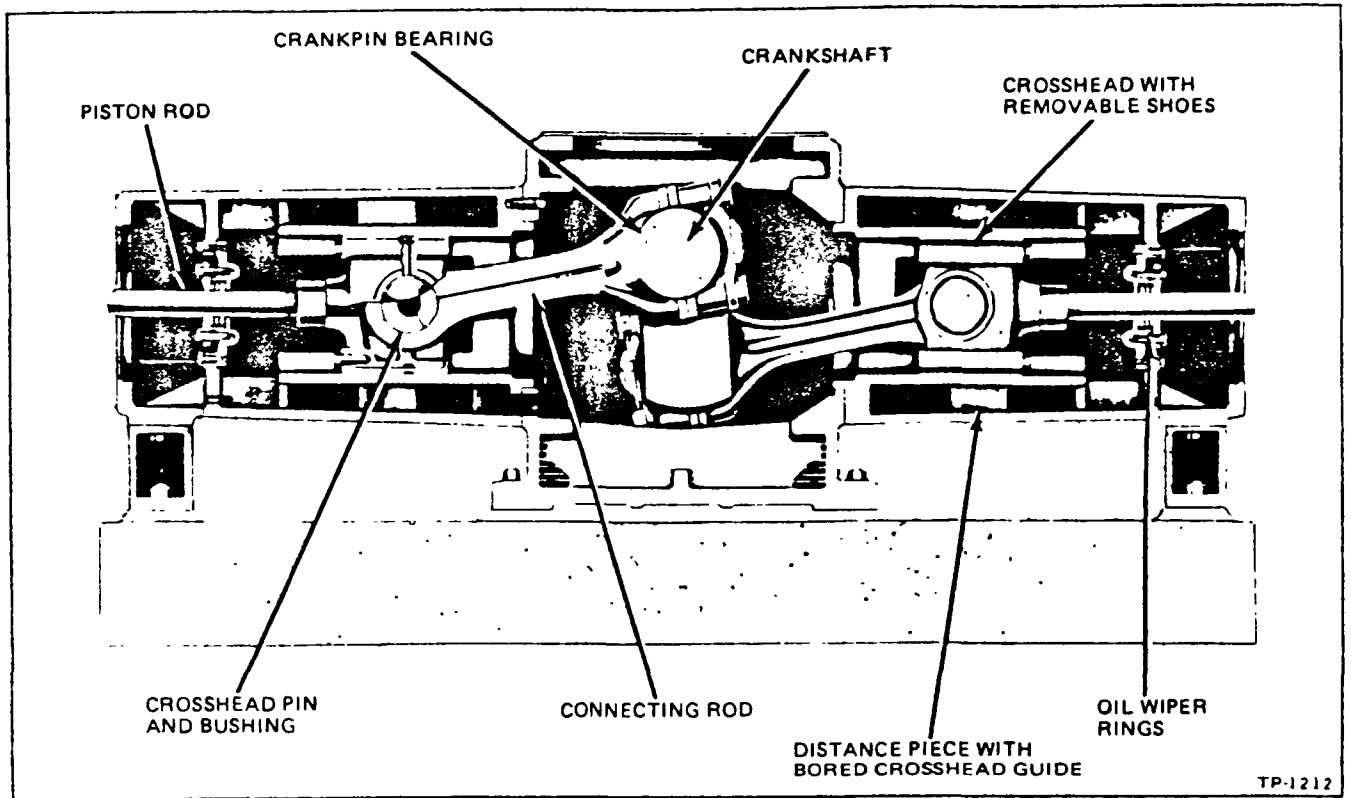


FIGURE 12.4 C-711 CRANKCASE

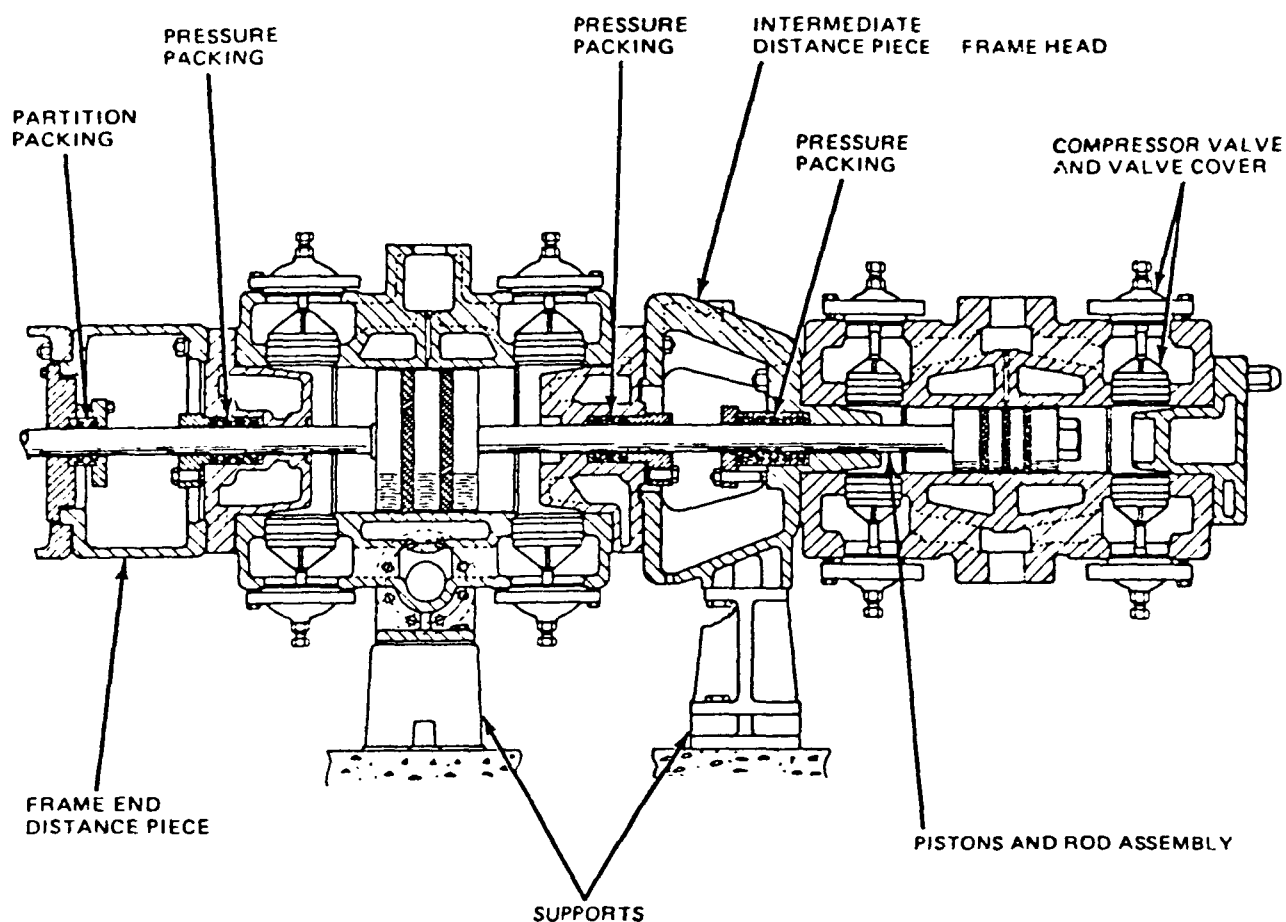


FIGURE 12.5 C-711 COMPRESION CYLINDER

13. SOLVENT AND OCTENE STORAGE

In the Dowlex process a large amount of solvent, (Isopar E) is used. The main function of solvent is to absorb heat from the reaction and be the carrier for the ethylene polyethylene and catalyst. It will take approximately 5 pounds of solvent per pound of ethylene to absorb the heat generated during the reaction process.

13.1 SOLVENT STORAGE

Solvent is received by tank car or tank truck and is stored in D-801 which will hold 24,000 gallons. D-804 (sometimes referred to as the swing tank) can also be used to store solvent. D-804 can also be used for waste solvent (Section 13.5) or for a solvent and octene mixture coming from D-611. This is how it gets the name swing tank.

The safety equipment for these two vessels (D-801 and D-804) are identical. They consist of level indications, low and high level alarms, and pressure indications with a low pressure alarm. To keep the pressure from getting too low or under vacuum, a nitrogen pad has been installed. They also have two pressure relieving devices to prevent the vessels from over pressuring. One device is a pressure-vacuum relief valve (PVRV) relieving to the vent header at 12 inches water or from the atmosphere at 2 ounces vacuum and another larger emergency relief valve (ERV) relieving at 24 inches water to the atmosphere.

Other equipment associated with D-801 is P-806 A and B, P-801 and Y-801.

Solvent is pumped from tank cars or tank trucks using P-806 A or B directly to D-801 or through Y-801 which is designed to remove water in the

solvent from 50 parts per million using silica gel. (See Fig. 6.6) The regeneration procedure is the same as Y-611's. Section 24.2 shows analyzers in this area.

If a tank truck or car has to be unloaded while Y-801 is in the regeneration cycle, the solvent is unloaded directly to D-801. When Y-801 has completed the regeneration cycle, the solvent in D-801 is then recirculated through Y-801. As optimum flow is required through Y-801 in order for moisture adsorption to be accomplished, therefore a flow control valve has been installed in the recycle line back into D-801.

P-801 is used to recirculate solvent through Y-801 and also supply the different areas of the plant such as to D-305, D-311, D-312, D-804, D-811, and P-311's.

13.2 OCTENE STORAGE

Octene is received by tank car or tank truck and is stored in D-802 or D-803, which will hold 129,000 gallons or 5 tank cars each.

P-806 A or B is used to pump the octene from the unload station through Y-802 to D-802 or D-803. Y-802 is a silica gel bed (See Fig. 6.6 for capacity). If Y-802 is being regenerated the octene is unloaded directly to D-802. When Y-802 has completed the regeneration cycle, (which is the same as Y-611's), octene in D-802 is then recirculated through Y-802 using P-802 A or B back to D-802 or D-803.

An optimum flow is required through Y-802 in order for moisture absorption to be accomplished therefore a flow control valve has been installed in the recycle line to D-802 or D-803 to maintain the minimum flow. Section

24.2 shows analyzers in this area.

Octene is pumped from D-803 using P-803 A or B to the inlet of Y-211's for further drying and to be mixed with the solvent-octene mixture coming from Y-611's.

The amount of octene added depends on the amount needed for the correct octene percent in the solvent for the density target. This percent of octene in the solvent as determined by the on stream analyzer is controlled by the computer depending on the density required.

The safety equipment for D-802 and D-803 are identical. They are equipped with low and high level alarms, level and pressure indications, and a low pressure alarm. A nitrogen pad has been installed to keep air from entering the vessels.

D-802 and D-803 also have two pressure relieving devices to prevent the vessels from over-pressuring or to prevent a vacuum on them.

One device is a pressure vacuum relief valve (PVRV) relieving to the vent collection header at 12 inches of water and from the atmosphere at 2 ounces of vacuum, the other is a larger emergency relief valve (ERV) relieving to the atmosphere at 24 inches of water.

13.3 SOLVENT/OCTENE MIXTURE

In the Dowlex process ethylene is dissolved in a solvent/octene stream before it enters the reactor. After these components have gone through the reaction process, the solvent and unreacted octene are returned to D-611. Any accumulation of solvent in this solvent 'loop', from catalyst addition or solvent content in the fresh octene (2-3%), will cause D-611 level to continually increase. The excess solvent is returned to D-811. If for some reason the

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level in D-811 gets too high this solvent/octene mixture can go to D-804 (swing tank) or D-809 (waste solvent). If the level gets too low, solvent can be added from D-801.

13.4 WASTE SOLVENT

In the Dowlex process some of the solvent gets badly contaminated with moisture or other impurities such as, C-711 interstage solvent and regenerated solvent. This solvent can no longer be used and must be disposed of. It is sent to D-809 which is referred to as the waste solvent tank. D-809 is also used for 'killed' catalyst and solvent from D-308. (Excess solvent from D-811)

Waste solvent is loaded on tank trucks for shipment and sold.

The safety equipment and alarms for D-809 and D-811 are identical to the safety equipment and alarms on D-801, D-802, D-803, and D-804.

The pressure vacuum relief valves (PVRV) on these vessels are dual acting. The valves relieve positive pressure to the vent collection header. They are also capable of relieving on a negative pressure or vacuum by equalizing the vessel pressure with the atmosphere.

13.5 SOLVENT LOADING AND UNLOADING

Solvent and octene are received by tank truck or tank car. A tank truck is unloaded from the bottom. To prevent air or a vacuum in the tank truck a nitrogen line, open on one end, is attached to the tank truck to maintain atmospheric pressure on the tank and also provide a nitrogen atmosphere. The same applies when loading a tank truck, except the nitrogen line provides a means of venting the tank truck above ground level.

A tank car is unloaded from the top. A nitrogen pad is used to pressure

the solvent or octene to the pump suction, and to displace the liquid as it is taken out to prevent a vacuum on the tank. The nitrogen pad for the tank cars are pressure controlled by a pressure control valve to about 50 psig to prevent the tank from over pressuring and as a safety device a pressure safety valve is installed.

Before a tank car or tank truck can be unloaded the car or truck must be grounded. The unloading pumps P-806A or B will not run if the ground cable has not been connected. This is for safety reasons. A ground indicator light is installed to indicate a proper ground.

When waste solvent from D-809 is loaded, P-809 is used.

TABLE INDEX FOR SOLVENT AND OCTENE

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
13.1	Loop Controls

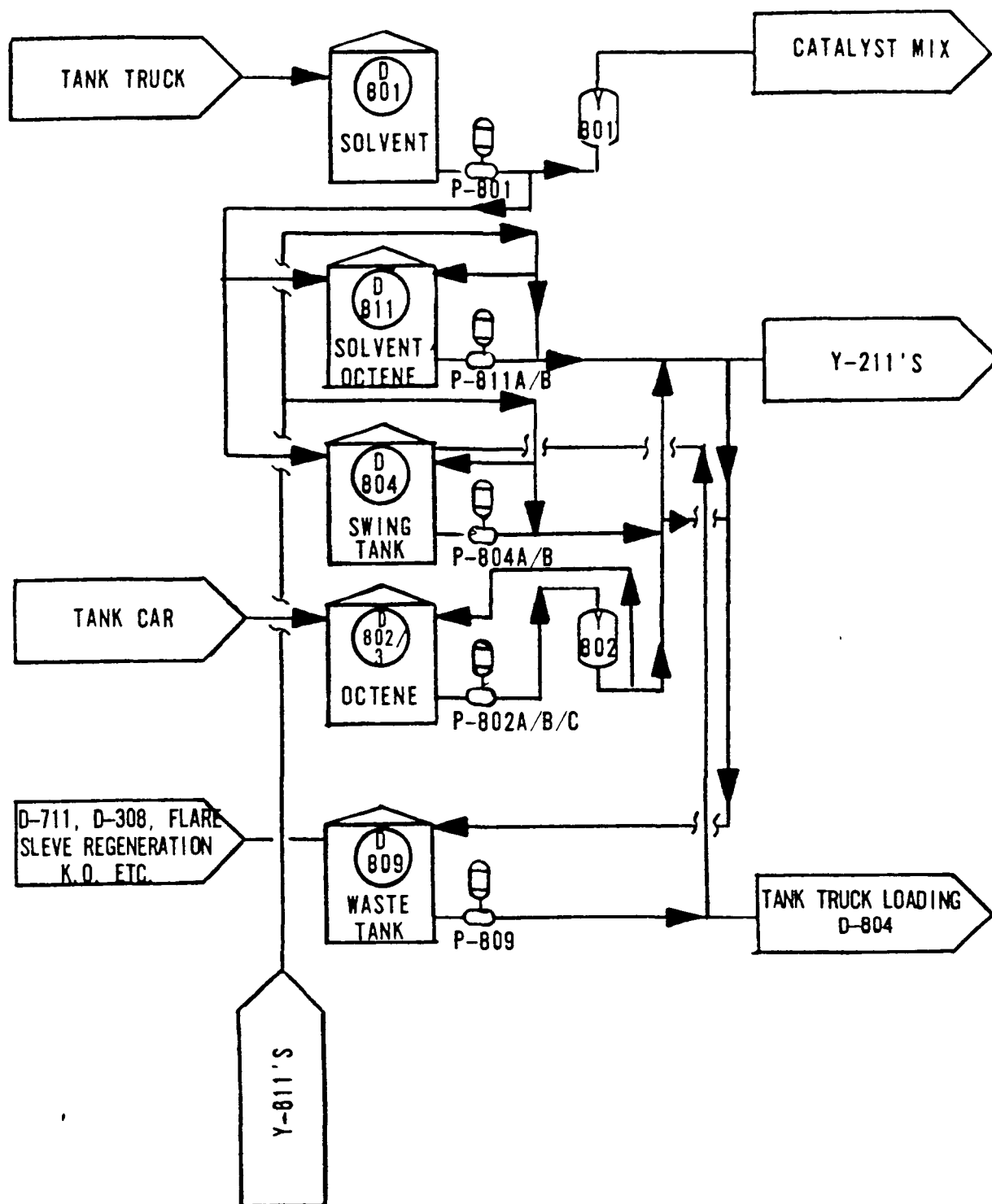
FIGURE INDEX FOR SOLVENT AND OCTENE

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
13.1	Solvent and Octene storage and flow

TABLE 13.1

LOOP CONTROL FOR THE SOLVENT AND OCTENE STORAGE

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC-8005	Control solvent flow through Y-801	Opens or closes to maintain minimum flow through Y-801
FIC-8048	Controls octene flow through Y-801	Opens or closes to maintain minimum flow through Y-802
LIC-8100	Controls level in YD-801	Opens or closes allowing liquid back to D-809 depending on the level in YD-801



SOLVENT AND OCTENE STORAGE

DO A 056862
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14. ADDITIVE SYSTEMS

14.1 HOT MELT ADDITIVE SYSTEM

The purpose of the hot melt additive system is to add substances to the final product to stabilize against oxidation or ultra violet light or to add slip (See Section 4.3). In this system, two vessels are available for melting and mixing of the additives (D-513 & 516). Each has an agitator to aid in the mixing process. Both vessels are jacketed and use hot water from the D-510 hot water system to heat the vessels. For low flow additive, generally 300 PPM or less in the finished product, D-516 will be used for melting and mixing. The additive can then be transferred to D-517 or D-518 by nitrogen padding. Normally D-517 and D-518 will be the additive feed drums. For high flow additives generally from 400-1200 PPM in the finish product, the additive will be melted and mixed in D-513 (D-513 is larger than D-516) then padded to D-517 where it will be level controlled into the process at D-512. For extreme high flow additive generally 1500-4500 PPM the additives will be melted and mixed in D-513, then padded out to D-516. From D-516 the additive will be flow controlled into D-512. A detailed description of how the rate of additives are controlled and injected into the process can be found in the Safe Operation Procedures. All of the additive lines to and from each of the vessels are so designed that they are hot water traced. Because of a certain amount of plugging problems in this system, the mineral oil system is tied into the additive line and will be used for flushing. The additive tanks are all jacketed and have hot water flowing to the jackets from D-510.

14.2 SIDEARM EXTRUDER AND FEED SYSTEM

The sidearm extruder (XS-511) is driven by a 75 hp AC variable speed motor

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1750 RPM's maximum with a capacity of 25 pounds per hour minimum to 375 pounds per hour maximum. The purpose of the extruder is to inject additives (that cannot be added into the process with the hot melt additive system) into the process just ahead of the static mixer (MX-512). These additives are known as anti-block. Due to physical properties of the anti-block additives, being of a sandy type material, it has to be added after the gear pump, to protect the bearings in the gear pump. The feed for the sidearm extruder is a blend of polyethylene pellets and anti-block silica. The feed system is filled by the unloading rail cars using Bac-7 that air conveys the material from the rail car to either the additive storage hoppers (HAS-1 or HAS-2), or directly to the additive hoppers (HA-1A or HA-1B) located above the sidearm extruder that gravity feeds the extruder. XS-511 is a cold work extruder with a 3½" screw and L/D of 24, which simply mixes and melts the material as it passes through the barrel of the extruder. The barrel of the extruder has an outer shell that is divided into three sections and has 235 psig steam piped to each section. At the outlet of the barrel of XS-511 is a three way valve that can be diverted in the direction of the ground for purging of the extruder and then back to the process line. The three-way valve diverts to the ground automatically when XS-511 or P-512 shutdown. There is a nitrogen purge on the inlet to the extruder to keep air from causing black specks in the polyethylene.

14.3 D-510 HOT WATER SYSTEM

This system is used for supplying hot water to the jackets of D-513, D-516, D-517, D-518, and for tracing of all additives lines connected to these

vessels. This is a closed water system in which "condensate" from the D-908 system is used in level controlling D-510. Hot water from D-510 is circulated to the various additive drums and lines mentioned above with P-510 and back to D-510. The water in this system is heated by a steam coil located inside of D-510. Steam from the 235 psig steam system flows through the coil. A temperature control valve located in the inlet line to the coil regulates the amount of steam flow through the coil. This flow depends on the set point of the temperature controller versus the actual temperature of the water inside D-510.

HOT MELT ADDITIVE

FIGURE INDEX

FIGURE
NUMBER

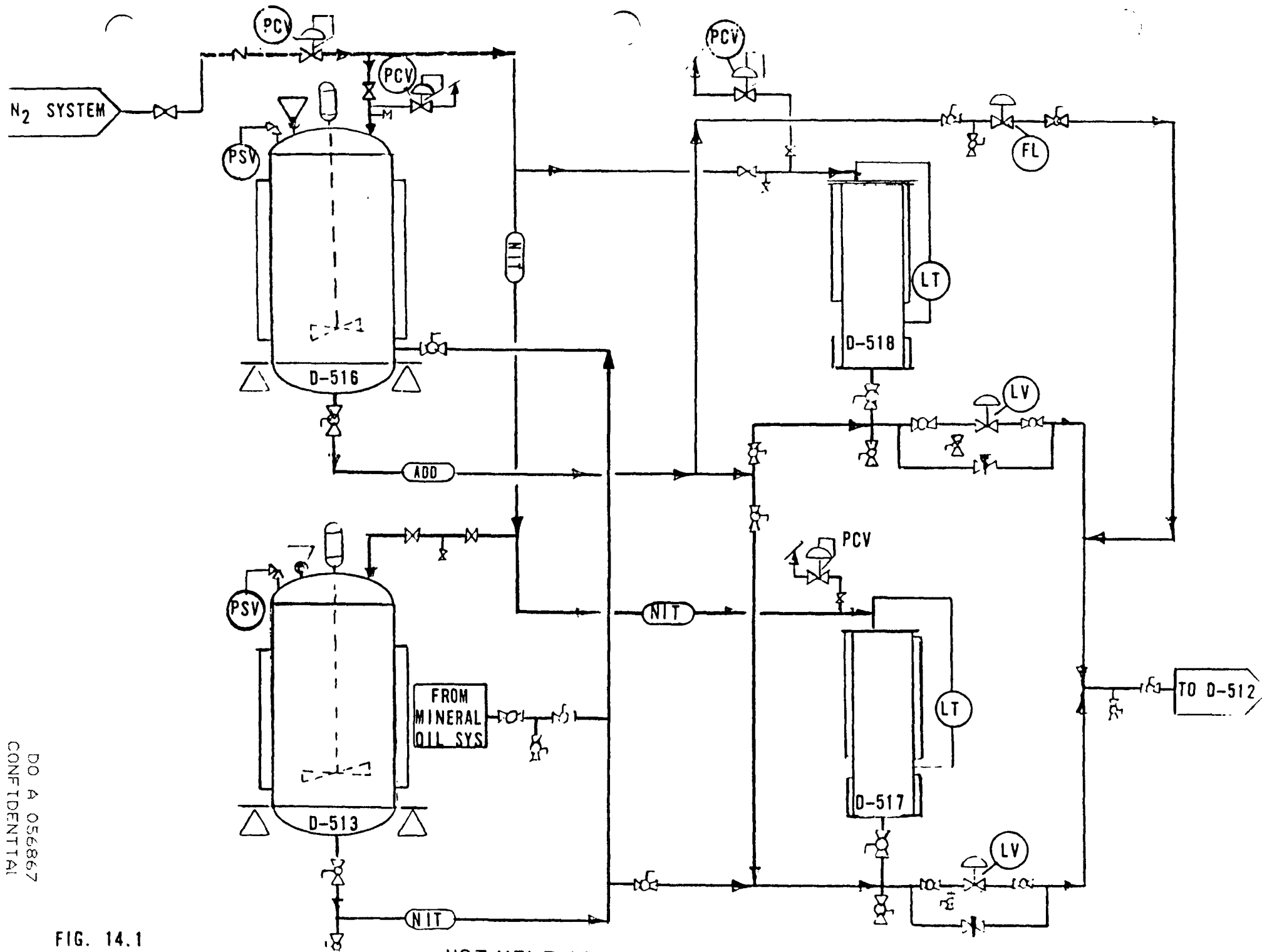
DESCRIPTION

14.1

Hot Melt Additives System

14.2

Sidearm Extruder



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FIG. 14.1

HOT MELT ADDITIVES SYSTEM

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FIGURE 14.2 SIDEARM EXTRUDER

15. GEAR PUMP AND PELLETIZER

15.1 GEAR PUMPS

In this process there are two gear pumps on each train P-511, P-512, and P-521, P-522. Each are 34" Dow designed pumps driven through a gearbox by a 500 hp 1800 RPM AC variable speed motors. The motors are totally enclosed water and air cooled (TEWAC). The pumps' capacity is from 6000 pounds per hour at 2 RPM minimum speed to 40,000 pounds per hour at 20 RPM maximum speed. P-511 pumps 98% polymer from D-511 through the plate exchanger, E-512, to D-512, (See Sec. 10.0). P-512 pumps polymer with less than 2000 ppm solvent through static mixer, MX-512, to the pelletizer, K-511. The static mixer is 22 feet long with 11 mixing elements. It is designed for 4000 psig. There is a rupture disc upstream of the static mixer that relieves at 4000 psig to protect the pump. There is also a rupture disc on the pelletizer that relieves at 2500 psig to protect the pelletizer die. The static mixer is used to uniformly mix additives with the polymer.

The speed of the pump is controlled from the control room or from the pelletizer control panel.

The gear pumps have two herringbone gears which results in zero axial thrust. The pump body and gears are constructed of 4140 steel hardened to Rockwell 'C' of 32 to 36 hardness. The bearings are polymer lubricated and made of 4140 steel hardened to 36 to 40 hardness and plated with 0.005 inches of silver. The bearing surface is spiral-grooved to allow polymer to flow from the discharge side of the pump through the bearing to the seal cavity. From there the polymer flows through an internally bored channel in the pump

housing to the pump suction. An adjustable screw in the channel is used to set a certain back pressure in the seal area. The seal is asbestos packing in a conventional stuffing box arrangement.

15.2 GEAR BOX

Each gear pump is driven by a speed reducer (G-511 and G-512) using both gear shafts. The speed reducers are 4 stage gearboxes made by Horsburgh and Scott. The gears are single helical and the teeth surfaces are carburized for hardness. The overall gear ratio is 90.3 to 1 and the torque rating is 131,300 foot-pounds with a service factor of 1.75. Torque sensing strain gauges are installed on one low speed output shaft. Output from these gauges shuts down the motor on high torque. There are strain gauges on the input shaft that can be used for torque measurements if needed. The gear pump and gear box are coupled on both shafts with 'Sier-Bath' couplings. The couplings are clamped to the shafts using 'Ringfeder' locking rings which expand onto the shaft and coupling. The oil system on each gearbox has the following features:

1. Two 2 hp, 1200 RPM gear type oil pumps.
2. Duplex oil filters.
3. Oil cooler requiring 20 GPM of cooling water.
4. Oil low flow switches for alarm and shutdown.
5. Two 2 KW electric oil heaters inside the gearbox.
6. All lubricated points have sight glass flow indicators.

15.3 PELLETIZER

The pelletizer is driven by a 100 hp variable speed AC motor with the capacity of 35,000 pounds of polymer per hour. The purpose of the pelletizer is to convert the molten polymer into pellet form for handling purposes as a finished product. The polymer enters the pelletizer through a three way diverter dump valve. This valve is hydraulically operated. The polymer then goes through an arrangement of cylindrical screen pack elements. There are 27 of these screen elements giving 418 square inches of total screen area. The screen packs filter out black specks that may occur in this process. From the screen pack the polymer goes through a die plate which has approximately 900 holes that are 0.125 inches in diameter. The face of the die is 1/8" thick and covered with pie-shaped segments of tungsten carbide tile. After the polymer is forced through the small holes of the die it enters the water box. Here the polymer is cut into the pellets by a rotating cutter assembly positioned right at the die face. Simultaneously the polymer is rapidly cooled by water that enters through the bottom of the water box. Inside the water box, there is a shroud that directs some of the water flow directly at the disc. The flow of the pellet water transfers the pellets out the top of the water box and up to the spin dryer. The pellet size and shape which is referred to as granulation, is important in the majority of the product types that are made. To achieve and maintain good granulation several things are to be considered: pelletizer speed, the flow rate from the gear pump, the amount of wear of the cutter knives, pellet water temperature, melt index and density of the polymer.

The die, die housing, the diverter valve, and the screen changer are heated with liquid Dowtherm.

15.4 THE HYDRAULIC SYSTEM FOR K-511 SCREEN CHANGER AND THREE WAY DIVERTER VALVE

This system has a 40 gallon reservoir; 5 hp 1800 RPM hydraulic oil pump. There are two accumulators that hold 7.5 gallon of fluid each and maintain 1500 psig. A high and a low pressure switch monitor the pressure in the system and start and stop the pump accordingly. There are two safety valves that relieve back into the reservoir. For the screen changer, hydraulic fluid flows through a 4-way solenoid operated valve that diverts the screen changer in or out. For the three way diverter valve the fluid flows through a 4-way solenoid operated valve to the diverter valve.

In both cases operation of the 4-way solenoid valves is by push buttons on the pelletizer/gear pump control panel (CP-K511).

TABLE INDEX FOR GEAR PUMPS AND PELLETIZER

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
15.1	Control Panel and Name Plates
15.2	P-511, 512/K-511/XS-511 Interlocks and Alarms

FIGURE INDEX FOR GEAR PUMPS AND PELLETIZER

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
15.1	Hydraulic System
15.2	Pelletizer Spin Dryer and Classifier Flow
15.3	Pelletizer
15.4	Devolatilizer & Pelletizer Control Panel

TABLE 15.1 CP-K-511 and NAMEPLATES

CP-K-511			
ITEM	TAG NUMBER	NAMEPLATE ENGRAVING	
		FIRST LINE	SECOND LINE
1		SEE ANNUNCIATOR ENGRAVING	
2	T1-5126	D-512	BTMS TEMP
3	S1-512B	P-512	SPEED
4	L1-5127A	D-512	LEVEL
5	I1-5129A	P-512	AMMETER
6	T1-5133A	D-512	OUTLET TEMP
7	T1-5137A	MX-512	OUTLET TEMP.
8	T1SN-5453	P-512	DRIVER TEMP.
9	PB-5455	P-512	START / RESET
10	G-5450	G-512 AUX. LUBE	OIL PUMP RUN
11	HOA-5450	G-512 AUX LUBE	OIL PUMP
12	PB-5456	P-512	EMER STOP
13	G-5451	G-512 MAIN LUBE	OIL PUMP RUN
14	HOA-5451	G-512 MAIN LUBE	OIL PUMP
15	VS-5454	P-512	POWER ON
16	R-5165	G-512	HEATER ON
17	HOA-5165	G-512	HEATER CONTR.
18	HOA-5457	P-512 VARIABLE	SPEED CONTROL
19	G-5453	P-512 DRIVER	RUNNING
20	HOA-5453	P-512 DRIVER	CONTROL
21	SC-5128	P-512	SPEED CONTROL
22	TIC-K-511A	DV-511	TEMP.
23	TIC-K-511B	SC-511	TEMP.
24	TIC-K-511C	DIE HOUSING	TEMP.
25	TIC-K-511D	DIE PLATE	TEMP.
26	S1-K-511	K-511	SPEED
27	I1-K-511A	K-511	AMMETER
28	PR-5143	(PEN-1) DV-511 INLET	(PEN-2) DIE HOUSING
29	POI-5152	DV-511 /	DIE HOUSING
30	T1-K-511E	DIE HOUSING	MELT TEMP.
31	G-FSD-511	FSD-511	RUNNING
32	HS-FSD-511B	FSD-511	START
33	G-SD-511	MSD-511	RUNNING
34	HS-SD-511B	MSD-511	START
35	G-BACP-10	BACP-10	RUNNING
36	G-BACP-11	BACP-11	RUNNING
37	G-CL-511	CL-511	RUNNING
38	HS-CL-511B	CL-511	START
39	G-RF-HUN-1	RF-HUN-1	RUNNING
40	G-MK-511	K-511	RUNNING
41	PB-K-511B	K-511	START / RESET
42	PB-K-511A	K-511	EMER. STOP
43	SC-K-511	K-511	SPEED CONTROL
44	HS-K-511	BYPASS	INTERLOCK
45	VS-K-511	K-511	POWER ON
46	HOA-K-511	K-511 DRIVER	CONTROL
47	G-5157	HYDRAULIC	SYSTEM RUN
48	PB-5157A	HYDRAULIC	SYSTEM START
49	PB-5157B	HYDRAULIC	SYSTEM STOP
50	HOA-5158	HYDRAULIC	SYSTEM CONTR.
51	G-DV-511A	DV-511	DUMP POSITION
52	PB-DV-511A	DV-511	DUMP
53	G-DV-511B	DV-511	PROCESS POS.
54	PB-DV-511B	DV-511	PROCESS
55	A-K-511B	K-511	KNIVES POS.
56	R-SC-511	SCREEN NOT	IN POSITION
57	PB-SC-511A	SCREEN "A"	IN POSITION
58	PB-SC-511B	SCREEN "B"	IN POSITION
59	T1-E-517C	E-517 COOLING	WATER OUTLET
60	T1-WPC-1A	E-517 PELLET	COOL H ₂ O OUT
61	FI-K-511B	PELLET	COOLING WATER
62	G-FV-K-511A	FV-K-511	OPEN
63	R-FV-K-511B	FV-K-511	CLOSED
64	HS-K-511	FV-K-511	CONTROL
65		ANNUNCIATOR	ACKNOWLEDGE
66		ANNUNCIATOR	TEST
67		ANNUNCIATOR	SILENCE
68		ANNUNCIATOR	RESET
69		NO ENGRAVING - ACROMAG RACK	
70		NO ENGRAVING - ACROMAG RACK	

TABLE 15.2

P-511, 512; K-511 & XS-511 INTERLOCKS AND ALARMS

SHUTDOWNS FOR P-511 & P-512

P-511 or P-512 will shut down if:

1. High level in D-512 (P-511 only)
2. High discharge pressure in process line.
3. Rupture of disk on pump is blown.
4. Low oil flow to gear box.
5. High motor temperature.
6. High torque on output shaft.
7. Pump will not start if the temperature of polymer is below set point for the following points: inside the pump, and the pipe downstream. Low temperature will not shutdown pumps once they are running.

SHUTDOWNS ON P-512 ONLY:

1. Additive feed valve must be open to dump position for pump to start.
2. Low temperature of screen changer, diverter valve, die plate, die housing and after MX-512 will prevent start-up but does not shutdown.
3. Pelletizer diverter valve must be in dump position to start P-512 unless interlocks are in the by-pass position.
4. Spin dryer and classifier must be running.
5. Screen changer must be all the way in one position or the other.
6. High pressure before the screen changer or before the die.
7. If 3-way polymer valve does not divert to process or dump position within 10 seconds after initiation P-512 shuts down and alarms.
8. Low pelletizer speed or pelletizer shutdown.

P-511 & P-512 ALARMS ONLY:

1. High or low speed.
2. High or low motor current.
3. High pressure in process line.
4. Low temperature in process line.
5. High bearing temperature of pump - four points.
6. Low oil flow to gear box.
7. High torque of output shaft.
8. High water level to motor cooler.
9. High motor temperature - starts auxilliary blower to cooler motor.
10. High or low pump body temperature.

INNERLOCKS FOR K-511 AND DV-511

1. Water box attached to die.
2. Die temperature - above minimum.
3. Pellet water pressure high or low.
4. Pellet water flow low.

5. Knife speed - above minimum.
6. Knives against die - circuit between knives and die complete.
7. Spin dryer and classifier running.
8. HS-K511 not in bypass position.

ALARMS FOR K-511:

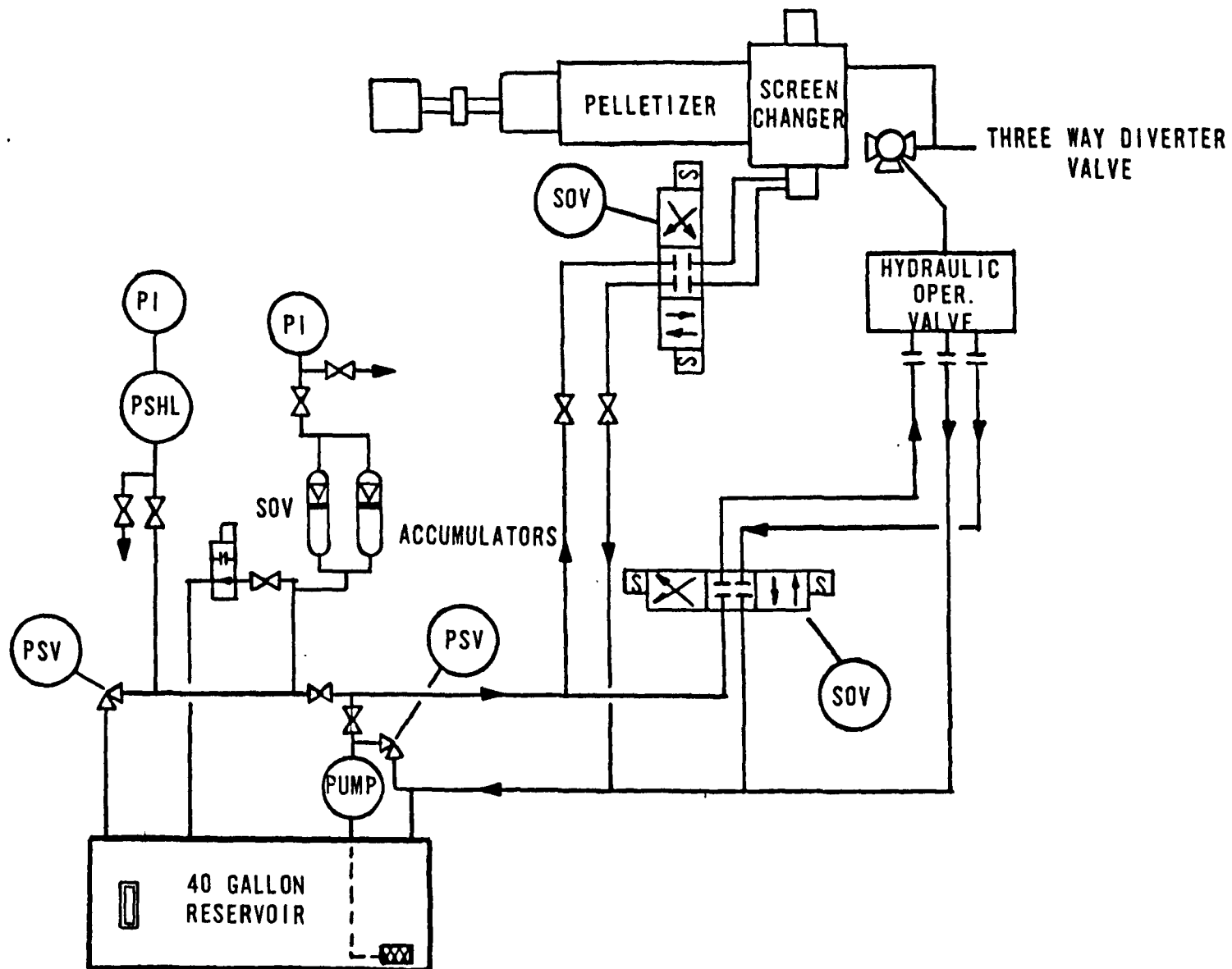
1. High pressure before and after screen changer.
2. Low speed alarm.
3. High or low motor current.
4. Low temperature of diverter valve, screen changer, die plate, and housing.
5. High differential pressure across screen changer.
6. HS-K511 in by-pass position.

SHUTDOWNS FOR XS-511:

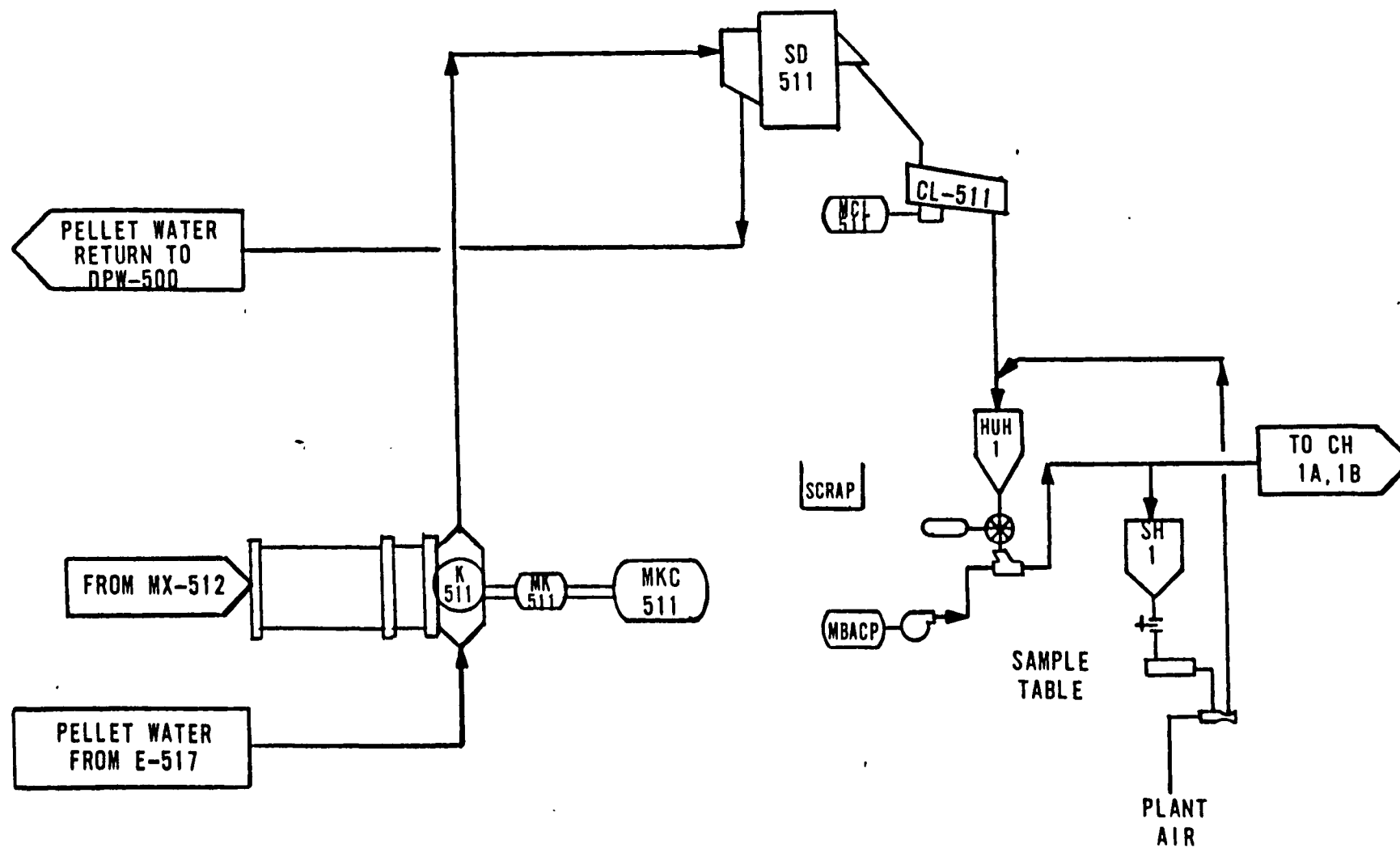
1. Gear box oil pressure low.
2. High discharge pressure.
3. Rupture of disk.
4. Low temperatures in Zones 1, 2, 3 will prevent start-up only.
5. Low level in feed hoppers.
6. P-512 shutdown. If gear pump goes down and XS-511 is running, XS-511 will automatically shut down and 3-way valve switch to "dump" position.

ALARMS FOR XS-511:

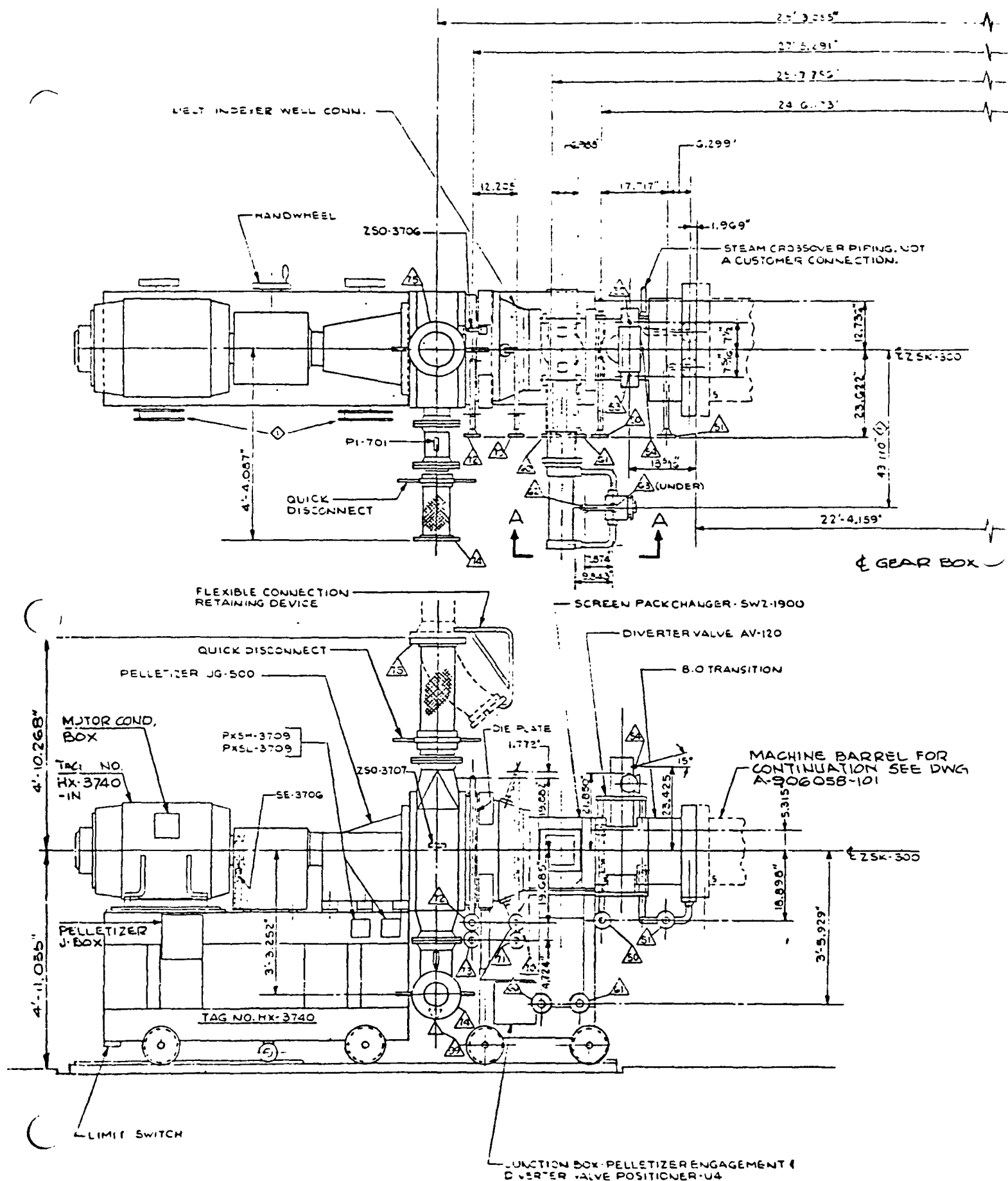
1. High or low motor current.
2. High discharge pressure.
3. High or low motor speed.
4. Low nitrogen purge flow to additive feed to XS-511.



HYDRAULIC SYSTEM



PELLETIZER, SPIN DRYER AND CLASSIFIER



PELLETIZER

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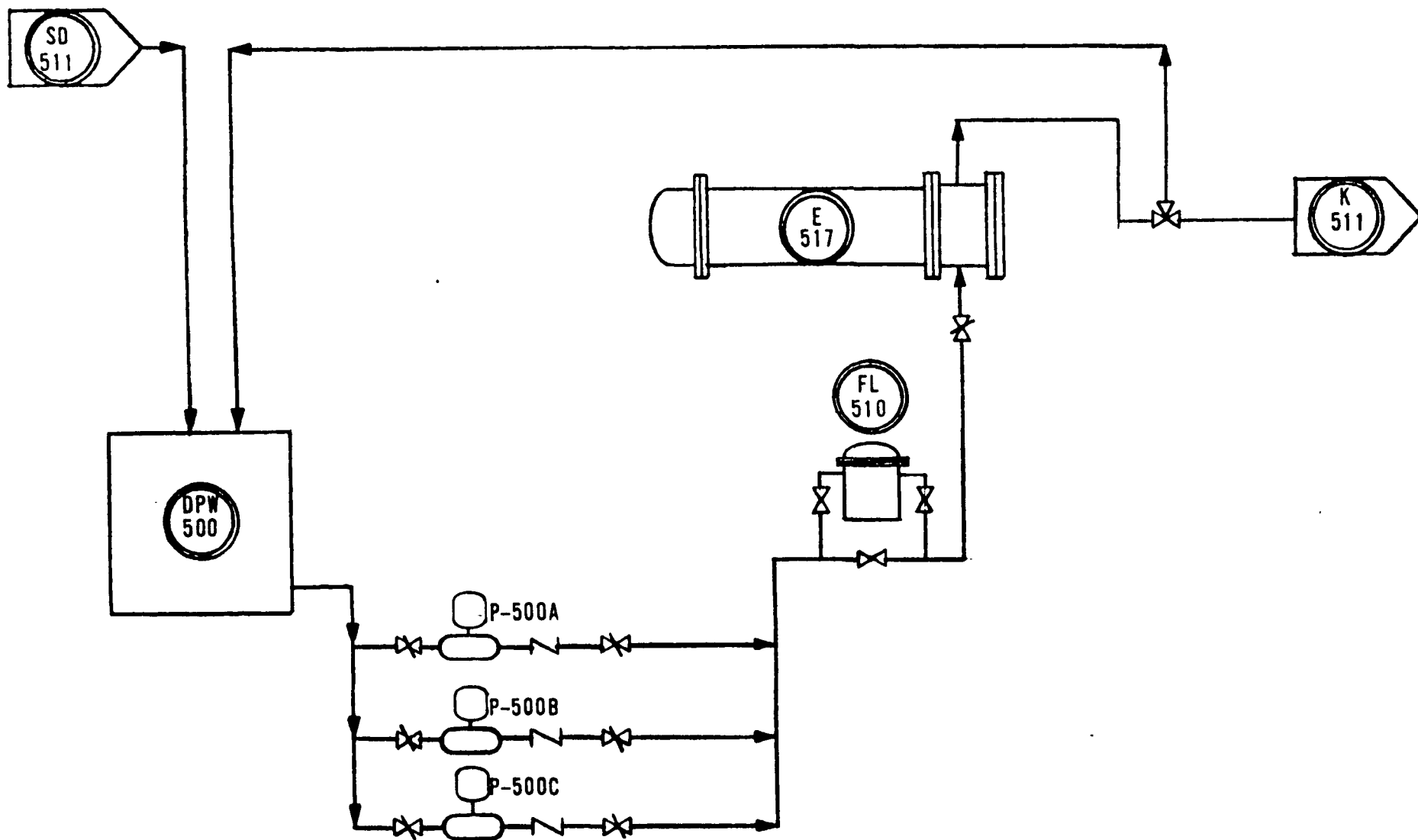
16. PELLET WATER SYSTEM

The pellet water system is a closed system used in the pelletizing part of the process. Water is stored in DPW-500. Makeup water is provided and level controlled from the condensate system. Pellets, fines, and flakes which float to the top of the water periodically spill over into a screened basket. DPW-501 and then to a sump, DPW-502. PW-501 pumps the sump water back to DPW-500. PW-500 A, B, or C pump from DPW-500 through a filter FL-510 that filters out any remaining pellets fines. The filter has a high differential pressure switch. From the FL-510 the pellet water goes to the tube side of a heat exchanger, E-517. Cooling tower water flows through the shell side of the exchanger and is temperature controlled for removing heat from the pellet water. After leaving the heat exchanger, the water passes through a three way valve that can bypass the flow back to DPW-500 when the pelletizer is down. The water flow is measured. The water then flows to the bottom of the waterbox on the pelletizer K-511, contacts the pellets and conveys them out the top of the waterbox up to the spin dryer SD-511. Here the water is separated from the pellets in the dewatering section of the spin dryer and gravity flows back to DPW-500. DPW-500 and PW-500 A, B, and C are common to both trains. There is a separate filter and heat exchanger for Train 1 and Train 2.

16.1 SPIN DRYER AND ROTEX CLASSIFIER (SD-511 & CL-511)

The pellets and water enter the dryer through a perforated chute known as the dewatering section, where the major portion of the water is removed. The pellets and remaining water enters the bottom of the rotor which turns at _____ RPM. This creates a centrifugal force slinging the pellets against cylindrical screens, removing the remaining water which drains out

the bottom. The pellets move in an upward spiral path and are discharged through an outlet at the top. Dry air, pulled through a filter at the top by the blower action of the rotor, passes through the pellets, through the cylindrical screens and out the top into an exhaust blower system that discharges atop the roof. The tangential outlet at the top of SD-511 has a diverter valve that directs the flow of pellets either to a scrap bin for off-grade start-up material or to the rotex classifier. The normal flow will go to the classifier. The purpose of the rotex classifier is to separate the undersize and oversize pellets from the correct size pellets. The rejected pellets are also directed down to the scrap bin. The correct size pellets are then gravity fed from the classifier to a small hopper (HUH1). Directly beneath the HUH there is a rotary feeder, the purpose of which is to feed a certain amount of pellets into a line where the pellets are air conveyed to the check hoppers (CH1A; CH1B). Between the HUH and the check hoppers, a continuous sample of pellets is taken by an automatic sampler, SAM-1, and piped to a sample hopper (SH1) to be checked periodically for specks, color, granulation, etc.. These pellets are then air conveyed downstream of the sample point using an ejector and plant air.



PELLET WATER FLOW

17. MATERIAL HANDLING SYSTEM

The purpose of the material handling system is to transfer polyethylene pellets from one place to another. In this process the pellets are air conveyed by certain blowers (BAC) through aluminum pipes at velocities of several thousand feet per minute. There are two basic conveying systems by which the polyethylene pellets are transferred through the plant: one being the pressure system (Fig. 17.1), and the other is the vacuum - pressure (Fig. 17.2). On the pressure systems, to prevent air from blowing backwards into the storage hopper, there is an air-lock rotary feeder (RF) which takes pellets into a rotating chamber turning downward and dumping the pellets into the flow of air. To avoid generating dust, fines, and streamers as the pellets travel through the lines at such high velocities, the inside of the lines have spiral grooves, 1/32 inch deep, every 3/8 inch which cause the pellets to bounce rather than skid or slide. These lines are referred to as transfer lines.

Diverter valves (DV) are located in the transfer lines to direct the flow of pellets to the desired destinations. All diverter valves are equipped with limit switches to indicate in which direction the valve is diverted. The Modicon 584, which is a programmable controller, will control all transfers in the material handling system. The Modicon accepts inputs, and outputs from the various blowers, rotary feeders, slide valves, diverter valves, and levels of each vessels. Direct communication with this system is achieved by a connection with the PDP-11 computer which in turn has input/output communication with a CRT and a keyboard. When the correct sequence of entries are made to the computer, the computer which supervises the Modicon, will do the following:

1. Align diverter valves to the correct position.
2. Verify diverter valve to correct position.
3. Start blower and rotary feeder.
4. Check blower pressure and determine if blower is running.
5. Open slide valve - when applicable.
6. Verify slide valve open.
7. Verify feed pressure, (PSH), to check if pellets are transferring.
8. Shut down system if system alignment is interrupted.
9. Shut down system if system pressure increases enough to activate a high, high pressure switch on the blower discharge.
10. Shut down system on high level in destination hopper or receiver.
11. Shut down system on low blower pressure (transfer complete).

Of the two basic air conveying system, there are five individual systems used to transfer polyethylene to the desired destination.

BACP 10 or BACP 11; Single Blower Pressure System

This system transfers polymer from HUH1 (which is a small vessel known as a hold up hopper) to the check hoppers (CH1A, 1B). Beneath HUH1 there is a rotary feeder (RF HUH1). At a certain point in the transfer line between the HUH and the check hoppers, a sample line is piped to a sample hopper (SH1). A small continuous amount of pellets is directed to this sample hopper to be checked at various time intervals for specks, color, granulation, density and volatiles. There are two buttons located at the sample table, labelled 'prime' and 'off-grade'. Once the sample has been checked at the predetermined time intervals one of these buttons will have to be pushed in order to start transferring that particular check hopper which was being filled during the prior

time period. The sample pellets are air conveyed downstream of the sample line to the check hopper.

BACP 10 and BACP 11 are centrifugal Hoffman blowers. The same system is on Train 2.

BACP 1 or 12 Single Blower Pressure System

This system transfers polymer from the check hoppers (CH1A;1B) to the make-blenders (HMB1A, B, C, or 2C). The capacity of each blender being 200,000 pounds. In this system, a pressure switch located in the transfer line just down stream of the blower, indicates if the blower is running (PSH). There is also a high temperature switch. Whenever the hopper becomes empty and the pressure drops (PSL) the system automatically goes through a time out cycle and shuts down. The blowers in this system are centrifugal blowers. The TDC2000 monitors the motor current of each blower from the motor control center. There is a high motor current alarm on each blower. If a transfer line starts to plug, the motor current will go up. Each check hopper has a high level switch, if activated, the valve diverts to the other check hopper. If both hoppers become full, the system would have to shut down. The check hoppers are mounted on weigh cells. The PDP-11 calculates the amount of polymer in the check hoppers and displays it on the CRT. In the event the Modicon shuts down, there are manual switches for the blowers, rotary feeders and diverter valves, to line up and start a transfer. These switches are on a graphic panel in the control room.

BACP-3 Single Blower Pressure System

This system is used to blend and transfer polymer from the make blenders (HMB1A;1B or 1C). Once, a predetermined amount of polymers (180,000 pounds) (referred to as a lot) has been accumulated in one of the HMB's, the system is

used to blend the polymer. The polymer is cycled from the bottom of the blenders back through the top of that same blender for about 2 hours. After the blend cycle is completed, the polymer can then be transferred to the storage hoppers HS1 through HS6 (capacity of each is one million pounds) or to H1 through H8 (capacity of 600,000 pounds each), or to the bulk car loading hoppers (HL1-HL4) or to a bagging hopper (HB-1) 200,000 pounds capacity. BACP-3 is a positive displacement M. D. rotary-lobe blower. It will shutdown on low oil pressure. It has an inlet and outlet silencer. The Modicon has inputs from a low pressure switch that indicates if the blower is running, a high pressure switch to indicate pellets are transferring and a high-high pressure switch that indicates if the transfer line plugs. When the feed pressure drops below the set pressure of the high pressure switch, the system will time out and shut down. If the high-high pressure switch is activated the system will shut down. There is a button located at the bottom of the blender that an operator must push to confirm that the blender is empty before the computer will allow a new lot to be started in that blender. There is also a high temperature switch located in the transfer line that will alarm if the air temperature from the blower (after it passes through a cooling tower water exchanger, EA-3) is too high.

BACV-5 & BACP-5 Dual Vacuum - Pressure Blower System

This system transfers polymer from H1-H8 to the bulk car loading hoppers (HL5-HL8) or to the #2 bagging hopper (HB-2). These are positive displacement blowers. There are pneumatic slide valves under each of the H1-H8. Once the transfer is lined up and the blowers are running, depending on which hopper is being transferred the slide valve opens and gravity feeds polymer into the transfer line which is one the vacuum of BACV-5. The poly is pulled to a de-

duster receiver (RAC-5). The receiver is equipped with baffles that directs the polymer to the bottom. Fines and air flow through an annular space and out the top of the receiver-deduster to a filter (FACV-5) that filters out the polymer dust, fines and polyethylene pellets that may carry over. The air flows from the top of the filters through a silencer (SACV-5A) to the blower and is discharged through another silencer (SACV-5B) to the atmosphere. The polymer that is collected in the receiver is fed into a transfer line that is on the pressure side of BACP-5. The polymer is air conveyed to the desired destination. BACV-5 has a high vacuum switch that indicates when the blower is running; a low vacuum switch for the feed flow indication and a low-low vacuum switch to indicate if the transfer line plugs. BACP-5 pressure switches work the same as BACP-3. There is a high level switch on RAC-5 that alarms on the annunciator panel in the control room. Low oil pressure will shutdown the blower.

BACV-6 & BACP-6 Dual Vacuum - Pressure Blower System

This system transfers polymer from (HS1 - HS6) to the bulk car loading hoppers (HL5 - HL8) or to the #1 bagging hopper. This system operates the same as BACV5 and BACP-5.

BAC-7 Rail Car Unloading

There is a separate system used for transferring additives from a rail car. This is a Single Vacuum - Pressure Blower System BAC-7. The blower in this system is a positive displacement blower. With the vacuum side of the blower, the product is pulled from the rail car to a deduster receiver (RAC-7). Air is drawn out the top of the receiver through a filter (FACV-7), through another filter (FLT-7), then to a silencer (SACV-7) to the blower. The air flow from the discharge of the blower goes through a silencer (SACP-7), to an exchanger

EA-7 where the air is cooled. From the exchanger the flow is directed under the receiver. At this point the product from the receiver is fed into the line by a rotary feeder and conveyed either to the additive storage hoppers or the additive hoppers above the additive extruder. On the vacuum side of the blowers there is high level switch on RAC-7 and a high differential pressure switch on (FLT-7). On the discharge side of the blower a low pressure switch indicates when the blower is running, a high pressure switch indicates a plugged line. There is a high temperature switch after EA-7. The blower has a low oil pressure shutdown switch.

This system can be used to unload polymer to the blenders HMB-1A and HMB-2A if needed.

TABLE 17.1

CONVEYING SYSTEM SUMMARY

SYSTEM (LINE SIZE)	SOURCE (NO.)	& TO	DESTINATION (NO.)	POLYMER CAPACITY MAX. (#/HR)	TYPE	REMARKS
BACP 10 & 20 11 & 21 (8")	From HUH 1 & 2 1 Each Train	TO	Check Hoppers 1A-B; 2A-B 2 Each Train	35,000	PRESSURE	Spare blower for each Train BACP- 11 & 21
BACP 1, 2, & (8")	From Check Hoppers 1A-B; 2A-B 2 Each Train	TO	Blenders to 1A, B, C & 2A, B, C	35,000	PRESSURE	BACP1 also to HME2C BACP2 also to HMB1C BACP12 spare for both TR.
BACP 3 & 4 (10")	Recirculate blenders or from blenders	TO	Silos Car Loading to HL1-HL4 or bag- ging	Recirculate 120,000 Transfer 90,000	PRESSURE	Rotary feeder on HMBs are two speed; 24RPMs for recirculating 18 RPMs for transferring
BACV-5 BACP-5 (10")	From H1 to H8	TO	Car Loading HL5 - HL8 or bagging HB2	90,000	PRESSURE VACUUM	
BACV-6 BACP-6 (10")	From HS1-HS6	TO	Car Loading HL5 - HL8 or bagging HB1	90,000	PRESSURE VACUUM	
BAC-7 (8")	From Car Load- ing	TO	HAS1, 2 HA1A-B; 2A-B or HMB1A HMB2A	90,000	PRESSURE VACUUM	Unloads car of resin or additive concen- trate

17.1 PURGE AIR SYSTEM

This system includes three air blowers (BPA1, 2, &3). These are Hoffman centrifugal blowers driven by 200 hp electric motors. The blowers are piped to all hoppers except the additive hoppers. Due to the fact that not all of the solvent is devolatilized from the polymer, various percentages are entrained in the polymer and carried over into the hoppers. This system keeps a constant air purge on the hoppers to eliminate a concentration of solvent vapors. Low flow switches are installed in each of the purge lines to the various hoppers. In addition to the purge air, in the case of the check hoppers, there is an additional purge system; the low pressure nitrogen system is piped separately to each of the hoppers. There is a high flow switch installed in the nitrogen line that will indicate when this system is in service. The low pressure nitrogen system should only be used in cases where there is a high volatile level in a hopper (over 40% L. E. L.). If the nitrogen system was left open to a hopper, the gas detectors in the top will not detect a flammable mixture until the nitrogen is turned off. Thus, transfers could be made out of the check hoppers, of high-volatiles polymer, causing an explosive mixture in the blenders. There are also carbon dioxide cylinders for each of the check hoppers to be used in case of a fire. Generally solvent in polyethylene pellets will diffuse to the air at 10% per hour. That is for 10,000 pounds of polymer with 1% solvent in it (100 pounds solvent), 10 pounds would diffuse out in one hour. The lower explosive limit (L. E. L.) and upper explosive limit (U. E. L.) of solvent in air are 1% and 7% by volume respectively. Any source of ignition (static electricity) within these ranges would result in an explosion. Thus the need for purge air is very important. This system must be in operation at all times on all hoppers. (Purge air flow is mea-

sured on the lines to all vessels and low flow is alarmed.) Combustible gas detectors are installed in each of the check hoppers and HUH's, with indicators in the control room. At 20% of the L. E. L. the control room will get an alarm and a yellow warning light at 40% of the L.E.L., an alarm and a red light is displayed.

TABLE INDEX FOR MATERIAL HANDLING

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
17.1	Conveying System Summary
17.2	Purge Air Flow Summary

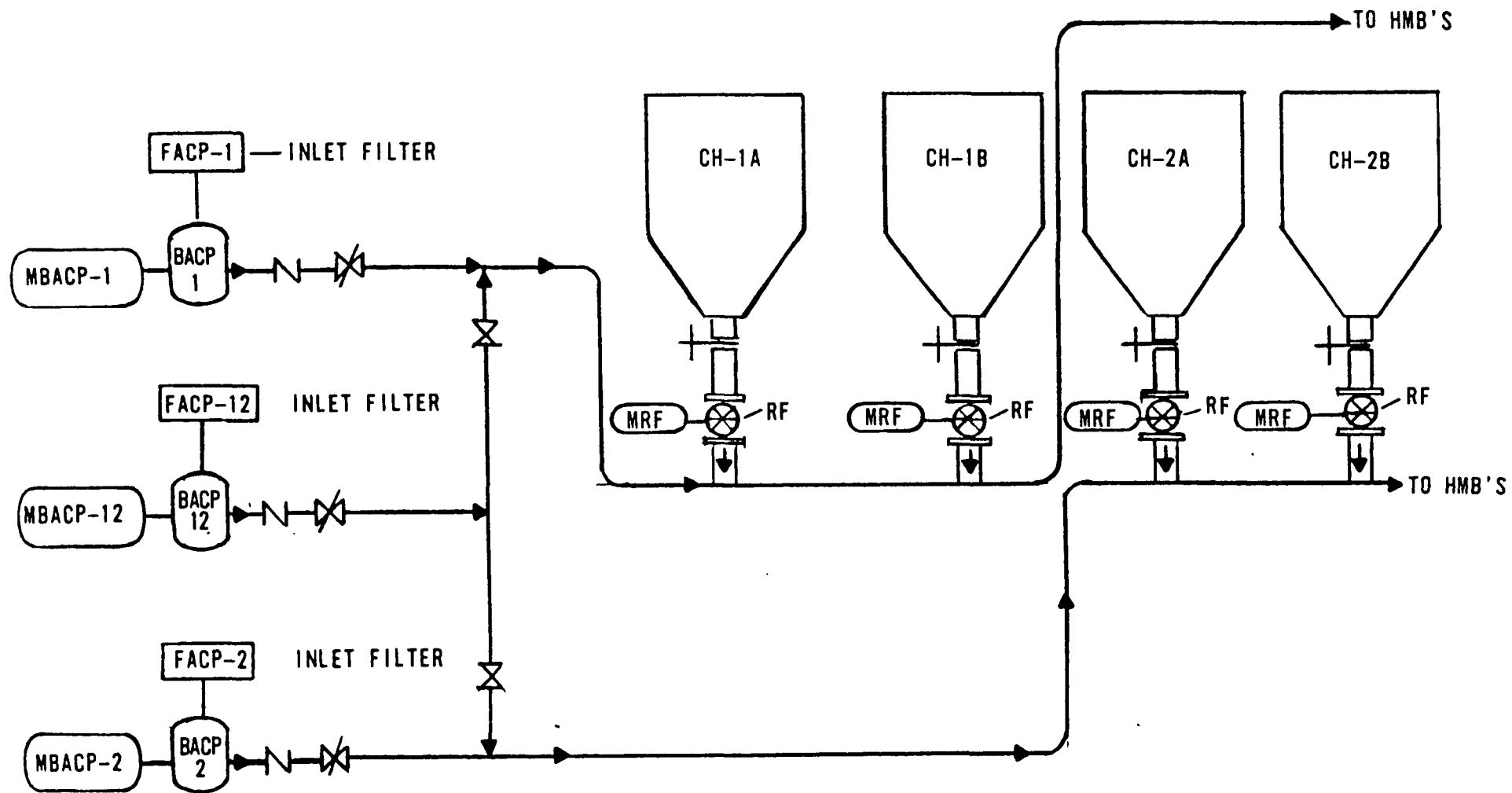
FIGURE INDEX FOR MATERIAL HANDLING

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
17.1	Single Blower Pressure System
17.2	Dual Blower Pressure System
17.3	Single Blower Pressure - Vacuum System
17.4	Receiver Separator and Deduster

S U M M A R Y O F P U R G E A I R F L O W

ITEM NO.	THEOR PURGE AIR FLOW/WSEL	% L.E.L. USED	PURGE RATE USED/WSEL	NUMBER OF HOPPERS	TOTAL FLOW REQUIRED
CH 1&2 A&B	400 CFM	15 %	400 CFM	4	1600 CFM
HMB 1A, B, C 2A, B, C	933 CFM	25 %	800 CFM	6	4800 CFM
H1 to H8	329 CFM	15 %	300 CFM	8	2400 CFM
HS1 to HS6	329 CFM	15 %	300 CFM	6	1800 CFM
HL1 to HL6	329 CFM	15 %	300 CFM	8	2400 CFM
HB1 to HB2	329 CFM	15 %	300 CFM	2	600 CFM
					13600 CFM
					<u>TOTAL</u>

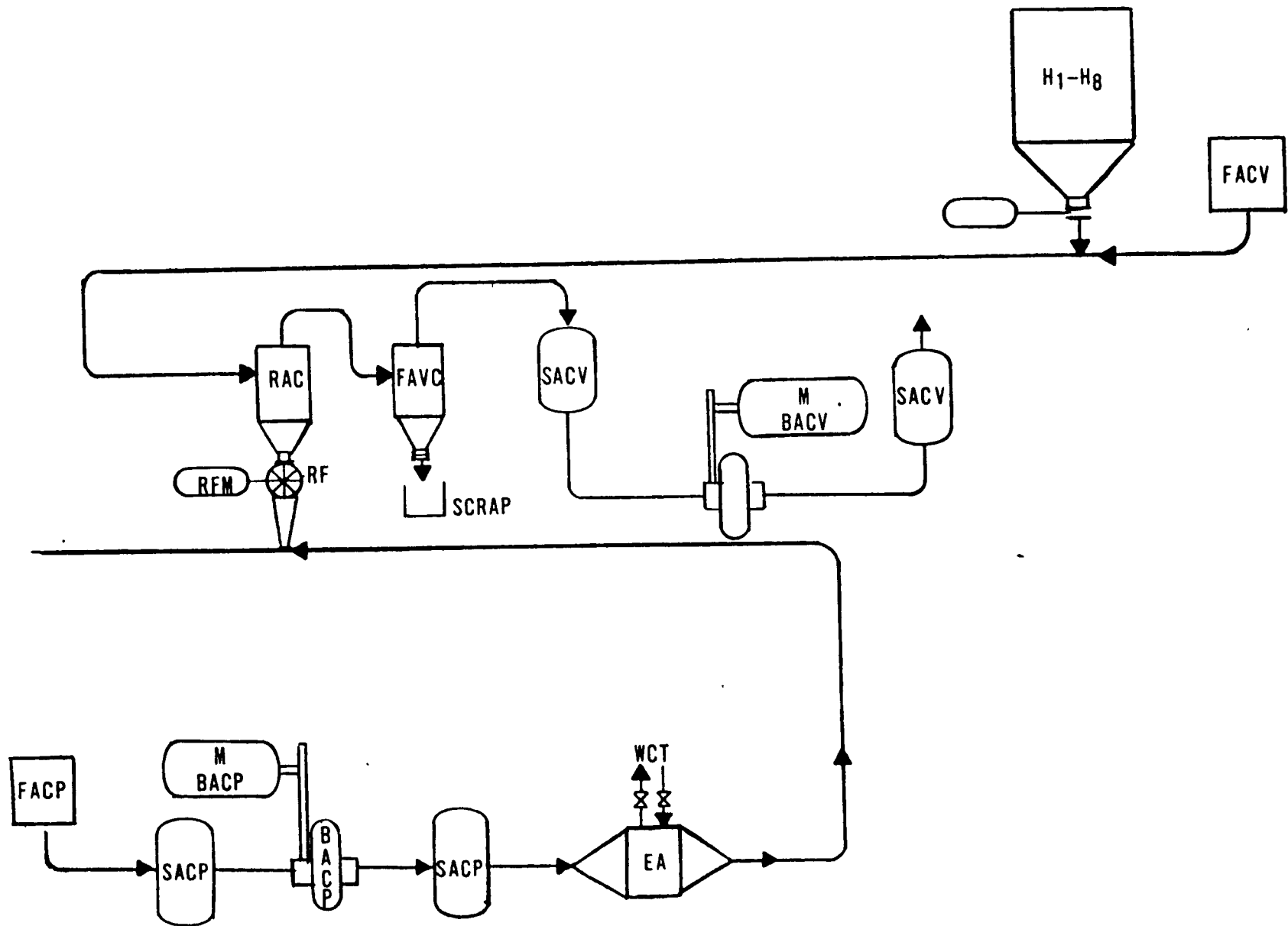
TABLE 17.2



SINGLE BLOWER PRESSURE SYSTEM

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FIG. 17.1



DUAL BLOWER PRESSURE - VACUUM SYSTEM

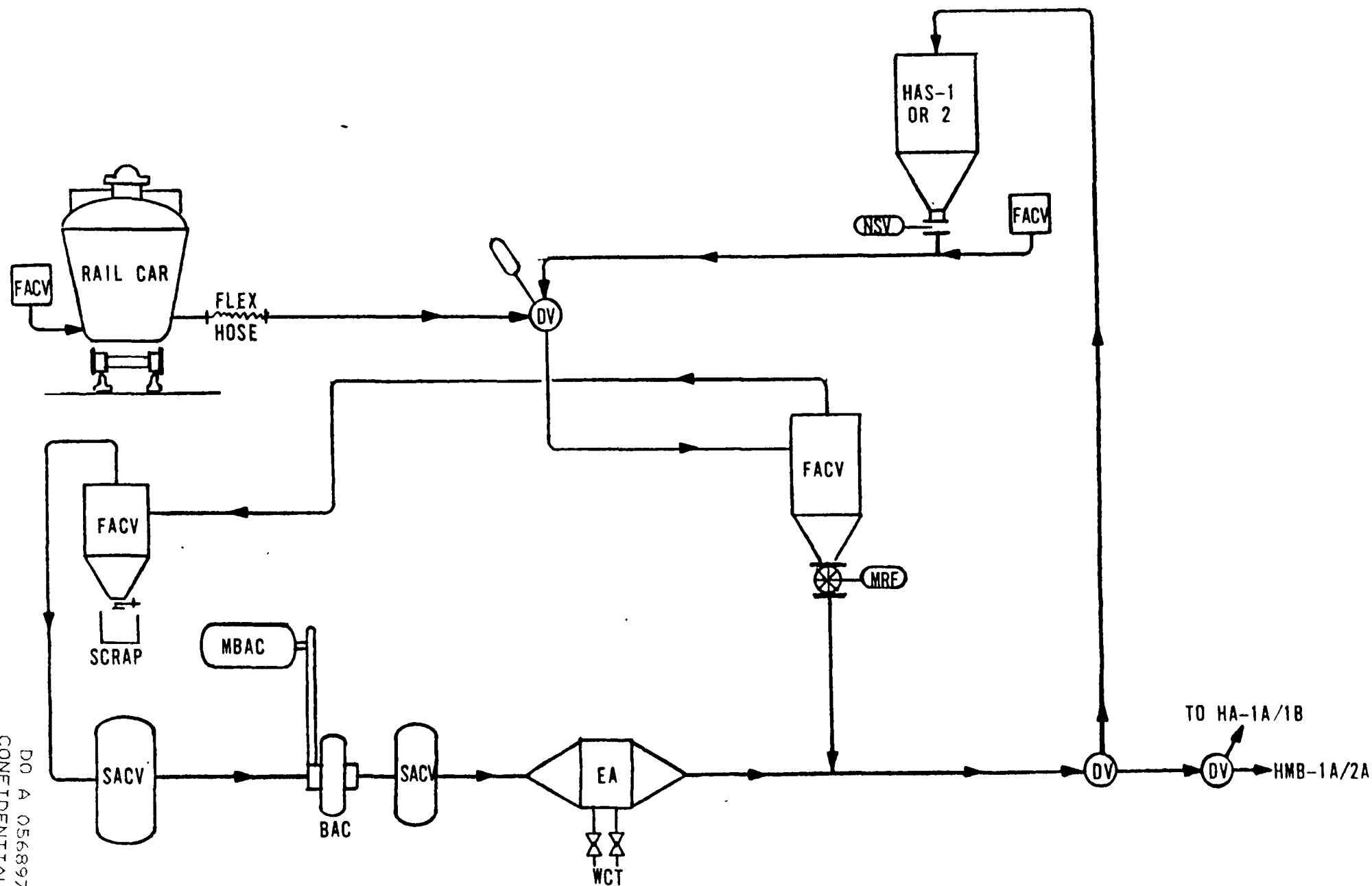
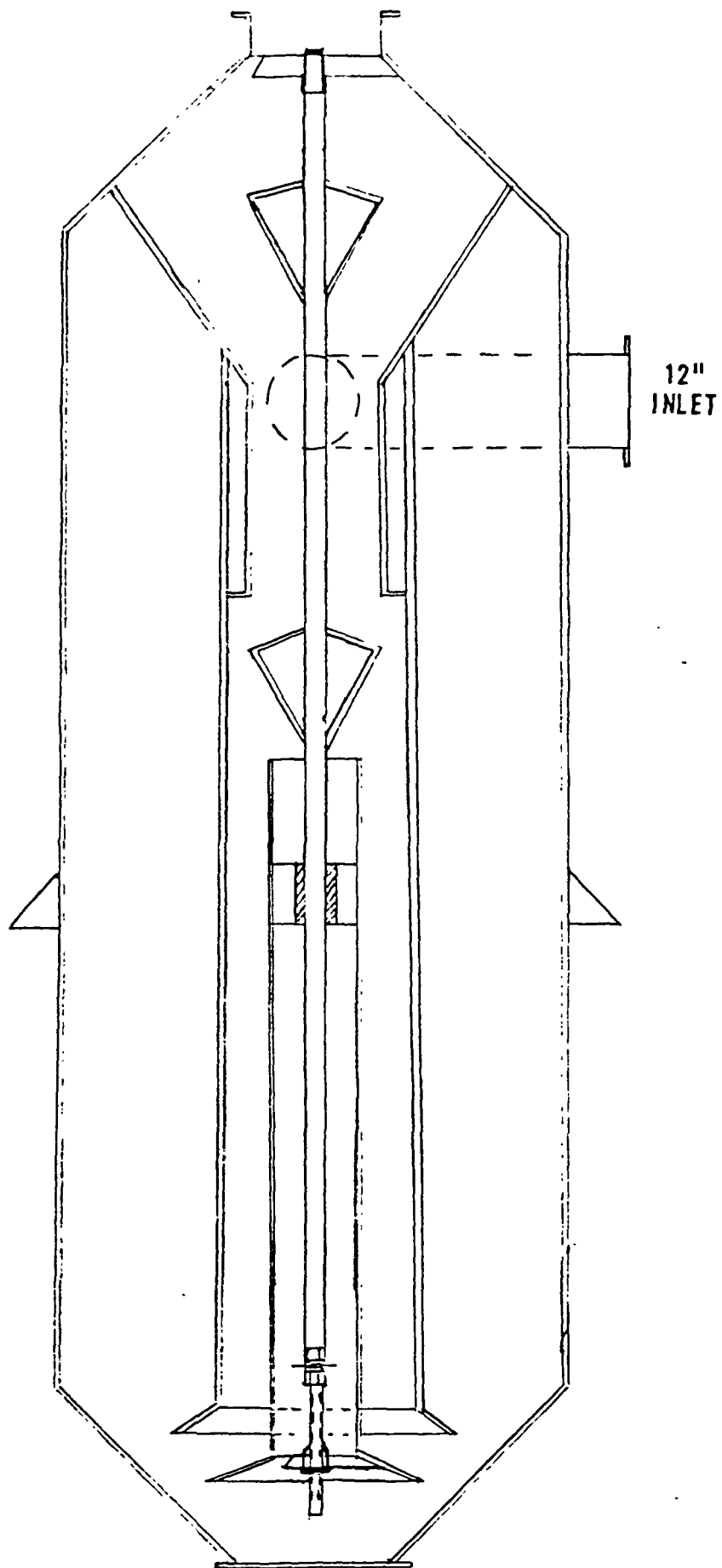


FIG. 17.3

SINGLE BLOWER PRESSURE - VACUUM



RECIEVER SEPARATOR DEDUSTER

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18. DOWTHERM SYSTEM

The purpose for this section of the plant is to produce hot Dowtherm liquid and vapors for heating of the polymer in the devolatilization section of the plant.

This is accomplished through a gas fired furnace, for heating the Dowtherm and then extracting hot vapors and liquid for circulation through various heat exchangers and jackets. The Dowtherm is then returned to the system. Dowtherm "A" when received is a clear, colorless, oily material with a very pungent odor. Dowtherm boils at 257°C at 0 psig. Dowtherm has a very high temperature compared to steam at the same pressure and this is the reason it is used at Dowlex.

235 psig steam temperature is approximately 310°C while 26 psig Dowtherm temperature will be 310°C.

18.1 DOWTHERM FURNACE (F-501)

The basic operation of the furnace consists of mixing fuel gas (methane) with air for combustion to heat the tubes in the tube section of the furnace.

F-501 is a gas fired, forced draft, single pass, counterflow furnace.

The normal operation of F-501 consists of air, supplied by B-501, being blown into the furnace through an air preheater, located in the stack, to the burner wind box for mixing with the fuel gas for combustion. The hot gases for combustion pass over the Dowtherm tubes, then over the air preheater section and finally out the stack. The Dowtherm flows into the convection section at the top first where it is heated by the hot flue gas. It then flows to the radiant section in the firebox where it is further heated by radiant heat from the flame.

B-501 has a control valve on it's discharge that regulates the amount of

140°C

WEAK ACIDS
air going to the furnace. If the stack temperature went below 100°C, ~~water~~ could condense in the stack causing corrosion. It is very important to maintain proper air to gas ratios to the furnace. To do this, a sample of the hot gases leaving the furnace is extracted and analyzed for excess oxygen. The desirable control point is 2.0% excess oxygen in the flue gas. If air flow increases or gas flow decreases the oxygen in the flue gas will go up.

High oxygen results in poor efficiency and heat being carried out the stack by too much air flow. Too low an oxygen will result in what is called chocking the furnace; not burning all the fuel due to not having enough air flow.

A chocking furnace is an extremely dangerous condition that could result in a furnace explosion. The proper handling of this condition is discussed in detail in the safe operating procedures manual.

Fuel gas to the block comes from the Division pipeline at 275 psig and is regulated down at the block limits to 100 psig.

The fuel gas to F-501 at 100 psig is first regulated down to 50 psig by the field regulator. This 50 psig gas is pressure controlled to F-501 burner. The fuel gas pressure to the burner is controlled by the Dowtherm pressure in D-500. A portion of the 50 psig fuel gas is also regulated down to 20 psig for pilot gas. Both the burner gas line and the pilot gas line are equipped with double-block and bleed safety shut-off valves.

There is a 1" 235 psig steam line that enters the bottom of F-501 for use in an emergency such as a furnace fire. This line is equipped with an emergency trip valve that can be operated from the control room. The furnace will trip

(gas lines blocked) off if any of the following conditions occur:

- A. Low fuel gas pressure 10 psig
- B. High fuel gas pressure 30 psig
- C. Low air flow (redundant) 8,000 lbs/hr
- D. High D.T. pressure D-500 60 psig
- E. Flame out (loss of fire) Loss of all 4 flame detectors
- F. Low D.T. Flow (on any pass) 200 KLlbs/hr
- G. Power failure to controls
- H. Low level D-500 25%
- I. High stack temperature 427°C
- J. Main gas block valves Closed

F-501 is supplied with liquid Dowtherm from D-500 by P-501-A-B-C. A small portion of the discharge of the P-501's is sent back to D-500 through a filter (FL-502) to remove impurities in the system.

18.2 DOWTHERM "A" FLOW PATH

Tank trucks unload Dowtherm into D-502 which is the storage drum for the system. This vessel is under a nitrogen pad to prevent air from entering the system. The liquid Dowtherm is pumped from D-502 by P-502-A-B through a control valve for level control of D-500. There is a level control valve from Trains I and II liquid lines for high D-500 level. A small portion of the P-502's discharge passes through E-501 and E-502 (cooling tower water exchangers) then through FL-503 (filter) for use on the packing glands on P-501's and P-500's.

D-500 is where the liquid and vapor Dowtherm are separated for specific uses in the plant. E-502 is a fin-fan cooler located on top of D-502 and is used to condense any vapors in the storage drum.

Dowtherm safety valves located in the process area are piped back to D-502.

18.3 VAPOR CYCLE

Hot Dowtherm liquid from F-501 enters D-500 and is extracted from the top of D-500 at 26 psi and 310°C. At full furnace capacity 30% of the Dowtherm flowing back to D-500 from F-501 flashes overhead into the vapor line. This vapor goes only to E-511 where it is used to heat the solvent/polymer solution. After passing through E-511 the vapor is condensed and drains from E-511 to D-519 which is a level controlled collection drum from which the liquid Dowtherm is pumped back to D-500 by P-519 A/B. There is an identical system on Train 2.

18.4 LIQUID CYCLE

Hot liquid from D-500 is pumped by P-500 A/B/C to the gear pumps and jackets of the devolatilizers to keep the polymer hot.

Hot Dowtherm flows first through a temperature control valve at each devolatilizer and back to D-500 to start the cycle over again. Most of the Dowtherm liquid is used for the plate heat exchangers E-512, and E-522 inside the second devolatilizers. This Dowtherm is flow controlled to the exchangers. The polymer temperature out of E-512 is changed by controlling the Dowtherm liquid temperature on each train.

If the Dowtherm liquid from D-500 is too hot, a portion of the cooler Dowtherm from the train can be controlled directly to the suction of the P-500 A/B/C thus bypassing D-500. Thus the Dowtherm liquid system temperature is controlled.

TABLE INDEX FOR DOWTHERM SYSTEM

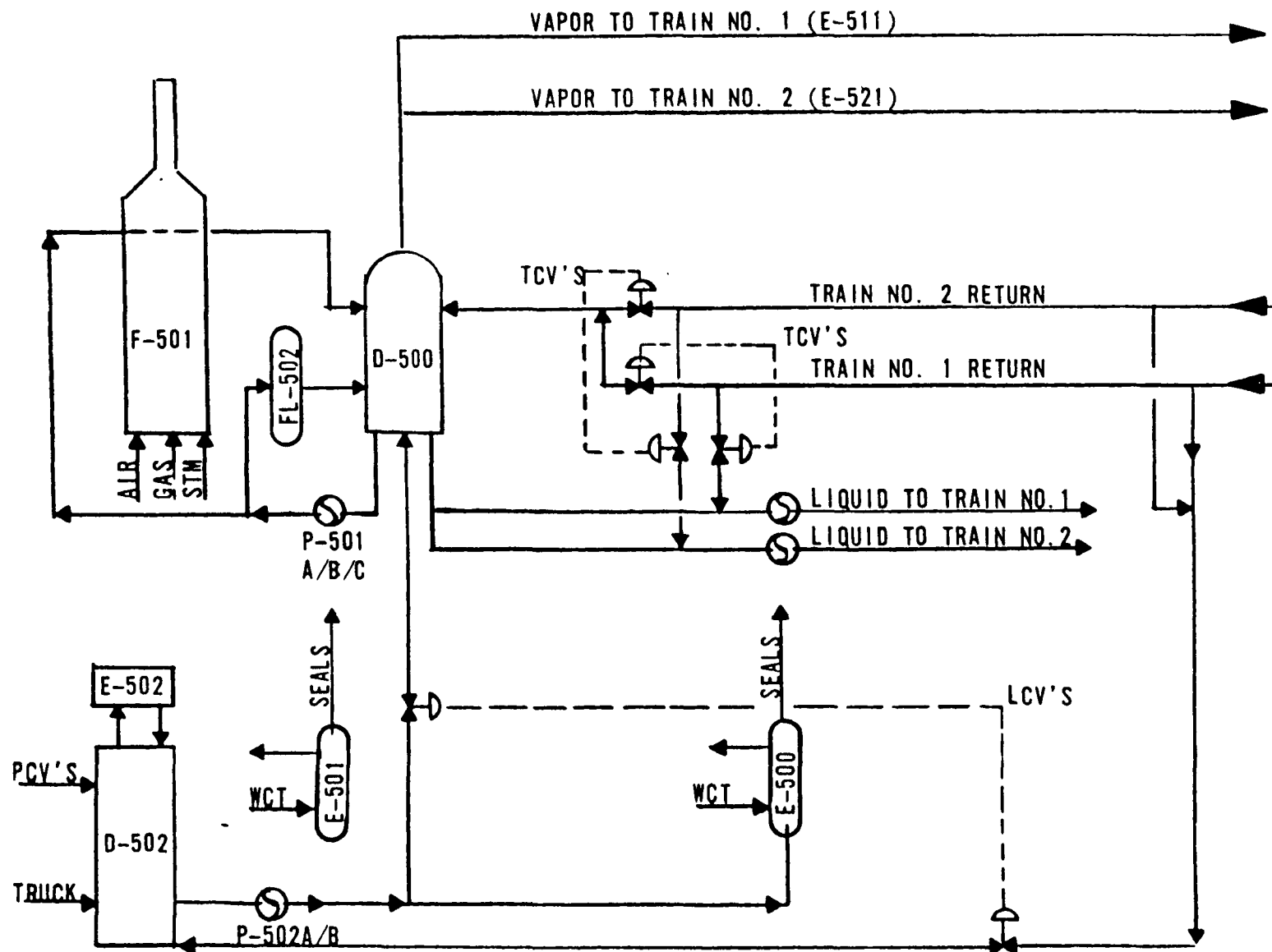
<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
18.1	Dowtherm System Control Loops

FIGURE INDEX FOR DOWTHERM SYSTEM

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
18.1	Flow Path for Furnace Area
18.2	Flow Path for Distribution

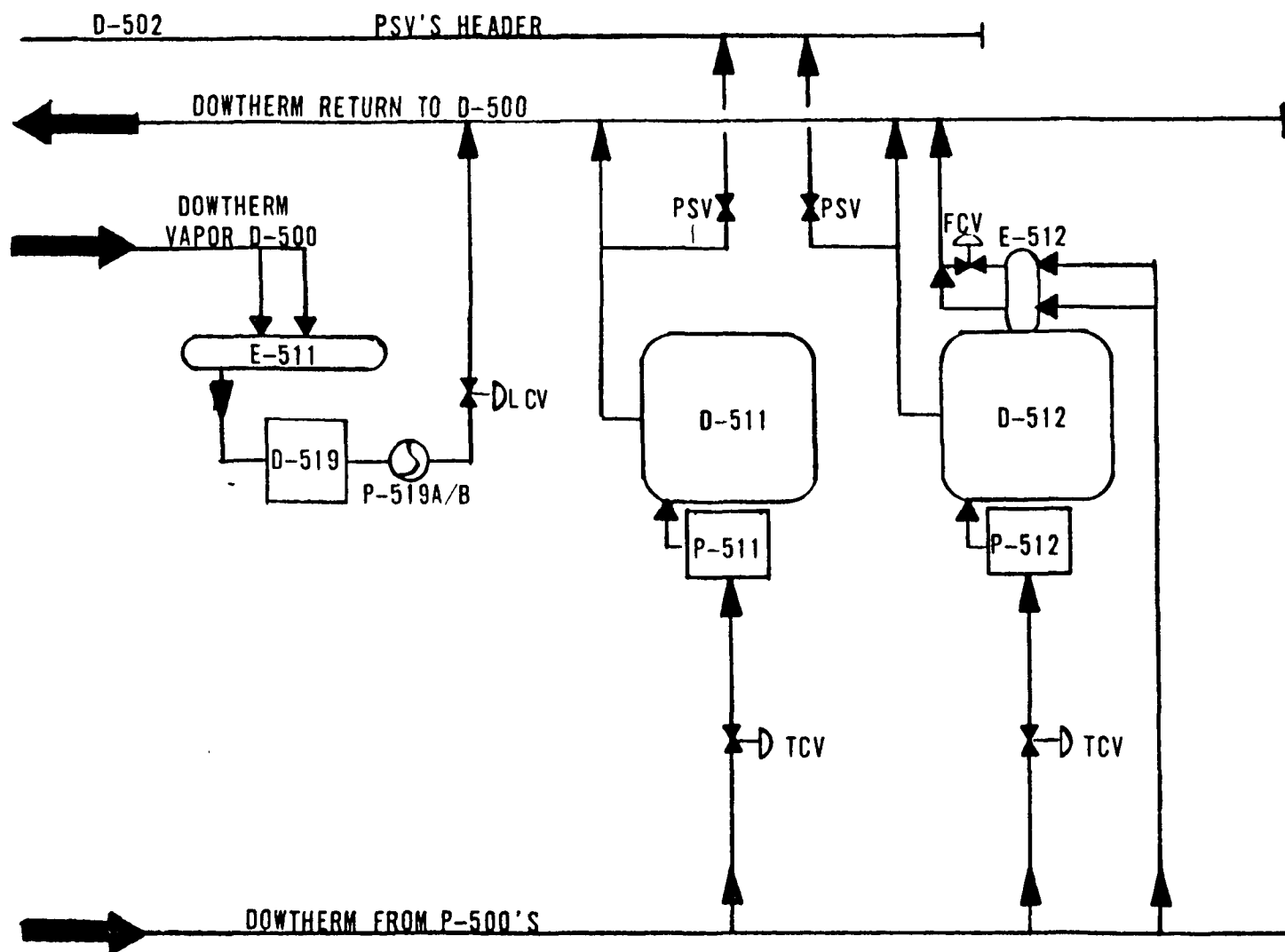
TABLE 18.1
DOWTHERM SYSTEM CONTROLLERS

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
AIC 5002 Air Indication and Control	To maintain an excess % air in the flue gas leaving the furnace (F-501).	By taking the air flow indication (FIC-5004) and multiplying it by a ratio between 0.8 and 12.
PIC 5241 Pressure Indication and Control	D-500 pressure	By controlling the gas valve (PV-5241) and the air valve (PV-5004) to the furnace with relationship to Dowtherm pressure in D-500.
LIC-5243 Level Indication and Control	To maintain level in the Dowtherm flash drum (D-500).	By making up from D-502 to D-500 (LV-5243-B) or by dumping to D-502 (LV-5243-A).
TIC-5251 Temperature Indication and Control	To maintain a set temperature on Train I Dowtherm liquid.	By recycling a portion of Train I return Dowtherm to pump suction through TV-5251-B.
TIC-5252 Temperature Indication & Control	To maintain a set temperature on Train II Dowtherm liquid.	By recycling a portion of Train I return Dowtherm to pump suction through TV-5252-B.
FIC-5004 Air Indication and Controller	To control air flow to the furnace.	By controlling the air valve (PV-5004).
FIC-5029 Fuel Indication and Controller	To control fuel gas flow to the furnace.	By controlling the gas valve (PV-5029).



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FIG 1B 1



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FIG. 18.2

19. CHILLED WATER SYSTEM

19.1 ABSORPTION REFRIGERATION UNITS

The chilled water system is a closed system which supplies cold water to various exchangers, equipment, and Bldg. 8601. Three absorption refrigeration units supply the cold water. These units are tied together and can be run in series or parallel with all or two machines running and one on standby (Fig. 19.2). Steam, cooling tower water, and condensate are needed to run to ARU's to make chilled water.

The ARU's are physically made up of two sections -- upper and lower. Each of these sections is also divided internally into two more sections. These four sections are the evaporator, absorber, condenser, and generator. Water (condensate) is used as the refrigerant and lithium bromide is a water carrier. The unit is kept at a low vacuum (29.7 in Hg) because water at this pressure boils at 40°C.

Half of the lower section is an evaporator through which the chilled water flows and is cooled. The heat contained in the chilled water is given up to the refrigerant water in the evaporator, causing the refrigerant water to boil. There is also a pump on the evaporator. This pump's function is to circulate refrigerant water to spray the tubes through which the chilled water flows to help get better heat transfer.

The absorber is the other half of the lower section. Its function is to absorb the water boiled in the evaporator in order to maintain the vacuum. The water is absorbed readily because of the properties of the lithium bromide solution in the absorber. In the process of absorbing the boiling water, the lithium bromide solution heats up (and also loses capacity to absorb at high

temperatures), therefore cooling tower water is flowing through this section at all times to cool the lithium bromide solution. There is a pump on the absorber also. This pump has three functions -- to pump solution to the generator, to provide the driving force to remove non-condensables from the unit by use of ejectors, and to provide the pressure to purge the unit.

The generator is one half of the upper section. Its function is to remove the water from the lithium bromide solution which then returns by gravity feed to the absorber where it is sprayed over the tubes on entry. The water is boiled off using 15 psig steam.

The condenser is the other half of the upper chamber. Its function is to condense the water boiled off by the generator. It does this by using cooling tower water which has previously cooled the absorber. This condensed water is then returned to the evaporator by gravity feed through a restricting orifice; thus the cycle of the refrigerant water is complete.

The other part on the unit is a heat exchanger which heats the bromide solution going from the absorber to the generator by cooling the bromide solution coming from the generator going to the absorber. This is done to economize on the amount of steam needed in the generator while also requiring less cooling on the absorber. (Figure 19.3)

The temperature of the outgoing chilled water is controlled by steam going into the machine. The capacity control valve (Chilled water temperature controller) modulates steam to the generator and is positioned by a controller which senses leaving chilled water temperature. At full load conditions the control valve is wide open. As the load is reduced and the chilled water temperature drops below the temperature set point, the control valve will start closing. At no load conditions the control valve will be closed.

Low level control extender valve - when condensing water temperature is low, the refrigerant low level control extender valve limits dilution of the lithium bromide solution and maintains enough refrigerant in the evaporator circuit to prevent refrigerant pump cavitation.

When the solution (lithium bromide) approaches over concentration the cycle guard transfer valve opens to transfer refrigerant into the solution circuit and reduce the concentration. A combination of 3 refrigerant level switches and 2 solution temperature switches sense solution concentration to provide step control by the cycle guard device.

Cooling tower water temperature control valve - this valve is located on the cooling tower water outlet of the condenser section. The purpose of this valve is to control the cooling tower water temperature out of the ARU at about 40°C. Too cold cooling tower water leaving the condenser will shut the machine down due to crystallization. Too high a temperature and the machine will not cool efficiently (too much steam used) and chilled water temperature will not be cool enough.

Purge system - properly inhibited, leak tight absorption machines generate hydrogen in very small quantities due to corrosion. (A corrosion inhibitor, lithium chromate, is charged into the machine with the lithium bromide. The inhibitor is used in conjunction with alkalinity control to minimize the amount of non-condensables normally generated within the machine. Excessive non-condensable generation interferes with machine performance. The inhibitor is gradually depleted during machine operation and occasional replenishment is necessary. Solution alkalinity also changes over a period of time and must be adjusted.) Some non-condensables are normally generated within the machine and need to be removed on a continuous basis. During machine operation, lithium bromide sol-

ution from the discharge of the solution pump flows through two ejectors. The absorber purge transfer device discharges directly into the secondary heat exchanger after drawing non-condensables from the absorber. The non-condensables pass from there into the condenser. They are removed from the condenser by a second transfer device and are carried to the separation pot. From the separator pot, non-condensables flow into the storage chamber and solution passes back into the absorber. Purge evacuation is started by closing the solution return valve and purge valve. Solution from the pump discharge is thereby forced into the storage chamber, compressing the non-condensables to a pressure higher than atmospheric. The exhaust valve is opened to pass the non-condensables through the exhaust bottle, and is closed when the non-condensables have been exhausted. To return to normal operation, the return valve is opened to allow the flow of solution back to the absorber and the purge valve is opened to resume purging. The purge operation is continuous, automatic, and motorless. The non-condensables are stored outside the machine, thus avoiding any flow back into the machine. Machines should be purged at least three times per day. (Fig 19.4)

19.3 OTHER EQUIPMENT IN THE SYSTEM

D-202 - chilled water surge tank - capacity _____ gallons

D-908 - condensate makeup tank - capacity _____ gallons

ARU-201, 202, 203, - model 16JB068 - capacity 500 tons each

P-202 A&B - chilled water header pumps

Equipment chilled water is going to:

C-911 & 921 - freon compressors

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E-211B & 221B - product feed exchangers going to reactors

E-515 & 525 - exchangers to chill solvent to vacuum pump seals

E-513B & 523B - second cooling exchanger on vacuum system

Building - control, office-air conditioning

(See Figure 19.1)

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TABLE INDEX FOR THE CHILLED WATER SYSTEM

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
19.1	ARU Specifications
19.2	ARU Instrumentation
19.3	ARU 201 Control Loops
19.4	ARU 202 Control Loops
19.5	ARU 203 Control Loops

FIGURE INDEX FOR THE CHILLED WATER SYSTEM

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
19.1	Chilled Water System
19.2	ARU Chilled Water Flow
19.3	Internals of an ARU
19.4	ARU Purge System

- 1.1 Absorption refrigeration units, Model #16JB068, in accordance with this specification.

Tags Units: ARU-201
ARU-202
ARU-203

- 1.2 Service conditions and design parameters are as follows:

System Type Lithium Bromide/Water

Refrigeration Capacity 1500 tons total

Evaporator:

Chilled Water -

Flow 2278 GPM (Series Flow)
Temperature in 55.8 deg. F.
Temperature out 40 deg. F.
Pressure drop 39.3 ft. H₂O
Fouling factor 0.0005 hr.-sq.ft.-deg. F./BTU

Absorber:

Cooling Tower Water -

Flow 2000 GPM/Unit (Parallel Flow)
Temperature in 90 deg. F
Temperature out 94.6 deg. F
Fouling factor 0.001 hr.-sq.ft.-deg. F./BTU
Pressure supply 60 psig
Pressure return 40 psig

Condenser:

Cooling Tower Water -

Flow 2000 GPM/Unit (Parallel Flow)
Temperature in 94.6 deg. F.
Temperature out 102.2 deg. F.
Pressure drop 32.3 ft. H₂O (Absorber plus Condenser)
Fouling factor 0.001 hr.-sq.ft.-deg. F./BTU

Generator:

Steam -

Flow at full load 9925 lb./hr.
Pressure 15 psig (saturated steam)

Cooling water to flow thru absorber and condenser in series.

TABLE 19.1

TABLE 19.2 - INSTRUMENTATION FOR ARU's

The instrumentation on each ARU is identical but below is for ARU-201.

1) Field mounted instrumentation:

- A) PI 2021 - steam pressure downstream of the capacity control valve.
- B) Light for low chilled water inlet flow.
- C) Light for cycle guard being open.
- D) Light for low level in the absorber.
- E) Light on low chilled water temperature.
- G) Hand switch for PS-201.
- H) Hand switch for PR-201.
- I) Control panel for ARU-201.

2) Control Room Instrumentation:

- A) Steam:
 - 1) TIC 2008 - capacity control valve - controls chilled water temperature by controlling steam flow.
- B) Cooling tower water:
 - 1) TIC 2009 - cooling water outlet temperature controller. Controls outlet temperature by restricting or opening control valve on the water inlet.
 - 2) FI 2014 - indicates incoming flow. Alarms on high and low flow.
 - 3) TI 2022 - indicates temperature leaving absorber.
- C) Chilled water:
 - 1) TI 2015 - entering chilled water temperature.
 - 2) TT 2008 - leaving chilled water temperature. Signal goes to TIC2008 which controls the capacity control valve.
 - 3) FI 2016 - entering chilled water flow. Alarms on high and low flow will close the capacity control valve if flow gets too low.
- D) Refrigerant Section:
 - 1) LSH 2029 - these switches sense 2 upper levels of refrigerant in LSH 2030 the evaporator. Each is tied into 2 temperature elements on the strong solution downstream of the heat exchanger. At a specific temperature and level they will activate the cycle guard valve and dump refrigerant into the suction of PS-201 thereby diluting the solution and lowering the level in the evaporator.
 - 2) LSHH 2028 - this switch will activate the cycle guard valve no matter what the solution temperature is. This is the highest level point in the evaporator.
 - 3) TI 2017F - temperature inside the evaporator.
 - 4) TSL 2019 - low chilled water temperature cutout. When this switch is activated, the solution pump (PS 201) and capacity control valve (TV 2008) will close.

TABLE 19.2 (CONT'D)

E) Solution Section:

- 1) TI 2017A - solution temperature from the absorber to the suction of PS 201.
- 2) TI 2017B - solution temperature after heat exchanger going to the generator.
- 3) TI 2017C - strong solution temperature from generator.
- 4) TI 2017D - strong solution temperature after heat exchanger.
- 5) TI 2017E - high level overflow line from generator (temperature increase on this line would indicate solution is solidifying in the heat exchangers)

G) ARU 201 Control Panel:

- 1) Alarm when unit shuts down.
- 2) Indication when purge is needed.
- 3) Indication when cycle guard valve is energized.

TABLE 19.3

CHILLED WATER CONTROL LOOPS

(FOR ARU-201)

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
TIC 2008	Controller for leaving chilled water temperature.	Receives signal from TT 2008. Temperature is controlled by operating TV 2008 and varying steam to the unit. Valve is air to open.
TIC 2009	Controller for leaving cooling tower water temperature.	Receives signal from TT 2009 on cooling water tower leaving the unit and controls the temperature with TV 2009 on the incoming CWT header. Valve is air to close.
LSLL 2031	To prevent cavitation of refrigerant pump.	On a low level in the refrigerant section, the low level control extender valve (LV 2031) will open, allowing solution to flow into the section.
LSHH 2028 LSH 2029 LSH 2030 TSL 2024 TSL 2025	To prevent over concentrations of the lithium bromide.	LSH 2029 and TSL 2024 operate LV 2028. At a given temperature and level they will, open the valve. LSH 2030 and TSL 2025 do the same but at a different temperature and level. LSHH 2028 alone opens LV 2028.

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TABLE 19.4

CHILLED WATER CONTROL LOOPS

(FOR ARU-202)

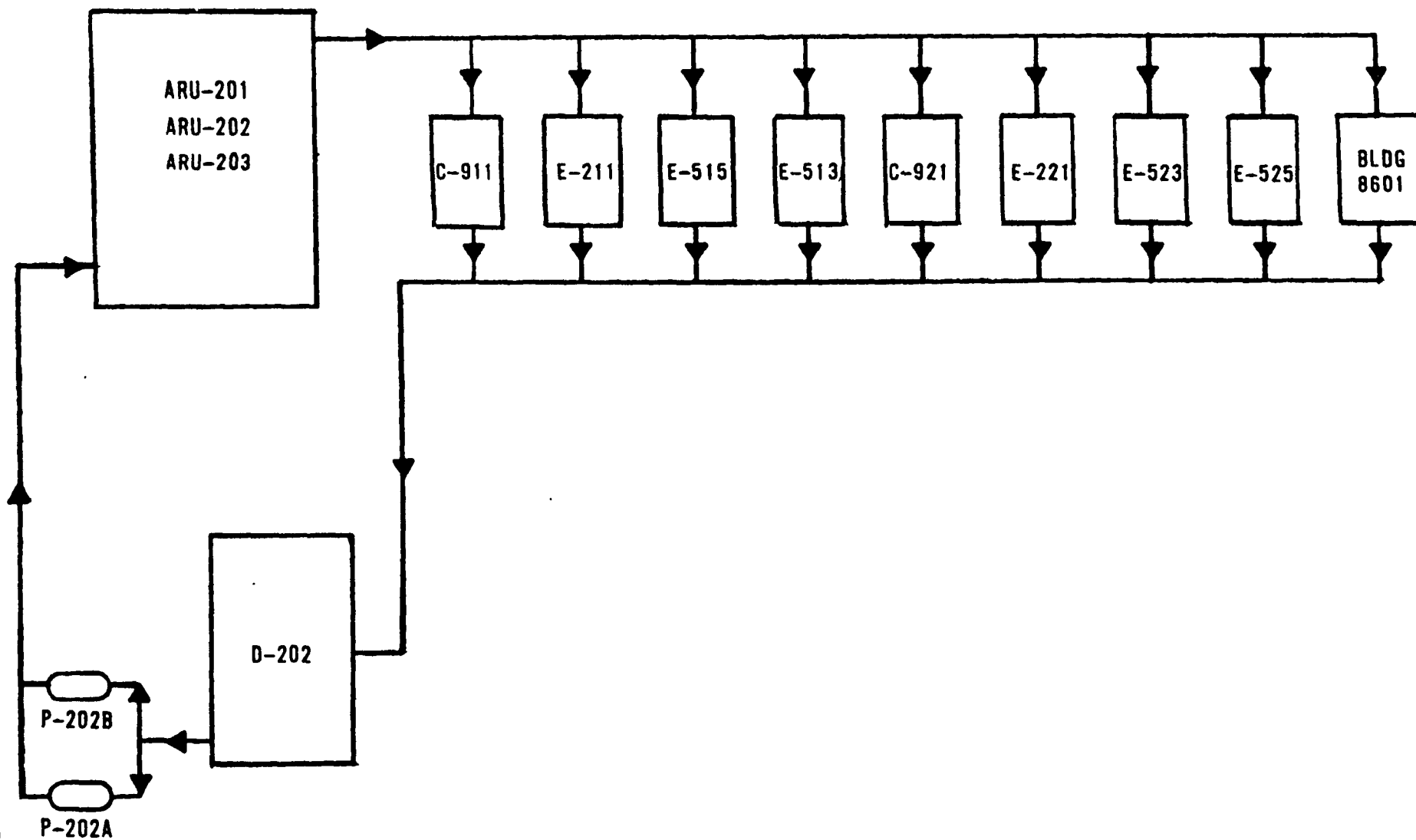
<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
TIC 2144	Controller for leaving chilled water temperature.	Receives signal from TI 2144. Temperature is controlled by operating TV 2144 and varying steam to the unit. Valve is air to open.
TIC 2142	Controller for leaving cooling tower water.	Receives signal from TI 2142 on the CTW leaving the unit and controls the temperature with TV 2142 on the incoming CTW header. Valve is air to close.
LSLL 2160	To prevent cavitation of the refrigerant pump.	On a low level in the refrigerant section, the low level control extender valve (LV 2160) will open allowing solution to flow into the section.
LSHH 2157 LSH 2159 LSH 2158 TSL 2153 TSL 2154	To prevent over concentration of the lithium bromide.	On a given temperature and level TSL 2153 and LSH 2158 will open LV 2157. At another given temperature and level TSL 2154 and LSH 2159 will open LV 2157. LSHH 2157 alone will open LV 2157.

TABLE 19.5

CHILLED WATER CONTROL LOOPS

(FOR ARU-203)

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
TIC 2341	Controller for leaving chilled water temperature.	Receives signal from TT 2341. Temperature is controlled by operating TV 2341 and varying steam to the unit. Valve is air to open.
TIC 2343	Controller for leaving cooling tower water.	Receives signal from TT 2343 on the CTW leaving the unit and controls the temperature with TV 2343 on the incoming header. Valve is air to close.
LSLL 2357	To prevent cavitation of the refrigerant pump.	On a low level in the refrigerant section, the low level control extender valve (LV 2357) will open allowing solution to flow into the section.
LSHH 2354 LSH 2355 LSH 2356 TSL 2350 TSL 2351	To prevent over concentration of the lithium bromide.	At a given temperature and level TSL 2350 and LSH 2356 will open LV 2354. At another given temperature and level TSL 2341 and LSH 2355 will open LV 2354. LSHH-2354 alone will open LV 2354.
D-202 LIC 2003	Maintain desired level.	Receives signal from LT 2003. LV-2003 opens/closes and receives and from D-908. Valve is air to open.



CHILLED WATER SYSTEM

CHILLED WATER
RETURN

D-202

P-202A

P-202B

ARU-201

ARU-202

ARU-203

CHILLED WATER
DISTRIBUTION

ARU'S CHILLED WATER FLOW

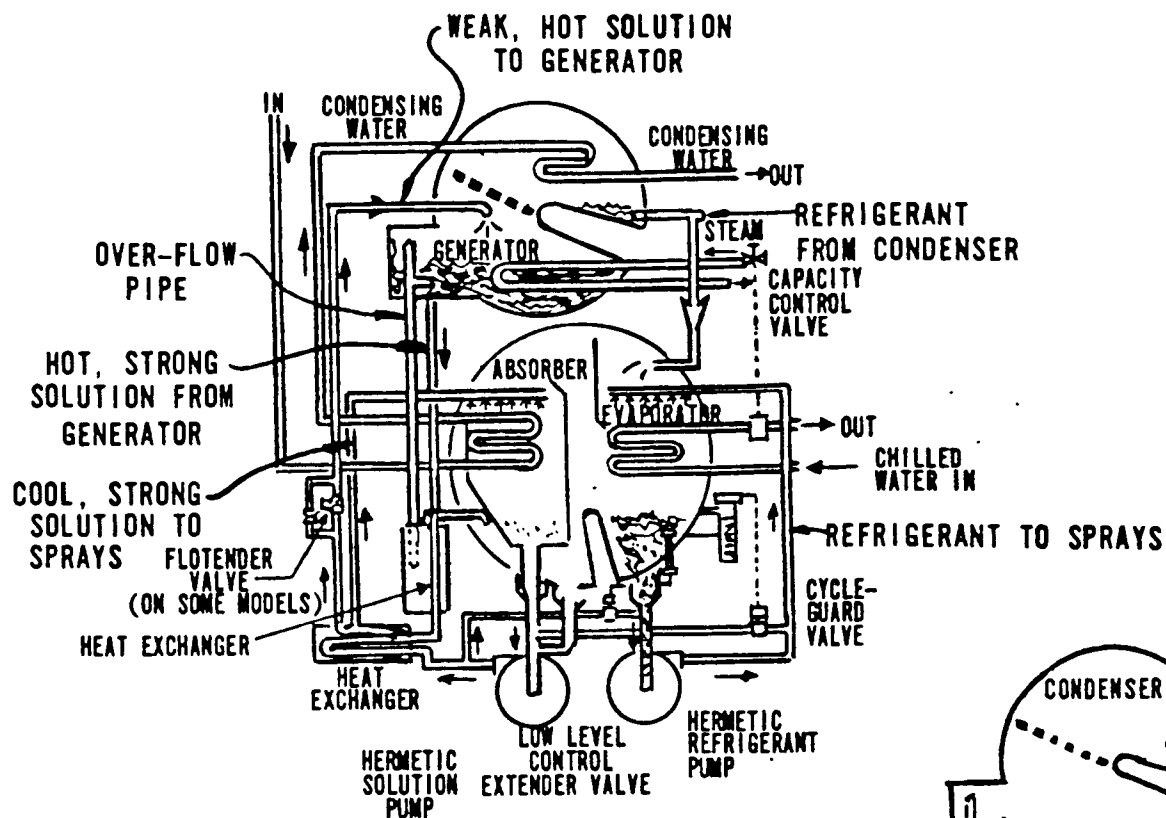
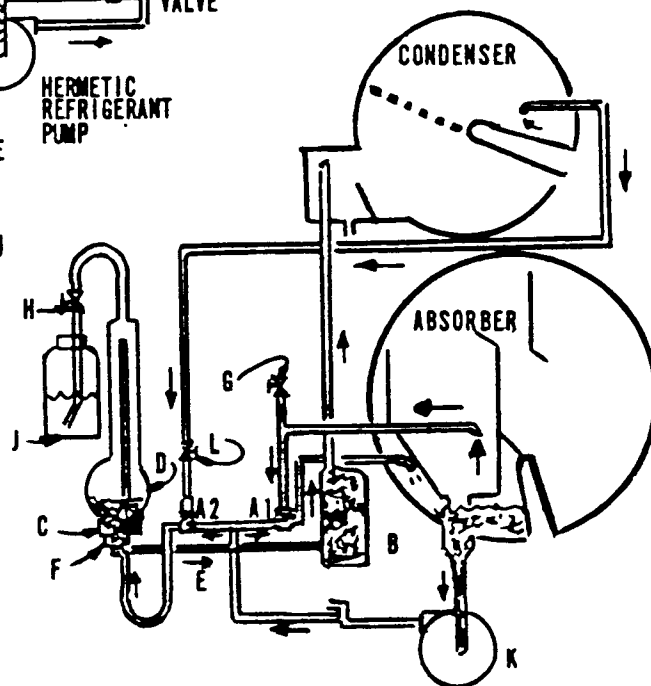


FIG. 19.3

INTERNALS OF AN ARU



LEGEND

A1-ABSORBER TRANSFER DEVICE	G-AUXILIARY EVACUATION VALVE
A2-CONDENSER TRANSFER DEVICE	H-EXHAUST VALVE
B-SECONDARY HEAT EXCHANGER	J-EXHAUST BOTTLE
C-SEPARATION POT	H-HERMETIC SOLUTION PUMP
D-STORAGE CHAMBER	J-PURGE VALVE
E-SOLUTION RETURN VALVE	(LATER MODELS ONLY)
F-LEVEL INDICATOR	

FIG. 19.4 ARU PURGE SYSTEM

ARU DRAWING

20. COOLING TOWER

This portion of the plant is a closed, recirculating cooling tower system where hot water from exchangers and other water cooled equipment in the plant enters the top of the cooling tower and falls, in drops, to the bottoms of the tower. Air is drawn into the bottom of the tower and out the top by a fan, thus cooling the water as it falls through the tower (Fig. 20.3).

20.1 NORMAL FLOWS

Cold water from the cooling tower sump is pumped with P-901 A, B, C through various pieces of equipment in the plant and returns to the top of the tower. Through spray nozzles, the hot water falls through the tower and is cooled. Water is evaporated as it falls through the tower. This is how the water is cooled but also represents a loss of water which must be made up.

Process water is used to make up for the loss of water through evaporation and blowdown. The cooling tower sump is level controlled and opens the level control valve when the water level starts dropping. Process water contains a certain amount of dissolved solids. If we continued to add these dissolved solids without removing them, the system would soon fill up with solids, silt, scale, and foulants. The cooling tower must continually be blown down to the drain.

Another way of removing undissolved solids, (mud, dirt, dead micro-organisms), is FL901, the cooling tower side stream filter. Approximately two percent of the cooling tower flow is filtered through FL901 and re-enters the cooling tower sump. The filter automatically backwashes itself when the differential pressure between the inlet and outlet reaches a given point (Fig. 20.2).

20.2 TREATING SYSTEM

A properly treated cooling tower system is the only way to insure that the field equipment and piping doesn't corrode, and the tower operates properly without clogging, rotting, or filling up with silt. Proper treatment helps keep treatment costs down and minimizes down time due to the above problems.

The pH of the system is controlled by adding 35% aqueous HCl into the tower sump. The pH is monitored and controlled. pH should be maintained at 6.8 - 7.2, checked and recorded once per shift. High pH results in scale formation on metal, which results in poor heat transfer and increased corrosion due to scale formation. Low pH results in corrosion of metal and formation of foulants and scale, which again causes poor heat transfer in cooled equipment.

Inhibitors are used to coat the metal with a film of protective material to reduce corrosion. Betz 2040 inhibitor is a special blend of organic and inorganic inhibitors which does not contain chromate. This product is designed to control corrosion and scale formations in open recirculating cooling water systems. Because Betz 2040 does not contain heavy metals, it enables plants to comply with local water quality standards. A small amount of inhibitors is continuously added to the system to maintain protection. Samples should be taken daily, analyzed, and recorded. Rates should be adjusted to maintain _____ PPM. Low concentration levels results in increased corrosion and scale formations. High level concentrations are unnecessary and result in higher cost of operating this system.

Betz 2020 inhibitor is a special organic deposit control agent designed to control calcium phosphate formation in open recirculating cooling water

systems. This chemical promotes the formation of a passivating gamma iron oxide film to coat the walls of the piping and equipment.

Betz 2040 also contains an organic dispersant to control fouling due to suspended solids and other calcium salts. The actual concentrations of Betz 2020 and 2040 will be determined by Betz Laboratories and technical personnel in the Dowlex plant.

Chlorine is added to the tower to control micro-biological growth. Too little chlorine results in micro-biological growth (bug fouling) which in turn results in scale formation. Too much chlorine results in ecology and safety hazards. A sample should be taken daily to determine parts per million residual chlorine. This should be maintained at _____ PPM.

Biocides are used to control bug growth and are added on a "slug" basis once and twice a week as prescribed by the cooling tower treatment representative. Insufficient control results in growth of micro-organisms, fouling, scale formation, and corrosion. Generally, biocides are hazardous to health and should be handled with extreme care.

20.3 EQUIPMENT ASSOCIATED WITH THE COOLING TOWER ARE:

FN-901 A/B - (Cooling tower fans) 125 hp motors with two speed operation.

P-901 A/B/C - Cooling tower water recirculating pumps. Each capable of pumping 9,250 gpm. Two will be in operation with one spare.

D-901 A/B - Betz 2020 & 2040 storage tanks

FL-901 - Cooling tower side stream filter

Equipment cooling tower water flows to, is on Figure 20.1.

For instrumentation on the tower see Table 19.1 and Figure 20.5.

TABLE INDEX FOR COOLING TOWER SYSTEM

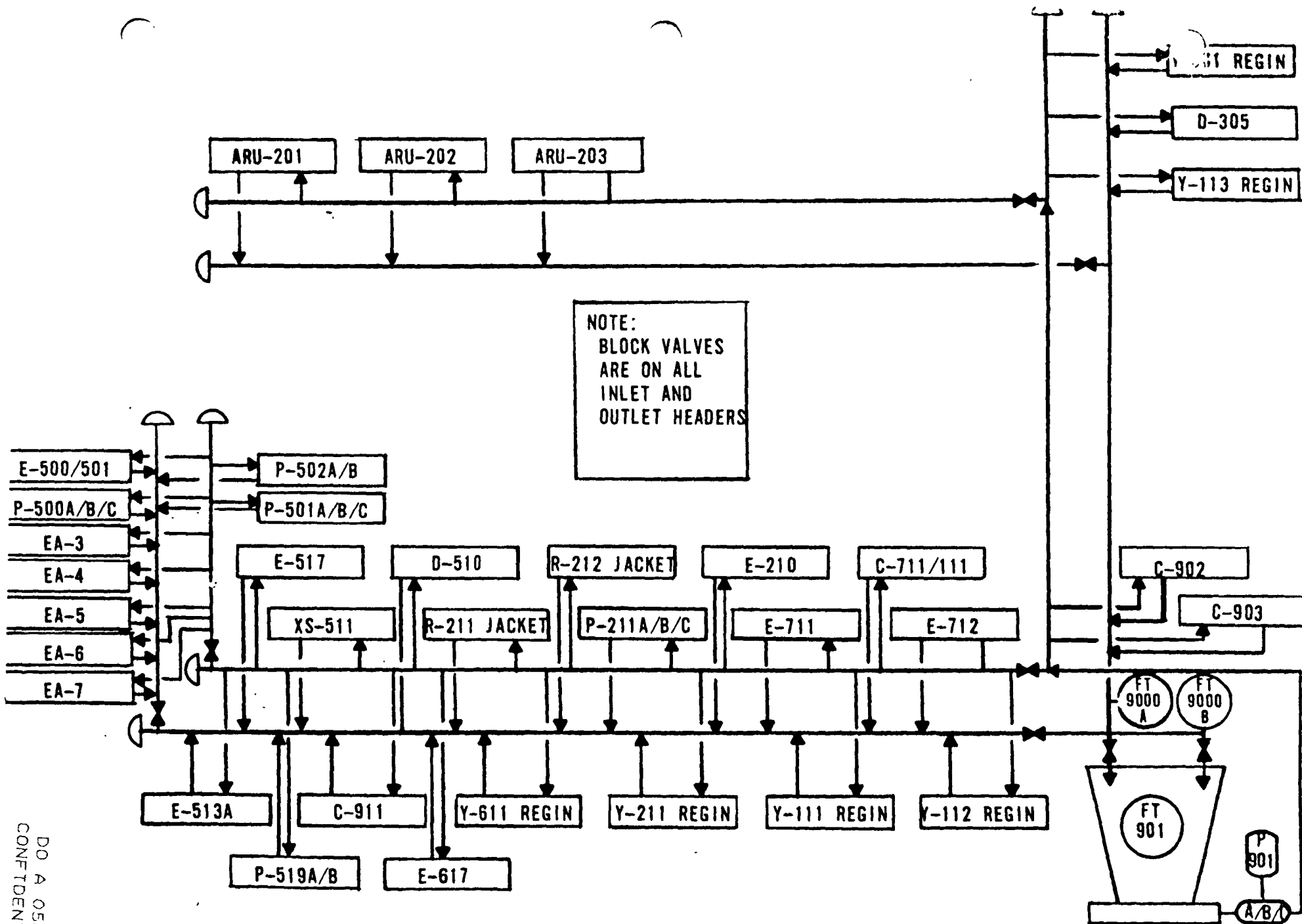
<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
20.2	Cooling Tower Water Control Loops

FIGURE INDEX FOR COOLING TOWER SYSTEM

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
20.1	Cooling Tower Water Flow Path
20.2	FL-901 and Valve Arrangements
20.3	Cooling Tower
20.4	Chemical Addition Locations
20.5	Cooling Tower System Instrumentation Locations

TABLE 20.1
COOLING TOWER CONTROL LOOPS

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC 9007	Controls Cl ₂ flow to tower.	Receives signal from FT 9007. Valve (FV-9007) is air to open. Valve will close on low cooling tower water flow reading on FT-9007 A/B.
PHIC 9017	Control tower water pH.	Increases or decreases HCl additive depending on setpoint. Receives signal from PHE 9017 inside the tower. Air to open valve (PHV-9017) Valve will close on low cooling tower flow reading on FT 9000 A/B.
LIC 9015	Controls level in tower.	Receives signal from LT 9015 and regulates makeup water from the process water header. Control valve (FV 9001) is air to open.
AIC 9019	Control tower water conductivity.	Receives signal from AE 9019 and controls conductivity by setpoint. Control valve (AV 9019) is air to open.
FIC 9001	Flow controller to FL-901.	Receives signal from FT 9001 air to open valve (FV-9001).



COOLING TOWER DISTRIBUTION

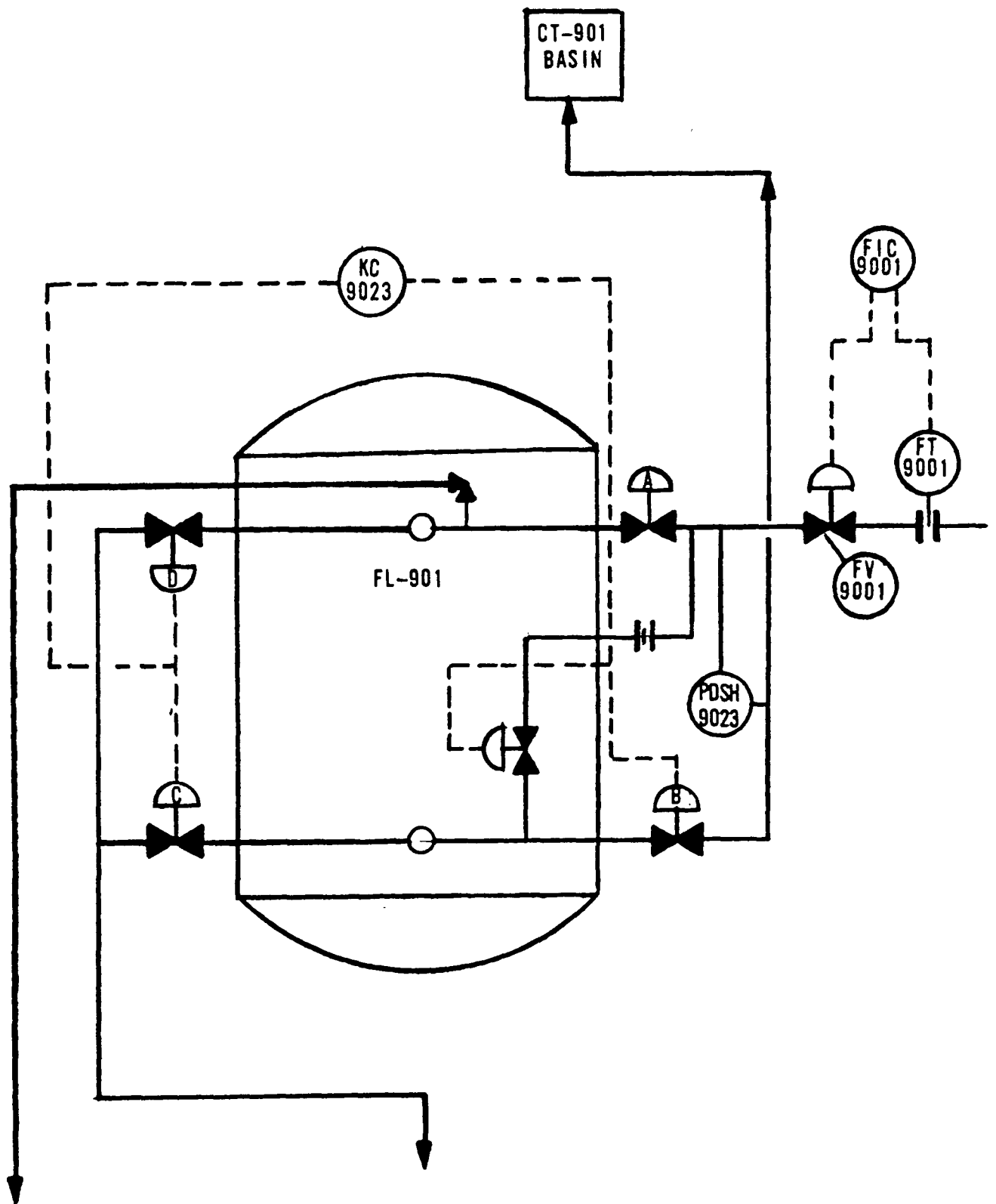


FIG. 20.2

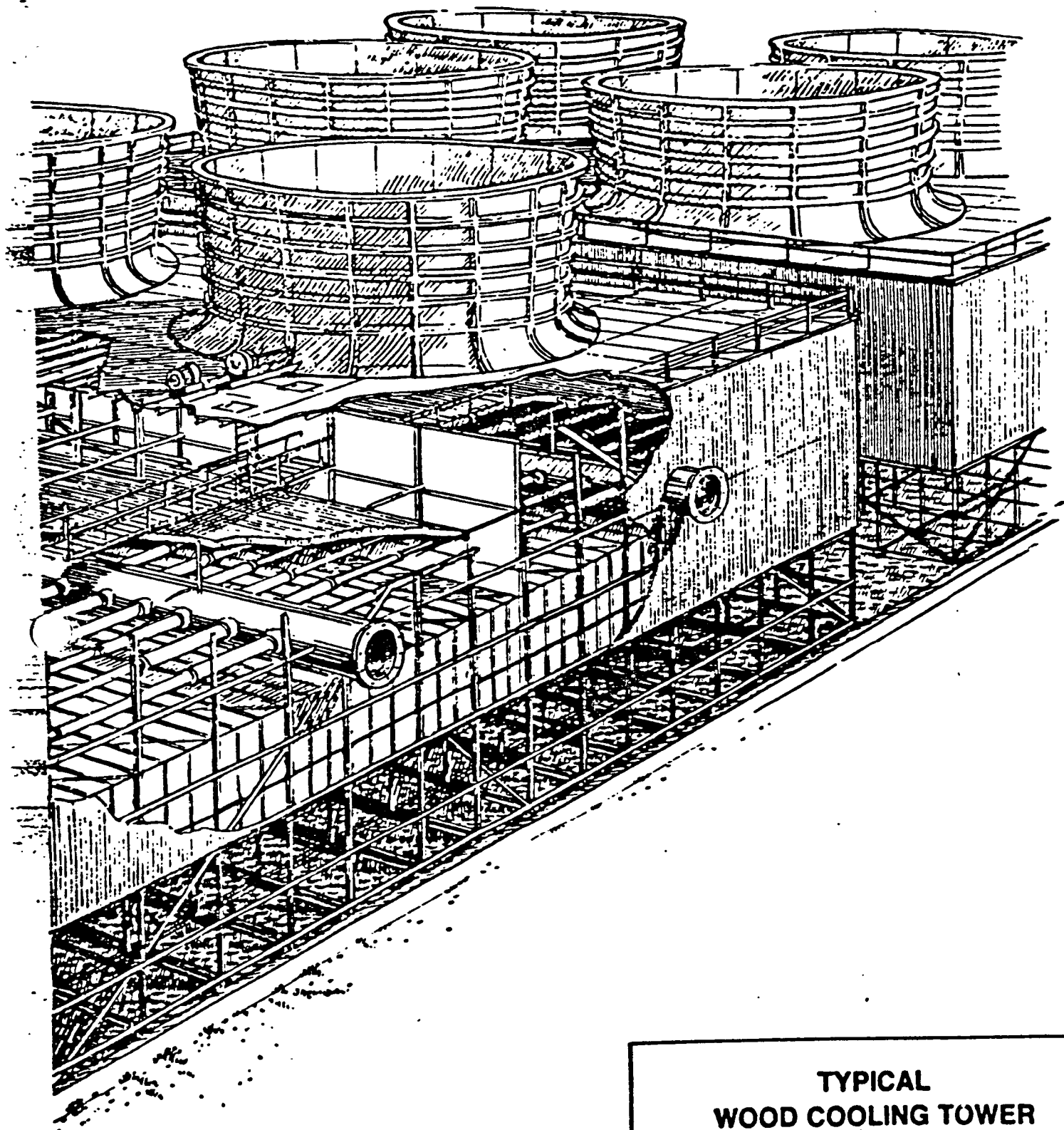


FIG. 20.3

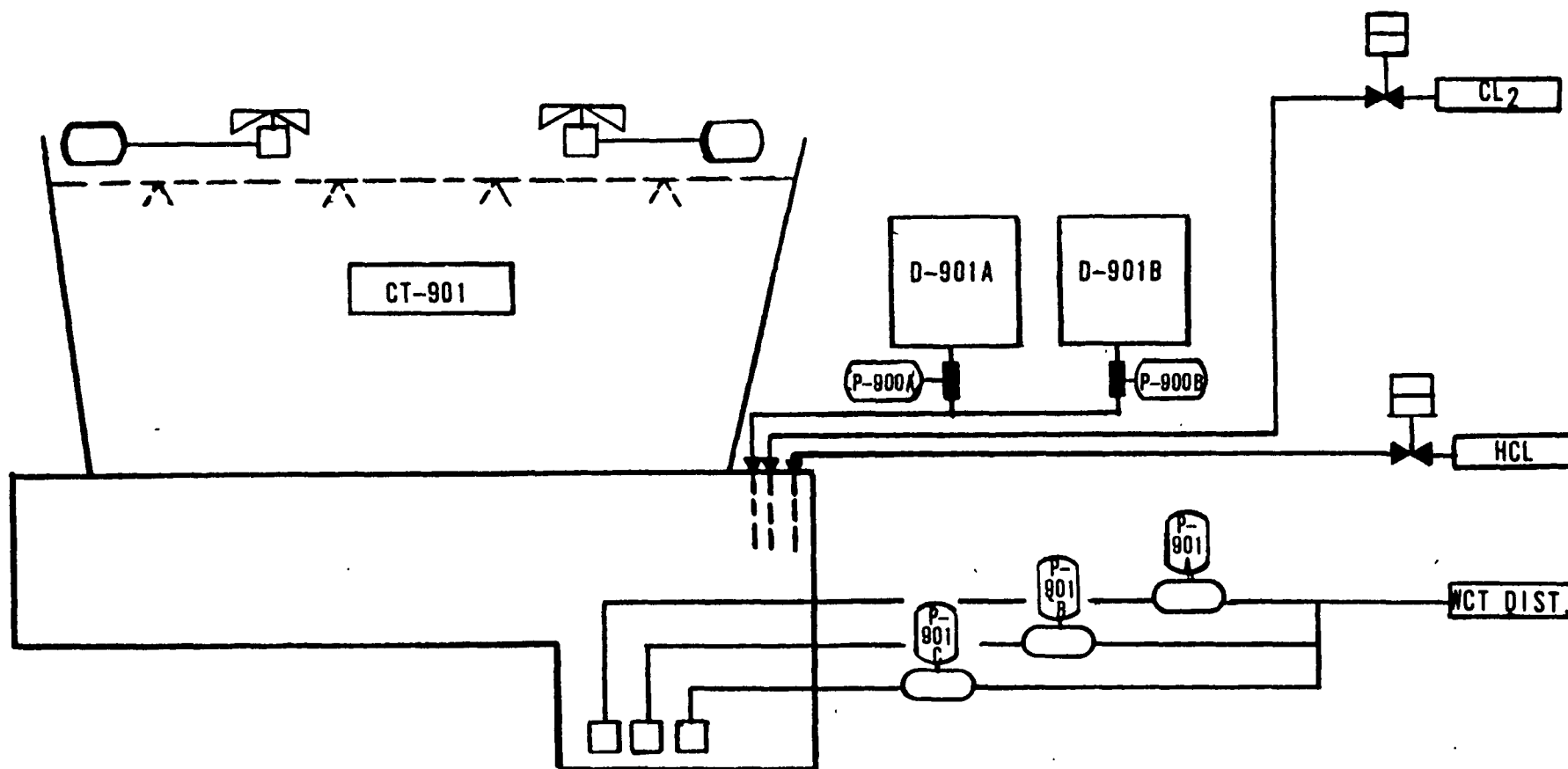
**TYPICAL
WOOD COOLING TOWER**

Research-Cottrell

Hamon Cooling Tower Division

P. O. BOX 755 BOUND BROOK, NEW JERSEY 07005

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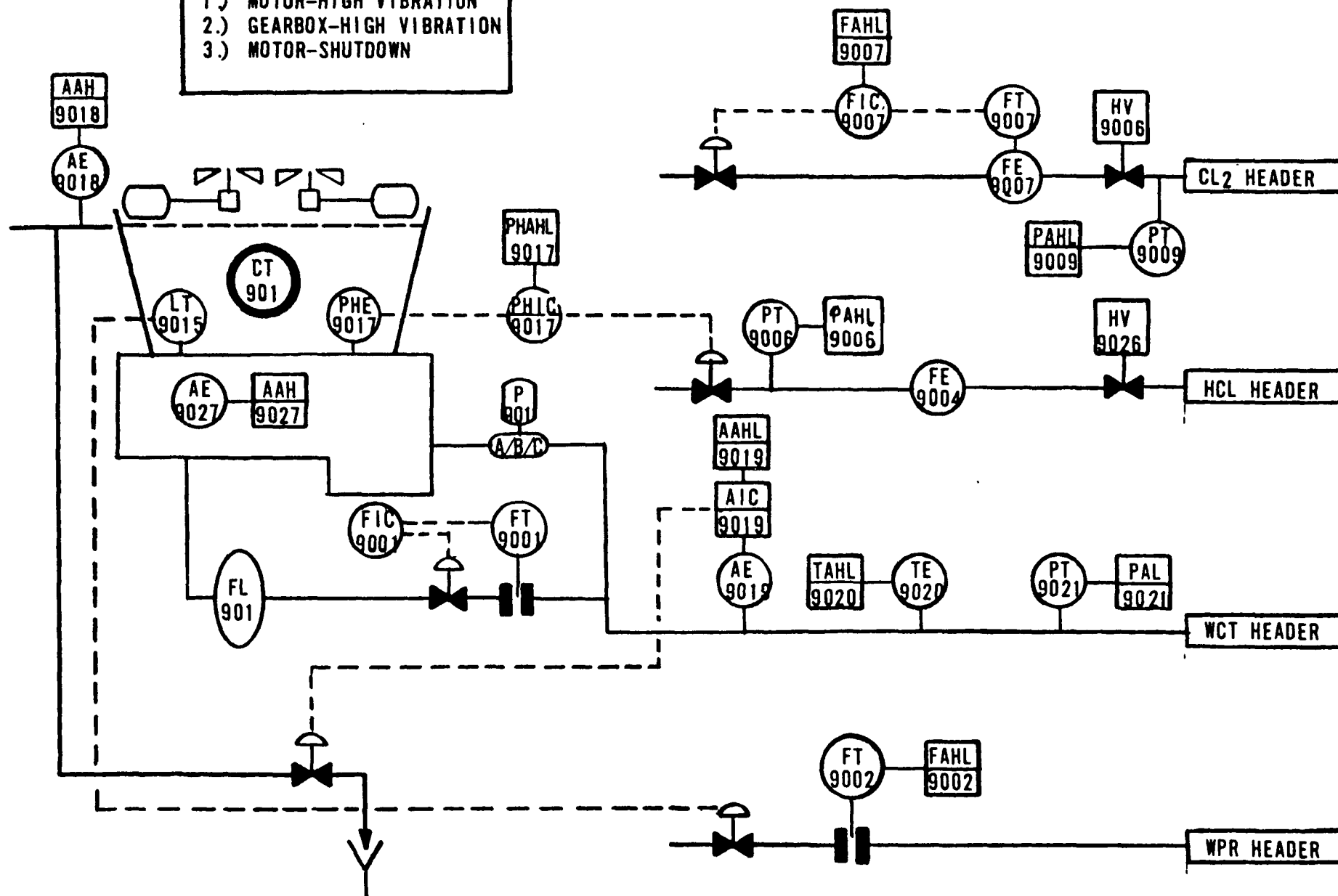


COOLING TOWER ADDITIVES

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COOLING TOWER FAN ALARMS

- 1) MOTOR-HIGH VIBRATION
- 2) GEARBOX-HIGH VIBRATION
- 3) MOTOR-SHUTDOWN



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FIG. 20.5

21. OTHER UTILITIES

21.1 PROCESS WATER

Process water enters the block from the division header and is used for cooling tower water makeup, utility stations, on D-300 (HCl weight tank for catalyst mixing), D-308 (catalyst dump tank), D-212 and D-222 (reactor dump vessels). There is a flow transmitter on the incoming line with alarms to indicate low pressure and high flow. Normally the division header pressure runs between 60 and 80 pounds. (See figure 21.1)

21.2 NITROGEN

Nitrogen is an inert gas used mainly for purging or padding equipment. Flow, temperature and pressure are recorded in the control room. There are also two oxygen analyzers. Nitrogen enters the block at 400 psig, goes through a restricting orifice where it tees off, one line going to the reactors and the other going to various pieces of equipment and utility stations. The latter line has a pressure control valve that steps 400 psig nitrogen down to 100 psig. N₂ also keeps a purge on flare (vent) header. (See fig. 21.2)

21.3 STEAM AND CONDENSATE

There are two sources of steam in our plant. One internal and one external supply. The internal source is steam generated from E-611 and E-621. Hot solvent (180°C) flowing through the tubes heats condensate on the shell side producing steam controlled at 15 psig. This steam's primary use is for absorption refrigeration units, steam tracing, potable water temperature controller, and building heating. The condensate returned from this system is collected in

D-908. There, condensate is sent to E-611, E-621, D-202 (chilled water surge drum), and DPW-500 (pellet water drum). Excess condensate is sent to the division power plant. P-908 A/B forwards the condensate to the above locations. (Figure 21.32)

The 15 psig steam is controlled by the levels in E-611 and E-621 and by a pressure control valve (PV-9148) located downstream of D-907 (steam/condensate surge drum). If the pressure rises above set point this control valve opens and allows the excess steam to flow into E-908 (fin-fan cooler) and be condensed. Steam condensed in E-908 gravity flows into D-908 (condensate storage tank). In case of a low level in D-908, condensate from the division header is used. There are two control valves on the condensate out header, one to send condensate out and one to receive condensate. These two valves are split range, both receiving their signals from D-908 level transmitter. There is also a conductivity probe on the condensate out header. This probe measures in MHOS, an indication of impurities in the condensate. (Rust, acid, caustic, etc.) On a high conductivity reading, a signal is sent to a three way valve downstream of the D-908 level control valve. This valve will dump the condensate to the ditch. When the conductivity returns in range, around 10 MHOS, the three way valve will switch back to normal and send condensate out the block.

On low 15 psig steam pressure, 235 psig steam can be introduced manually into D-907 to raise the pressure. 235 psig is our external source of steam and is received from the division power plant. This steam goes to all reactor jackets, regeneration systems, side-arm extruders, the flare, devolatilizer tracing, reactor blowdown jackets, D-510 (hot melt additive tanks), and polymer solution pipe jacketing and tracing. The 235 psig steam is metered for pressure, temperature and flow. Alarms are set up on these variables (high

and low). Condensate trapped from the 235 psig steam system goes into D-907, where it flashes, the steam going into the 15 psig steam header, and the condensate, level controlled into D-908. (See fig. 21.31) All steam traps in the plant are the 'TLV' type with automatic internal venting and by-pass for start-up conditions.

21.4 PLANT AIR SYSTEM

Air from Dowlex is supplied from two Joy air compressors (C-902 and C-903). These are three stage centrifugal compressors driven by 800 hp, 3600 RPM motors. The compressors are capable of putting out 3000 SCFM of air each. Normally one compressor will run with one as a spare.

Associated equipment with C-902 are:

- 1) FLY-902 (coalescer - filter) to remove moisture before entering the dryers.
- 2) Y-902 (air dryers) - are loaded with activated alumina to absorb moisture. There are two separate beds in this system, one on the line and the other in a regeneration cycle. These beds switch automatically every 10 minutes. When a dryer goes into a regeneration cycle, the dryer depressures to atmosphere, then dry air from the other dryer purges through this dryer. After this step, the dryer is pressured up and is switched back on the line with the other going through the regeneration cycle.
- 3) FL-902 A/B - From the dryers, the air goes through FL-902 A/B to remove any alumina, rust, etc., in the air. These filters have to be switched manually and should be switched when a 10 psig pressure differential develops.

From the filters the air goes to the air headers throughout the plant.

Figure 21.41 shows the air network in the plant.

Instrumentation on the air system are as follows:

- 1) FLY-902 - (PDT 9296) - measures differential pressure across the knock out pot. Alarms on high differential pressure.
- 2) FL-902 A/B - (PDT 9291) measures differential pressure across the filter. Alarms on high differential pressure.
- 3) Outlet of FL-902 A/B:
 - a) AE 9295 - measures the dew point of the air going to the plant. Alarms on high reading.

- b) FT 9294 - measures total plant air use. Alarm on high and low flow.
- c) PT 9293 - measures pressure on air header. Alarms on high and low pressure.
- d) PSL 9289 - pressure switch that will start the spare air compressor upon a given air pressure. Alarms on low pressure.

Figure 21.42 shows the above instrumentation.

The following is information on our air compressors. C-902 and C-903 are identical but the equipment and instrumentation listed below is for C-902.

- A) Oil System - this is a force feed lubrication system. The main oil pump (POC-902A) is gear driven from the compressor drive shaft. The auxilliary oil pump must be started and oil up to pressure before the main drive motor will start. The auxilliary oil pump (POC-902B) will have a hand-off-auto (HOA) switch which should be in the automatic position at all times. On low oil pressure, this pump will automatically start. Also this pump has to be running in order for the air compressor to start automatically. From the discharge of the oil pump, the oil goes through a cooler (E-902D) then a filter (FL-902 A/B). These filters are full flow twin filters and use 10 micron filter elements. These filters have to be manually switched after a 10 pound differential pressure. From the filter the oil goes to the compressor. From the compressor, the oil flows into a reservoir and is pumped through the system again. In the reservoir, there is a heater used to heat the oil during startup conditions. Normal operations is for the oil temperature to run between 110°F and 120°F. The pressure inside the lube oil reservoir is kept low to minimize oil leaks. This is accomplished by using an ejector which vents the gasses and returns the entrapped oil to the reservoir. (Refer to Fig. 21.43)

Oil System Instrumentation:

- A) Field mounted instrumentation
 - 1) Temperature indicators
 - a) Before E-902D
 - b) After E-902D
 - c) After FL-902 A/B
 - 2) Pressure indicators
 - a) Before FL-902 A/B
 - b) After FL-902 A/B
 - c) Before C-902 inlet
 - 3) Temperature controllers
 - a) Lube oil temperature controllers
- B) Field panel mounted instrumentation
 - 1) Light for POC-902B running
 - 2) Light for low panel purge flow
 - 3) Light for low oil pressure from (PSL 9268)
 - 4) Light for high oil pressure from (PSL 9269)

- 5) H. O. A. switch for PC-902B
- C) Instrumentation monitored in the control room
 - 1) PAL 9236 - low oil pressure alarm
 - 2) TSH 9235 - high temperature alarm

The air compressor has two intercoolers (E-902 A & E-902B), and one aftercooler (E-902C). Cooling tower water is the cooling media for these exchangers. The leaving air from E-902C should be around 100°F. The following is a list of instrumentation on the air compressor air system. (Refer to Fig. 21.44)

- A) Field mounted instrumentation
 - 1) Temperature indicators
 - a) Inlet to E-902A
 - b) Outlet from E-902A
 - c) Inlet to E-902B
 - d) Outlet from E-902B
 - e) Inlet to E-902C
 - f) Outlet from E-902C
 - 2) Pressure indicators
 - a) 3rd stage discharge
 - b) downstream of E-902C
- B) Field panel mounted instrumentation
 - 1) Light for high temperature from E-902C from a temperature switch
 - 2) Light for high pressure from PSH 9225
 - 3) Push button for MC-902 start
 - 4) Push button for MC-902 stop
 - 5) Lights for excessive vibration, high vibration, and vibration probe not okay
 - 6) Light for okay to start
 - 7) Light for power on
- C) Instrumentation monitored in the control room
 - 1) PAH 9225 - high discharge pressure
 - 2) CPA 9223 - preliminary alarms
 - a) low purge pressure
 - b) high vibration (alert)
 - c) auxilliary lube oil pump running
 - d) vibration probe not okay
 - 3) SDA 9217 - shutdown alarms
 - a) low oil pressure
 - b) high oil temperature
 - c) high air temperature
 - d) excessive vibration (DANGER)
 - 4) Control valves in air system
 - a) FV 9219 - suction valve - position is controlled by MC-902 amps

- 2) FV 9220 - discharge high pressure controller. On high discharge pressure, PSH 9225 sends a signal to SOV 9225 (solenoid valve). SOV 9225 dumps the air to FV 9220 opening it. FV 9220 is an air to close valve. When FV 9220 opens, FV-9219 closes. When discharge (air) pressure gets below PSH-9225 setpoint, FV 9220 closes and FV 9219 opens back up.

NOTE: Normally FV 9219 will be controlling in the throttled position depending upon air usage.

AIR COMPRESSOR MANUAL

- I. BASIC DESCRIPTION
- II. MANUAL OPERATING CONDITIONS
- III. LUBRICATION
- IV. CONTROLS
- V. INSTRUMENTATION -- ALARMS AND TRIPS
- VI. START-UP AND SHUTDOWN PROCEDURES
- VII. ROUND CHECKS
- VIII. TROUBLE-SHOOTING GUIDE

9/29/81

I. BASIC DESCRIPTION

C-902 AND C-903 ARE THREE-STAGE CENTRIFUGAL JOY AIR COMPRESSORS DESIGNED TO SUPPLY THE DOWLEX BLOCK WITH INSTRUMENT AND UTILITY AIR AT A PRESSURE OF 115 LBS. THESE COMPRESSORS ARE DRIVEN BY 2 GENERAL DYNAMICS 800 HP 3595 RPM MOTORS. ALSO SUPPLIED WITH THE UNIT IS A RECIRCULATING COOLED AND FILTERED OIL SYSTEM WITH AN AUXILIARY BACK-UP. THE CONTROL PACKAGE CONSISTS OF A PRESSURE CONTROL SYSTEM, SAFETY PROTECTION DEVICES, MOTOR OVERLOAD PROTECTION, VIBRATION MONITORS AND AUXILIARY OIL PUMP START-UP.

9/29/81

II. NORMAL OPERATING CONDITIONS

A. COMPRESSOR

- 1) FLOW - 3327 CFM
- 2) 1ST STAGE PRESSURE - 40#
- 3) 2ND STAGE PRESSURE - 70#
- 4) 3RD STAGE PRESSURE - 114#
- 5) 1ST STAGE OUTLET TEMPERATURE
- 6) 2ND STAGE INLET TEMPERATURE - 90 DEG F TO 110 DEG F
- 7) 2ND STAGE OUTLET TEMPERATURE
- 8) 3RD STAGE INLET TEMPERATURE - 90 DEG F TO 110 DEG F
- 9) 3RD STAGE OUTLET TEMPERATURE - 340 DEG F
- 10) AFTER COOLER TEMPERATURE - 90 DEG F TO 110 DEG F
- 11) 1ST AND 2ND STAGE - 33000 RPM
- 12) 3RD STAGE - 46000 RPM

B. OIL SYSTEM

- 1) OIL TEMPERATURE TO BEARINGS - 110 DEG F TO 120 DEG F
- 2) OIL RESERVOIR TEMPERATURE - 130 DEG F TO 140 DEG F
- 3) MINIMUM OIL RESERVOIR TEMP - 70 DEG F
- 4) OIL VOLUME - 171 GALLONS
- 5) OIL FLOW - 266 PM
- 6) OIL FILTER P = 10 PSIG - CHANGE AT 10 PSIG

C. COOLING SYSTEM

- 1) 1ST STAGE INTERCOOLER E-902-A - 104 GPM (P = 10.6 PSI)
- 2) 2ND STAGE INTERCOOLER E-902-B - 85 GPM (P = 7.3 PSI)
- 3) AFTERCOOLER - 66 GPM (P = 2.0 PSI)
- 4) OIL COOLER - 27 GPM (P = 3.0 PSI)

9/29/81

III. LUBRICATION

I M P O R T A N T : UNLIKE SOME OTHER TYPES OF ROTATING EQUIPMENT, HIGH SPEED, GEARED COMPRESSORS CANNOT OPERATE, EVEN FOR VERY BRIEF PERIODS, WITHOUT ADEQUATE LUBRICATION.

NO DELAYS CAN BE PERMITTED IN THE LUBE OIL SUPPLY.

NEVER ATTEMPT TO START THE COMPRESSOR WITHOUT ADEQUATE LUBRICATION.

THE LUBE OIL CONSOLE PROVIDES A CONSTANT SUPPLY OF COOLED AND FILTERED OIL TO THE COMPRESSOR THRUST BEARINGS, JOURNAL BEARINGS AND GEAR SPRAY. ALSO SUPPLIED IS AN OIL IMMERSION HEATER WHICH IS THERMOSTATICALLY CONTROLLED TO MAINTAIN OIL TEMPERATURE AT 100 DEG F.

A. DESCRIPTION AND PRINCIPLES OF OPERATION

(REFER TO OIL FLOW DIAGRAM)

THE LUBRICATION SYSTEM COMPRISES A COMPRESSOR MOTOR-DRIVEN MAIN OIL PUMP AND AN ELECTRIC-MOTOR-DRIVEN AUXILIARY PUMP.

UNDER NORMAL CONDITIONS OF OPERATION, THE MAIN PUMP PROVIDES ALL THE OIL FOR THE COMPRESSOR. OIL ENTERS THE MANIFOLD OF THE COMPRESSOR GEAR CASE AND IS DISTRIBUTED THROUGH OIL PASSAGES TO THE JOURNAL BEARINGS AND THRUST BEARINGS. SOME OF THE OIL IS DIVERTED TO THE GEAR SPRAY NOZZLES WHICH ARE POSITIONED TO DIRECT A CONSTANT SPRAY OF OIL AT THE MESH POINTS OF THE GEARS. INSPECTION PLATES LOCATED ON THE MAIN HOUSING CAN BE REMOVED TO INSPECT THESE NOZZLES

TO PREVENT OIL LEAKAGE TO THE COMPRESSOR CASING AND SURROUNDING EQUIPMENT A SLIGHT VACUUM IS MAINTAINED ON THE OIL RESERVOIR AND BEARING CASE. AIR FROM THE OUTLET OF THE AIR DRYERS IS SUPPLIED TO A 1/2 EJECTOR WHICH PULLS THE REQUIRED VACUUM. AIR FROM THE OUTLET OF THE EJECTOR IS PASSED THROUGH AN OIL-AIR SEPARATOR AND THEN THROUGH A MIST ELIMINATOR.

WHEN A MALFUNCTION IN THE MAIN PUMPING UNIT RESULTS IN A LOSS OF OIL PRESSURE, NORMAL OIL PRESSURE WILL BE RESTARTED BY THE AUXILIARY PUMPING UNIT AND THE COMPRESSOR WILL CONTINUE OPERATING. WHEN THE AUXILIARY PUMPING UNIT FAILS TO RESTORE THE OIL PRESSURE TO THE NORMAL OPERATING LEVEL, THE COMPRESSOR WILL BE SHUT DOWN AUTOMATICALLY.

II. NORMAL OPERATING CONDITIONS

B. START-UP PROCEDURE

- 1) START FLOW OF COOLING WATER THROUGH OIL COOLER.
- 2) OPEN AIR VENT ON TOP OF OIL FILTER.
- 3) START AUXILIARY LUBE OIL PUMP BY ACTIVATING POWER SUPPLY TO CABINET.
- 4) CLOSE FILTER AIR VENT WHEN FILTER BECOMES FILLED WITH OIL.
- 5) INSPECT ALL FITTINGS AND CONNECTIONS FOR LEAKS.
- 6) CHECK OIL PRESSURE AND TEMPERATURE (18-20 PSIG AT 110 DEG F TO 120 DEG F).

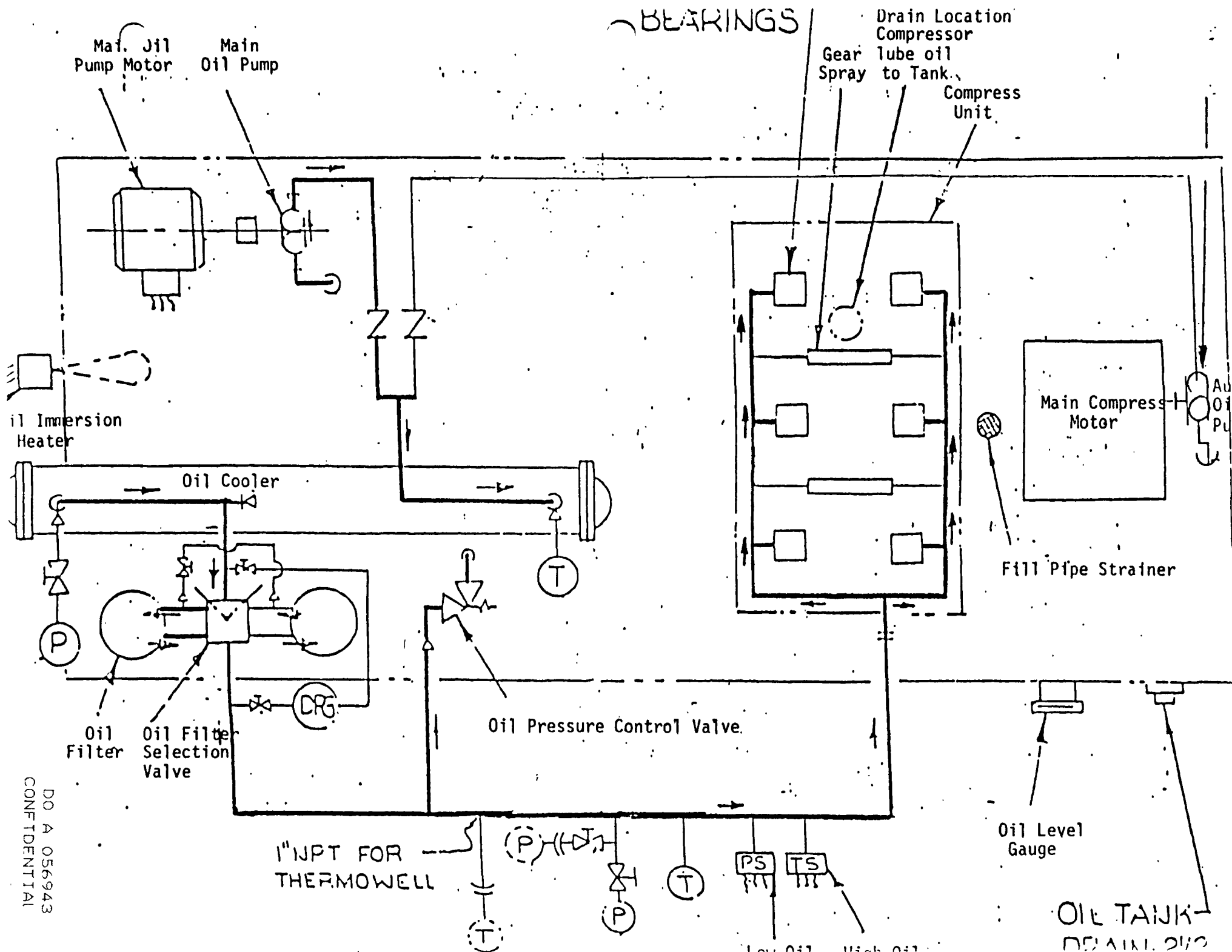
C. SHUTDOWN PROCEDURE

- 1) AFTER COMPRESSOR SHUTDOWN, OPERATE MAIN LUBE OIL PUMP OR AUXILIARY LUBE OIL PUMP AND OIL COOLER FOR APPROXIMATELY ONE HOUR TO REMOVE HEAT FROM THE SYSTEM.

D. FILTER ELEMENT REPLACEMENT PROCEDURE

- 1) TURN OFF OIL SUPPLY TO FILTER.
- 2) OPEN AIR VENT ON TOP OF FILTER.
- 3) OPEN FILTER DRAIN.
- 4) OPEN FILTER AIR VENT WHEN RECHARGING FILTER WITH OIL.
- 5) CLOSE AIR VENT WHEN FILTER BECOMES FILLED WITH OIL.

9/30/81



IV. CONTROLS

A. TOTAL CLOSURE DESCRIPTION -- PRESSURE CONTROL

TOTAL CLOSURE CONTROL MAINTAINS THE SYSTEM PRESSURE BETWEEN 95# AND 105# AND KEEPS THE COMPRESSOR OPERATING WITHIN ITS STABLE OPERATING RANGE. LOAD DEMAND CHANGES ARE AUTOMATICALLY SATISFIED WITHIN CERTAIN LIMITS BY THE VARIABLE FLOW AND PRESSURE CHARACTERISTICS OF THE COMPRESSOR. TOTAL CLOSURE CONTROL ALLOWS THE COMPRESSOR TO OPERATE IN A FULL LOAD CONDITION BETWEEN THE TWO PRESSURES.

AS THE SYSTEM PRESSURE INCREASES, THE 105# PRESSURE POINT IS EVENTUALLY REACHED. AT THIS POINT A PRESSURE SWITCH IS TRIPPED TO UNLOAD THE COMPRESSOR. THE PRESSURE SWITCH ACTUATES A THREE-WAY SOLENOID VALVE, WHICH IN TURN VENTS THE AIR LINES TO THE BLOW-OFF VALVE ACTUATOR AND THE INLET BUTTERFLY VALVE ACTUATOR. THIS DROP IN SIGNAL PRESSURE CAUSES THE BLOW-OFF VALVE TO OPEN AND THE INLET BUTTERFLY VALVE TO CLOSE.

IN THE EVENT THAT THE SYSTEM DEMAND HAS BEEN GREATLY REDUCED, THE COMPRESSOR WILL HAVE A CHANCE TO COMPLETELY UNLOAD. THIS HAS THE EFFECT OF COMPLETELY OPENING THE BLOW-OFF VALVE AND ALSO ROTATING THE INLET BUTTERFLY VALVE FROM A MAXIMUM OPENING OF 90 DEGREES PARALLEL TO THE INLET PIPE TO A MINIMUM OPENING OF 7 DEGREES. IN THE UNLOADED CONDITION THE COMPRESSOR IS RUNNING IN A THROTTLED VACUUM AND HAS A RESULTING NO LOAD HORSEPOWER OF 10 TO 15%.

AS THE COMPRESSOR DISCHARGE PRESSURE DROPS DURING THE UNLOADING CYCLE, THE DISCHARGE CHECK VALVE CLOSURES TO ISOLATE THE COMPRESSOR FROM THE PROCESS. THE RESIDUAL COMPRESSED AIR IN THE PIPING OR RECEIVER THEN SUPPLIES THE AIR NECESSARY TO MEET THE PROCESS DEMAND UNTIL THE 95# PRESSURE POINT IS REACHED.

AS THE SYSTEM PRESSURE DECREASES, THE 95# PRESSURE POINT IS EVENTUALLY REACHED. AT THIS POINT A PRESSURE SWITCH IS TRIPPED TO LOAD THE COMPRESSOR. THE PRESSURE SWITCH ACTIVATES A THREE-WAY SOLENOID VALVE WHICH IN TURN PRESSURIZES THE AIR LINES TO THE INLET BUTTERFLY VALVE AND THE BLOW-OFF VALVE ACTUATORS. THIS INCREASE IN SIGNAL PRESSURE CAUSES THE INLET VALVE TO OPEN AND THE BLOW-OFF VALVE TO CLOSE. THE COMPRESSOR WILL CONTINUE TO PROVIDE THE EXACT SYSTEM REQUIREMENT AND WILL NOT REPEAT THE UNLOAD/LOAD CYCLE AS LONG AS THE SYSTEM DEMAND REMAINS SOMEWHERE BETWEEN 95# AND 105# PRESSURE SET POINTS ON THE COMPRESSOR LOAD CHARACTERISTIC CURVE.

IV. CONTROLS (CONTINUED) -- (CONTINUED) --

B. SURGE CONTROL

DUE TO THE COMPRESSOR CHARACTERISTIC AND ITS RELATIONSHIP TO THE SURGE LINE, THE FOLLOWING INLET AND BLOW-OFF VALVE MOVEMENTS ARE REQUIRED TO AVOID SURGE.

TO LOAD: OPEN THE INLET BEFORE CLOSING THE BLOW-OFF.
TO UNLOAD: OPEN THE BLOW-OFF BEFORE CLOSING THE INLET.

IN GENERAL, IF THE COMPRESSOR SURGES AS IT IS LOADED, THEN OPEN THE INLET VALVE FASTER, OR CLOSE THE BLOW-OFF VALVE SLOWER. IF THE COMPRESSOR SURGES AS IT IS UNLOADED, THEN OPEN THE BLOW-OFF VALVE FASTER OR CLOSE THE INLET VALVE SLOWER.

	OPEN	CLOSE
INLET BUTTERFLY VALVE:	12 SECONDS	12 SECONDS
BLOW-OFF VALVE:	3 SECONDS	14 SECONDS

FLOW CONTROL VALVES ARE USED TO CONTROL THE OPERATING SPEEDS OF THE INLET BUTTERFLY VALVE AND THE BLOW-OFF VALVE. IN MOST CASE TWO CONTROL VALVES ARE PLACED BACK-TO-BACK IN SERIES WITH THE SIGNAL AIR TO THE DIAPHRAGM ACTUATOR FOR ADJUSTING THE SPEED OF THE VALVE IN BOTH DIRECTIONS. EACH FLOW CONTROL VALVE RESTRICT AIR IN THE DIRECTION OF THE ARROW AND ALLOWS FREE FLOW IN THE OPPOSITE DIRECTION. (NOTE THE DIRECTION OF THE ARROW ON EACH FLOW CONTROL VALVE.)

SINCE THE INLET BUTTERFLY VALVE REQUIRES CONTROL AIR PRESSURE TO OPEN (AIR-TO-OPEN TYPE VALVE) THEN IT FOLLOWS THAT:

----- THE INLET VALVE CAN BE ADJUSTED TO CLOSE SLOWER BY CLOSING THE FLOW CONTROL VALVE THAT HAS THE ARROW POINTED AWAY FROM THE INLET VALVE.

THE INLET VALVE CAN BE ADJUSTED TO OPEN FASTER BY OPENING THE FLOW CONTROL VALVE THAT HAS THE ARROW POINTED TOWARD THE INLET VALVE. -----

SINCE THE BLOW-OFF VALVE REQUIRES CONTROL AIR PRESSURE TO CLOSE (AIR-TO-CLOSE TYPE VALVE) THEN IT FOLLOWS THAT:

----- THE BLOW-OFF VALVE CAN BE ADJUSTED TO CLOSE SLOWER BY CLOSING THE FLOW CONTROL VALVE THAT HAS THE ARROW POINTED TOWARD THE BLOW-OFF VALVE. -----

IV. CONTROLS (CONTINUED) --

C. MOTOR OVERLOAD DESCRIPTION (TOTAL CLOSURE MODE)

MOTOR OVERLOAD CONTROL PREVENTS EXCESSIVE COMPRESSOR LOADING WHICH CAN RESULT IN AN INADVERTENT SHUTDOWN AND/OR MOTOR DAMAGE. EXCESSIVE COMPRESSOR LOADING IS MOST OFTEN CAUSED BY "OFF-DESIGN" COMPRESSOR OPERATION. THE MOTOR OVERLOAD CONTROL SENSES MOTOR LOAD, AND DURING OVERLOAD CONDITIONS, SENDS A SIGNAL TO THE COMPRESSOR INLET BUTTERFLY VALVE TO DECREASE THE OPENING OF THAT VALVE AND THEREBY THROTTLE THE MOTOR LOAD BACK TO A PRE-DETERMINED LOAD LIMIT.

THE LOAD LIMITING CONTROLLER HAS TWO ADJUSTMENTS, THE PERCENT-LOAD AND BAND WIDTH SET POINTS. THE PERCENT-LOAD ADJUSTMENT DETERMINES THE SET POINT FOR MAINTAINING MOTOR AMPERAGE BELOW A PRE-DETERMINED LOAD LIMIT. THE BAND-WIDTH ADJUSTMENT DETERMINES HOW RESPONSIVE OR HOW QUICKLY THE CONTROLLER WILL REACT TO CONTROL CHANGES. THE BAND-WIDTH ADJUSTMENT IS SET AS LOW AS POSSIBLE TO MAINTAIN GOOD CONTROL, BUT NOT SO LOW THAT CYCLING OCCURS.

D. VIBRATION MONITOR

1.1 GENERAL

THE JOY 9000 SERIES RADIAL VIBRATION MONITORING SYSTEM, MANUFACTURED BY BENTLY NEVADA CORPORATION, IS AN ACCURATE AND HIGHLY RELIABLE MACHINE PROTECTION SYSTEM THAT CONTINUOUSLY MONITORS THREE INDEPENDENT CHANNELS OF RADIAL VIBRATION. THE SYSTEM, AS SHOWN IN FIGURE 1-1, CONSISTS OF A PROBE AND PROXIMITOR FOR EACH MONITORED CHANNEL AND A RACK ASSEMBLY THAT CONTAINS A FRONT PANEL ANALOG DISPLAY, POWER SUPPLY, RELAY MODULE, AND ONE OR MORE MONITORS.

A 3000 SERIES EDDY CURRENT TYPE PROBE AND PROXIMITOR GENERATES A VOLTAGE SIGNAL FOR EACH CHANNEL THAT VARIES PROPORTIONALLY TO THE VIBRATION LEVEL. THE VOLTAGE SIGNAL OF EACH CHANNEL IS RECEIVED AND CONDITIONED BY A MONITOR. THE MONITOR OUTPUTS ARE SWITCH SELECTED TO DRIVE A COMMON FRONT PANEL METER. THE METER (WITH DUAL ENGLISH/METRIC SCALE) DISPLAYS EITHER THE HIGHEST VIBRATION LEVEL OF ALL MONITORED CHANNELS OR THE ACTUAL VIBRATION OF EACH CHANNEL. AN OK CIRCUIT FOR EACH CHANNEL MONITORS THE PROXIMITOR INPUT VOLTAGE TO DETECT AND INDICATE FAULTY TRANSDUCER OPERATION BY EXTINGUISHING A GREEN OK LED INDICATOR AND ACTIVATING A RELAY.

THE SYSTEM CONTAINS TWO ALARM CIRCUITS FOR EACH CHANNEL WITH INDIVIDUAL SET POINTS TO DETECT EXCESSIVE VIBRATION LEVELS (ALERT AND DANGER ALARMS). BY PRESSING FRONT PANEL SWITCHES

IV. CONTROLS (CONTINUED) --

D. VIBRATION MONITOR

1.1 GENERAL (CONTINUED) --

THE ALARM SET POINTS CAN BE DISPLAYED ON THE FRONT PANEL METER IF THE VIBRATION LEVEL MONITORED BY ANY CHANNEL EXCEEDS AN ALARM SET POINT LONGER THAN AN INTEGRATING TIME DELAY PERIOD, THE APPROPRIATE FRONT PANEL ALARM LED IS ILLUMINATED AND A RELAY IN THE RACK IS ACTIVATED. THE RELAY CONTACTS CAN BE USED TO ANNUNCIATE AN EXTERNAL VISIBLE OR AUDIBLE ALARM. A SPECIAL DANGER DISABLE FUNCTION INHIBITS DANGER ALARMS WHEN A NON-OK CONDITION EXISTS AND A TRIP MULTIPLIER CAPABILITY CAN BE REMOTELY ACTUATED TO DOUBLE THE SYSTEM ALARM SET POINTS. A COMMON RESET SWITCH IS PROVIDED TO SIMULTANEOUSLY RESET ALL SYSTEM ALARMS.

1.2 PHYSICAL DESCRIPTION

A TYPICAL 9000 SERIES RADIAL VIBRATION SYSTEM IS SHOWN IN FIGURE 1-3 WITH INDICATORS AND CONTROLS INDEXED TO THE DEFINITIONS PROVIDED IN TABLE 1-3. EXCEPT FOR THE PROBES AND PROXIMITORS, THE SYSTEM IS INSTALLED IN A RACK ASSEMBLY DESIGNED FOR PANEL MOUNTING. EXTERNALLY MOUNTED PROBES AND PROXIMITORS PROVIDE INPUTS THROUGH REAR RACK TERMINAL STRIPS.

TABLE 1-3 9000 SERIES FRONT PANEL

CALLOUT	DESCRIPTION
1	9000 SERIES INSTRUMENT RACK ASSEMBLY
2	DUAL SCALE METER --- DISPLAYS HIGH READ, SIGNAL, AND ALARM SET LEVELS FROM THE MONITORS.
3	POWER ON (LED) --- ILLUMINATES WHEN POWER IS APPLIED TO THE SYSTEM.
4	TRIP MULTIPLIER (LED) --- ILLUMINATES WHEN THE TRIP MULTIPLY FUNCTION IS SELECTED.
5	COMMON RESET (SWITCH) --- USED TO RESET MONITOR ALARM CIRCUITS.
6	HIGH READ/CHAN SELECT (SWITCH) --- SELECTS HIGH READ FUNCTION, OR IN CONJUNCTION WITH MONITOR SWITCHES, THE INDIVIDUAL MONITOR SIGNAL OR ALARM SET POINT.
7	CALIBRATION COVER. PROVIDES ACCESS TO METER SPAN POTENTIOMETER.
8	KEY 0 (BNC CONNECTOR) --- PROVIDES KEYPHASOR OUTPUT SIGNAL MONITORING.

IV. CONTROLS (CONTINUED) --

D. VIBRATION MONITOR (CONTINUED) --

TABLE 1-3 9000 SERIES FRONT PANEL (CONTINUED) --

CALLOUT	DESCRIPTION
9	COM (SIGNAL COMMON TEST POINTS) --- USED AS REFERENCE FOR SYSTEM SIGNAL MEASUREMENTS.
10	OK (LED) --- GREEN LED INDICATOR IS ILLUMINATED WHEN CHANNEL INPUT TRANSDUCER IS OPERATING WITHIN NORMAL OPERATING LIMITS. IF LIT VIBRATION CIRCUIT IS FUNCTIONING.
11	DANGER (LED) --- RED LED INDICATOR ILLUMINATES IF CHANNEL VIBRATION LEVEL EXCEEDS ALARM SET POINT. TRIPS COMPRESSOR.
12	ALERT (LED) --- RED LED INDICATOR ILLUMINATES IF CHANNEL VIBRATION LEVEL EXCEEDS ALARM SET POINT - ALARM ONLY.
13	SIGNAL (SWITCH) --- USED IN CONJUNCTION WITH CHANNEL SELECT SWITCH "6" TO SELECT CHANNEL SIGNAL LEVEL FOR METER DISPLAY. NOTE: LEFT SWITCH IS FOR COMPRESSOR STAGES 1 AND 2. LEFT SWITCH IN LEFT POSITION ACCESSES STAGE 1 IN RIGHT POSITION ACCESSES STAGE 2. RIGHT SWITCH IN LEFT POSITION ACCESSES STAGE 3.
14	DANGER (SWITCH) --- USED IN CONJUNCTION WITH CHANNEL SELECT SWITCH "6" TO SELECT CHANNEL DANGER SET POINT FOR METER DISPLAY. NOTE: LEFT SWITCH IS FOR COMPRESSOR STAGES 1 AND 2. LEFT SWITCH IN LEFT POSITION ACCESSES STAGE 1 IN RIGHT POSITION ACCESSES STAGE 2. RIGHT SWITCH IN LEFT POSITION ACCESSES STAGE 3.
15	ALERT (SWITCH) --- USED IN CONJUNCTION WITH CHANNEL SELECT SWITCH "6" TO SELECT CHANNEL ALERT SET POINT FOR METER DISPLAY. NOTE: LEFT SWITCH IS FOR COMPRESSOR STAGES 1 AND 2. LEFT SWITCH IN LEFT POSITION ACCESSES STAGE 1 IN RIGHT POSITION ACCESSES STAGE 2. RIGHT SWITCH IN LEFT POSITION ACCESSES STAGE 3.

IV. CONTROLS (CONTINUED) --

D. VIBRATION MONITOR (CONTINUED) --

TABLE1-3. 9000 SERIES FRONT PANEL (CONTINUED) --

CALLOUT	DESCRIPTION
16	CALIBRATION COVER. PROVIDES ACCESS TO DANGER AND ALER SET POINT POTENTIOMETERS. THE COVER LABEL DEFINES THE MONITOR RANGE.
17	PROX OUT --- BNC CONNECTOR PERMITS MONITORING OF UN-PROCESSED CHANNEL PROXIMITOR SIGNAL.

E. PROCEDURE FOR SETTING ALARM AND TRIP SET POINT

1) SET THE "HIGH READ/CHAN SELECT" SWITCH ON THE FRONT PANEL TO THE "CHAN SELECT" POSITION.

2) PRESS AND HOLD THE "ALERT" SWITCH ON THE MONITOR FRONT PANEL TO THE "READ" POSITION AND ADJUST THE "ALERT" POTENTIOMETER UNTIL THE DESIRED ALARM SET POINT IS INDICATED ON THE ANALOG DISPLAY METER. RELEASE THE "ALERT" SWITCH.

3) PRESS AND HOLD THE "DANGER" SWITCH ON THE MONITOR FRONT PANEL TO THE "READ" POSITION AND ADJUST THE "DANGER" POTENTIOMETER UNTIL THE DESIRED DANGER SET POINT IS INDICATED ON THE ANALOG DISPLAY METER. RELEASE THE "DANGER" SWITCH.

NOTE: ON THE DISPLAY PANEL THERE ARE TWO SWITCHES FOR "ALERT" AND TWO FOR "DANGER". THE LEFT SWITCH IS FOR STAGE 1 AND 2; THE RIGHT SWITCH FOR STAGE 3. PUSHING THE LEFT HAND SWITCH TO THE LEFT WILL ALLOW ACCESS TO COMPRESSOR VIBRATION SIGNAL AND TO THE RIGHT ACCESS TO STAGE 2. PUSHING THE RIGHT SWITCH TO THE LEFT ACCESSES STAGE 3.

10/02/81

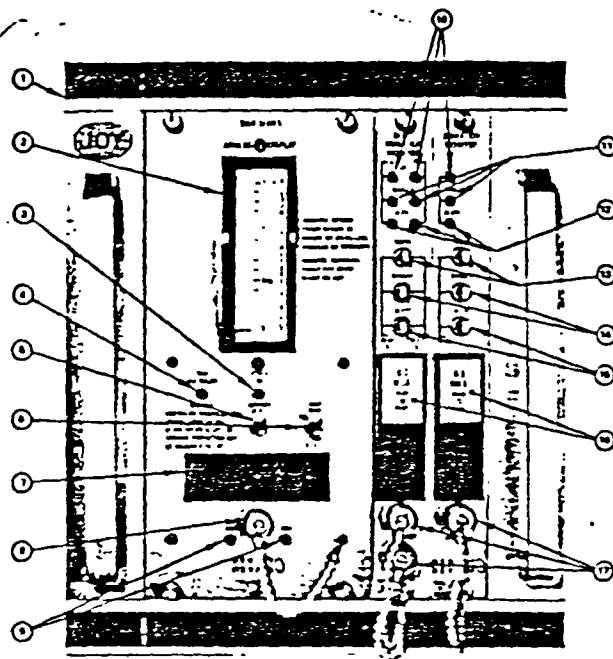
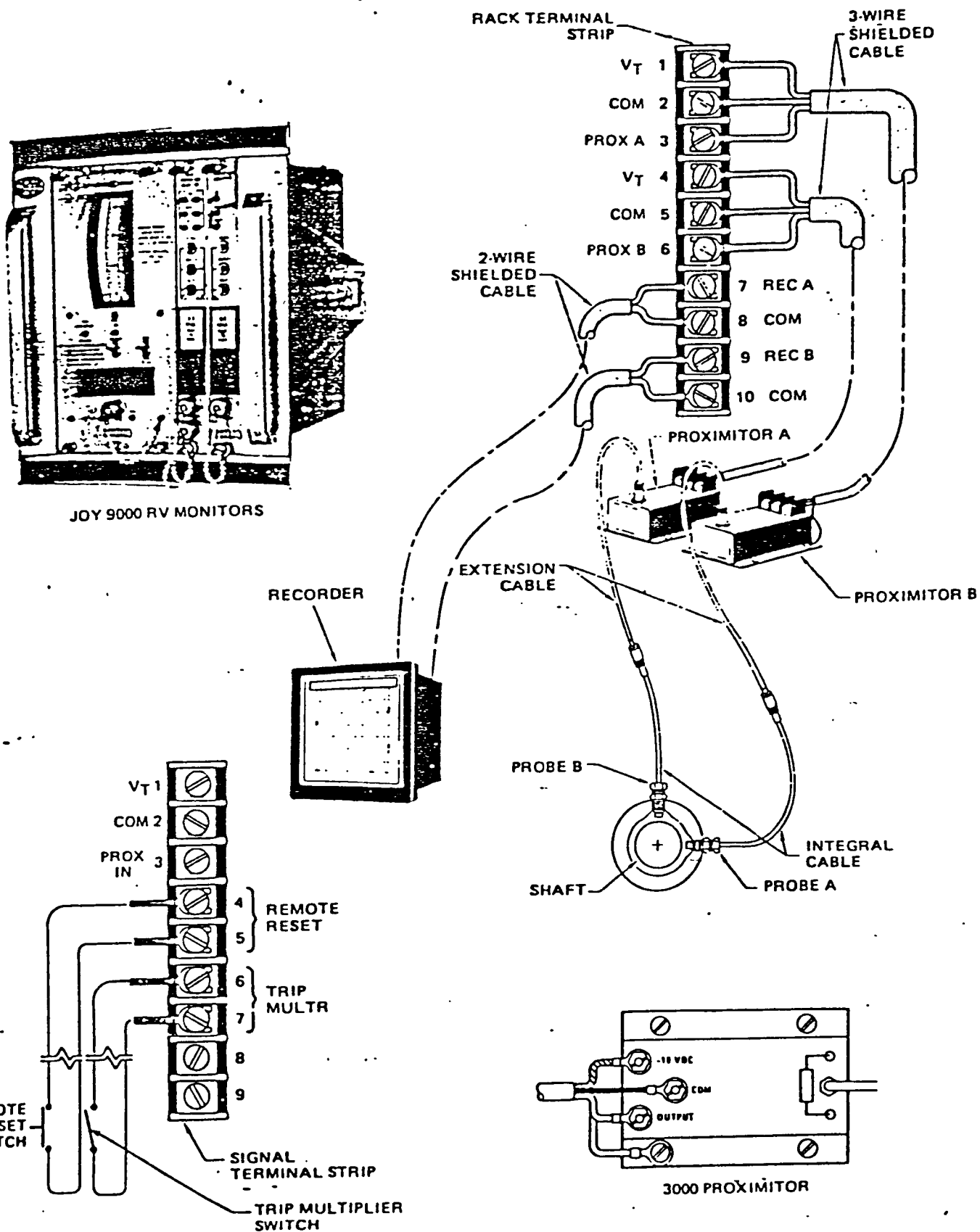


Figure 1-3. 9000 Series Radial Vibration System
Front Panels



V. INSTRUMENTATION -- ALARMS AND TRIPS

EQUIP NO.	INSTRUMENT NUMBER	DESCRIPTION	P&ID NUMBER	RANGE	ALARM POINT	TRIP POINT
C-902	TCV-9232	OIL TEMP CONTROL VALVE	B1-035	CON-TROLS BE-TWEEN 110 & 120		
C-902	PSL-9234 CONTACT 1	AUX 01 PUMP START-UP PRESSURE SWITCH	B1-035			12#
C-902	PSL-9234 CONTACT 2	LOW OIL PRESSURE TRIP	B1-035			8#
C-902		COMPRESSOR OVER-PRESS SWITCH			105#	
C-902		3RD STAGE HIGH TEMP SWITCH			105#	
C-902	TSH-9235	HIGH OIL TEMP TRIP SWITCH	B1-035			140 DEG F
C-902	VTS	VIBRATION TRANSMITTER SWITCH	B1-035		1ST & 2ND STAGE 1.3 MILS 3RD STAGE 1.0 MILS	1ST & 2ND STAGE 1.6 MILS 3RD STAGE 1.3 MILS

EQUIP NO.	INSTRUMENT NUMBER	DESCRIPTION	P&ID NUMBER	RANGE	ALARM POINT	TRIP POINT
C-903	TCV-9271	OIL TEMP CONTROL VALVE	B1-036	CON-TROLS BETWEEN 110 DEG F TO 120 DEG F		
C-903	PSL-9268 CONTACT 1	AUX OIL PUMP START-UP PRESS SWITCH	B1-036			12#
C-903	PSL-9268 CONTACT 2	LOW OIL PRESSURE TRIP	B1-036			8#
C-903	TSH-9269	HIGH OIL TEMP TRIP SWITCH	B1-036			140 DEG
C-903	VTS	VIBRATION TRANSMITTER SWITCH	B1-036		1ST & 2ND STAGE 1.3 MILS 3RD STAGE 1.0 MILS	1ST & 2ND STAGE 1.6 MILS 3RD STAGE 1.3 MILS
C-903		COMPRESSOR OVER-PRESS SWITCH			105#	
C-903		3RD STAGE HIGH TEMP SWITCH				140 DEG F
C-902 C-903		CONTROL BOX LOW AIR PURGE PRESS		0-. 5"	0-. 5"	

VI. START-UP AND SHUT DOWN PROCEDURES

START-UP PROCEDURE (SEE CHECK LIST AT BACK)

(1) MANUAL START-UP

- A. OPEN THE INSTRUMENT AIR TO CONTROL PANEL. IF NO AIR IS AVAILABLE, OPEN AIR SUPPLY FROM BOTTLE.
- B. OPEN COOLING WATER VALVES TO OIL COOLER INTER-COOLER AND AFTER-COOLER.
- C. START THE PRE-LUBE PUMP AT LEAST 15 MINUTES PRIOR TO COMPRESSOR START-UP.
- D. CLOSE PANEL POWER SWITCH S-1. INDICATOR LIGHT W-1 WILL ILLUMINATE.
- E. PUSH THE ALARM SILENCE PUSHBUTTON S-5 TO SILENCE THE ALARM HORN.
- F. PUSH THE CONTROL RESET PUSHBUTTON.

IF THERE ARE NO MALFUNCTIONS AT THIS TIME, THE ALARM LIGHTS WILL BE DE-ENERGIZED, EXCEPT THE AUXILIARY PUMP OPERATING LIGHT. GREEN PERMISSIVE START LIGHT SHOULD BE ENERGIZED.

- G. SWITCH S-2 MUST BE IN "AUTO" POSITION TO LOAD THE COMPRESSOR. WHEN TDR-1 (20 SECONDS) TIMES OUT THE COMPRESSOR WILL BEGIN LOADING UP. FOR THE INITIAL 20 SECONDS THE COMPRESSOR IS IN UNLOAD CONDITION.
- H. START THE COMPRESSOR BY PUSHING THE "START" PUSHBUTTON LOCATED ON THE MOTOR STARTER.

WHEN TDR-1 (20 SECONDS) TIMES OUT, THE AUXILIARY LUBE OIL PUMP IS AUTOMATICALLY SHUT DOWN. THE AUXILIARY PUMP OPERATING LIGHT WILL BE DE-ENERGIZED.

- I. THE COMPRESSOR WILL CONTINUE TO RUN UNTIL STOPPED MANUALLY WITH THE COMPRESSOR "STOP" PUSHBUTTON OR UNTIL STOPPED AUTOMATICALLY BY ONE OF THE MALFUNCTIONS.

INSPECT COMPRESSOR FOR AIR AND OIL LEAKAGE. ANY UNUSUAL SOUNDS AND EXCESSIVE VIBRATION MAY BE CAUSED BY INTERNAL RUBBING, WORN BEARINGS OR SHAFT MISALIGNMENT.

- J. PLACE UNLOAD/AUTO SELECTOR SWITCH IN THE "AUTO" POSITION IF NOT IN THAT POSITION ALREADY.
- K. CHECK TO ENSURE THAT STAGE INLET AIR TEMPERATURES ARE MAINTAINED BETWEEN 90 DEG F AND 110 DEG F. ADJUST WATER FLOW CONTROL VALVE TO OBTAIN DESIRED AIR TEMPERATURES.

VI. START-UP AND SHUT DOWN PROCEDURES

(I) MANUAL START-UP (CONTINUED) --

- L. CHECK OIL PRESSURE AND TEMPERATURE. THE TEMPERATURE WILL BE AUTOMATICALLY CONTROLLED BY WATER CONTROL VALVES. REGULAR OIL COOLER WATER FLOW TO OBTAIN REQUIRED OIL INLET TEMPERATURE OF 110 DEG F TO 120 DEG F.

(II) BACK-UP COMPRESSOR AUTOMATIC START-UP

THE AIR COMPRESSOR SYSTEM IS DESIGNED TO AUTOMATICALLY START UP THE BACK-UP COMPRESSOR IF THE AIR HEADER PRESSURE REACHES 80#. HOWEVER, THE COMPRESSOR WILL ONLY START AUTOMATICALLY IF THE FOLLOWING CRITERIA ARE MET:

- (A) "MANUAL OFF AUTO" KEY SWITCH ON THE CONTROL PANEL SHOULD BE IN "AUTO" POSITION.
- (B) AUXILIARY OIL PUMP SHOULD BE RUNNING. AN 8# PRESSURE SWITCH MUST BE SATISFIED FOR COMPRESSOR TO START.
- (C) OIL TEMPERATURE CANNOT EXCEED 140 DEG F.
- (D) VIBRATION PROBE CANNOT EXCEED TRIP LIMITS.
- (E) 3RD STAGE SUCTION PRESSURE CANNOT EXCEED 140 DEG F

IN ORDER TO ENSURE A RELIABLE BACKUP COMPRESSOR SEVERAL ITEMS SHOULD BE CHECKED WHEN MAKING ROUNDS OF THE PLANT. THIS LIST IS UNDER ROUND CHECK (B).

(III) SHUTDOWN PROCEDURE

- A. OPEN INTER-COOLER SHELL DRAINS PRIOR TO SHUTTING DOWN THE COMPRESSOR.
- B. TURN UNLOAD/AUTO SELECTOR SWITCH TO "UNLOAD" POSITION.
- C. DEPRESS "STOP" BUTTON ON CONTROL PANEL.
- D. ALLOW AUXILIARY LUBE OIL PUMP TO OPERATE FOR ONE HOUR, WITH COOLING WATER CIRCULATING THROUGH THE LUBE OIL COOLER, AFTER COMPRESSOR IS SHUT DOWN TO REMOVE HEAT FROM BEARINGS.
- E. OPEN PANEL POWER SWITCH.
- F. TURN OFF INSTRUMENT AIR SUPPLY.
- G. TURN OFF COOLING WATER SUPPLY.

VI. START-UP AND SHUT DOWN PROCEDURES (CONTINUED) --

(IV) NON-ROUTINE SHUTDOWN

- A. IN THE EVENT OF LOW OIL PRESSURE, PS1-1 WILL OPEN TO AUTOMATICALLY START THE AUXILIARY LUBE OIL PUMP. THE ALARM HORN WILL SOUND AND THE AUXILIARY LUBE OIL PUMP OPERATING LIGHT WILL BE ILLUMINATED.

IF OIL PRESSURE CONTINUES TO DECREASE, PS1-2 WILL OPEN TO AUTOMATICALLY SHUT DOWN THE COMPRESSOR. THE LOW OIL PRESSURE LIGHT (R-2) WILL BE ILLUMINATED.

- B. IN THE EVENT OF HIGH LUBE OIL TEMPERATURE, TS-1 WILL OPEN TO SOUND THE ALARM HORN AND AUTOMATICALLY SHUT DOWN THE COMPRESSOR. THE ALARM HORN WILL SOUND AND THE HIGH AIR TEMPERATURE LIGHT (R-4) WILL BE ILLUMINATED.

- C. IN THE EVENT OF HIGH AIR TEMPERATURE, TS-2 WILL OPEN AND AUTOMATICALLY SHUT DOWN THE COMPRESSOR. THE ALARM HORN WILL SOUND AND THE HIGH AIR TEMPERATURE LIGHT (R-4) WILL BE ILLUMINATED.

- D. IN THE EVENT OF HIGH VIBRATION, VS1-1 WILL CLOSE TO SOUND THE ALARM HORN AND THE "ALERT" LIGHT ON THE VIBRATION MONITOR WILL BE ILLUMINATED.

IF VIBRATION CONTINUES TO INCREASE VS-1-2A WILL OPEN TO AUTOMATICALLY SHUT DOWN THE COMPRESSOR. THE "DANGER" LIGHT WILL BE ILLUMINATED ON THE VIBRATION MONITOR.

- E. IN THE EVENT OF VIBRATION PROBE OUTPUT NOT OKAY, THE VIBRATION MONITOR OKAY CONTACT WILL CLOSE TO SOUND THE ALARM HORN AND THE VIBRATION MONITOR OKAY LIGHT WILL GO OUT.

- F. IN THE EVENT OF A LOSS OF PRESSURE FOR PANEL PURGE, DPS WILL OPEN TO SOUND THE ALARM HORN AND ILLUMINATE THE LOW PANEL PURGE PRESSURE LIGHT AL.

10/02/81

VII. ROUND CHECK

- A. OIL LEVEL
- B. LUBE OIL TEMPERATURE
- C. LUBE OIL PRESSURE
- D. OIL FILTER (F-902 AND F-903) P
- E. AUXILIARY OIL PUMP RUNNING
- F. THIRD STAGE SUCTION TEMPERATURE
- G. SECOND STAGE SUCTION TEMPERATURE
- H. AIR DISCHARGE TEMPERATURE
- I. BLOWDOWN 1ST AND 2ND STAGE INTER-COOLER TRAPS
- J. BLOWDOWN AFTER-COOLER TRAPS
- K. BLOWDOWN PRE-FILTER (FLY-902) TRAPS - 1
- L. FLY-902 P
- M. FL-902-A OR B IN SERVICE
- N. PURGE AIR FLOW
- O. PURGE AIR PRESSURE

BACK COMPRESSOR ROUND CHECK

- A. MANUAL-OFF AUTO SWITCH IN "AUTO" POSITION
- B. AUXILIARY OIL PUMP SHOULD BE RUNNING; CHECK PRESSURE
- C. CHECK OIL TEMPERATURE
- D. CHECK WATER FLOW THROUGH 1ST STAGE INTER-COOLER, 2ND STAGE INTER-COOLER, AFTER-COOLER AND OIL COOLER
- E. CHECK TO BE SURE OIL SUMP EJECTOR IS IN SERVICE
- F. CHECK VALVING FOR PROPER POSITION
- G. CHECK FOR AIR PURGE ON CONTROL BOX
- H. CONTROL POWER SHOULD BE LEFT ON
- I. GREEN PERMISSIVE START LIGHT MUST BE "ON"

10/05/81

VIII. SYSTEM TROUBLE ANALYSIS

PRELIMINARY SET-UP

A. TROUBLE: NO PRIMARY VOLTAGE

PROBABLE CAUSE:

DEFECTIVE PRIMARY POWER SOURCE
DEFECTIVE CIRCUIT BREAKER IN PRIMARY POWER SOURCE
DEFECTIVE INTERCONNECTING CABLING, OR LOOSE OR BROKEN CONNECTIONS

REMEDY:

REPAIR OR REPLACE PRIMARY POWER SOURCE, AS NECESSARY.
CHECK CIRCUIT BREAKERS IN PRIMARY POWER SOURCE. REPLACE IF DEFECTIVE.
CHECK ALL CONNECTIONS. PERFORM CONTINUITY CHECK ON CABLING.
REPAIR OR REPLACE AS NECESSARY.

B. TROUBLE: NO INSTRUMENT AIR PRESSURE (OR LOW AIR PRESSURE)

PROBABLE CAUSE:

DEFECTIVE INSTRUMENT AIR COMPRESSOR
INSTRUMENT AIR SUPPLY VALVE CLOSED
RUPTURED OR PINCHED AIR LINE
LEAKS AROUND FITTINGS

REMEDY:

REPAIR OR REPLACE AIR COMPRESSOR AS NECESSARY.
OPEN AIR SUPPLY VALVE.
REPLACE AIR LINE.
TIGHTEN OR REPLACE FITTINGS AS NECESSARY.

C. TROUBLE: NO LUBE OIL PRESSURE (OR LOW OIL PRESSURE)

PROBABLE CAUSE:

DEFECTIVE MAIN LUBE OIL PUMP
CLOGGED OR LEAKING OIL FILTER
LEAKS AROUND FITTINGS
RUPTURED OR PINCHED OIL LINE

REMEDY:

REPAIR OR REPLACE PUMP AS NECESSARY.
CLEAN OR REPLACE FILTER AS NECESSARY.
TIGHTEN OR REPLACE FITTINGS AS NECESSARY.
REPLACE OIL LINE.

VIII. SYSTEM TROUBLE ANALYSIS (CONTINUED) --

OPERATING CYCLE

D. TROUBLE: VIBRATION

PROBABLE CAUSE:

COMPRESSOR AND DRIVER SHAFTS MISALIGNED
WORN OR DEFECTIVE SHAFT COUPLING
WORN OR DEFECTIVE COMPRESSOR JOURNAL BEARING
WORN OR DEFECTIVE COMPRESSOR THRUST BEARING
DAMAGED BULL GEAR OR PINION
LOOSE ANCHOR BOLTS
DEFECTIVE DRIVER

REMEDY:

REALIGN.
REPLACE SHAFT COUPLING.
REPLACE JOURNAL BEARING.
REPLACE THRUST BEARING.
REPLACE BULL GEAR OR PINION.
TIGHTEN BOLTS.
REPAIR OR REPLACE DRIVER AS NECESSARY.

E. TROUBLE: HIGH LUBE OIL TEMPERATURE

POSSIBLE CAUSE: WATER FLOW TO OIL COOLER INTERRUPTED

REMEDY: CHECK COOLING WATER SYSTEM.

F. TROUBLE:

LOSS OF LUBE OIL PRESSURE (OR LOW PRESSURE) -- AUXILIARY
PUMP OPERATING

PROBABLE CAUSE:

MAIN LUBE OIL PUMP
DEFECTIVE MAIN LUBE OIL PUMP
CLOGGED OR LEAKING OIL FILTER
LEAKS AROUND FITTINGS
RUPTURED OR PINCHED OIL LINE

REMEDY:

REPLACE COUPLING.
REPAIR OR REPLACE PUMP AS NECESSARY.
CLEAN OR REPLACE FILTER AS NECESSARY
TIGHTEN OR REPLACE FITTINGS AS NECESSARY
REPLACE OIL LINE.

VIII. SYSTEM TROUBLE ANALYSIS (CONTINUED) --

G. TROUBLE:

LOSS OF LUBE OIL PRESSURE (OR LOW PRESSURE) -- AUXILIARY PUMP NOT OPERATING

PROBABLE CAUSE:

DEFECTIVE INSTRUMENT AIR COMPRESOR
DEFECTIVE AUXILIARY PUMP MOTOR
DEFECTIVE AUXILIARY LUBE OIL PUMP
LOW LUBE OIL LEVEL
MAIN LUBE OIL PUMP
DEFECTIVE MAIN LUBE OIL PUMP
CLOGGED OR LEAKING OIL FILTER
LEAKES AROUND FITTINGS
RUPTURED OR PINCHED OIL LINE

REMEDY:

REPAIR OR REPLACE AIR COMPRESSOR AS NECESSARY.
OPEN AIR SUPPLY VALVE.
REPLACE AIR LINE.
TIGHTEN OR REPLACE FITTINGS AS NECESSARY.
REPLACE COUPLING.
REPAIR OR REPLACE PUMP AS NECESSARY.
CLEAN OR REPLACE FILTER AS NECESSARY.
TIGHTEN OR REPLACE FITTINGS AS NECESSARY.
REPLACE OIL LINE.

H. TROUBLE: HIGH BEARING TEMPERATURE

PROBABLE CAUSE:

LUBE OIL SYSTEM MALFUNCTIONING
DEFECTIVE BEARING

REMEDY:

REPLACE COUPLING.
REPAIR OR REPLACE PUMP AS NECESSARY.
CLEAN OR REPLACE FILTER AS NECESSARY.
TIGHTEN OR REPLACE FITTINGS AS NECESSARY.
REPLACE OIL LINE.
REPAIR OR REPLACE AIR COMPRESSOR AS NECESSARY.
OPEN AIR SUPPLY VALVE.
REPLACE AIR LINE.
REPAIR OR REPLACE MOTOR AS NECESSARY.
ADD OIL TO OIL TANK.
REPLACE BEARING.

I. TROUBLE: HIGH DISCHARGE AIR TEMPERATURE

PROBABLE CAUSE: WATER FLOW TO INTER-COOLERS INTERRUPTED

REMEDY: CHECK COOLING WATER SYSTEM.

STARTING PROCEDURE CHECK LIST

- _____ 1. CHECK LUBE OIL LEVEL.
- _____ 2. APPLY INSTRUMENT AIR SUPPLY TO CONTROL PANEL AND CONTROL VALVES.
- _____ 3. OPEN COOLING WATER SUPPLY VALVE TO OIL COOLER, INTER-COOLERS AND AFTER-COOLER.
- _____ 4. START AUXILIARY LUBE OIL PUMP. AMBER LIGHT INDICATES PUMP IS RUNNING.
- _____ 5. CLOSE CONTROL PANEL POWER SWITCH. WHITE LIGHT INDICATES POWER IS ON.
- _____ 6. DEPRESS CONTROL RESET PUSHBUTTON.
- _____ 7. DEPRESS ALARM SILENCE PUSHBUTTON.
- _____ 8. TURN UNLOAD/AUTO SLECTOR SWITCH TO "UNLOAD" POSITION.
- _____ 9. CHECK LUBE OIL PRESSURE AND TEMPERATURE GAUGES.
- _____ 10. PERMISSIVE START LIGHT (GREEN) SHOULD BE ON. COMPRESSOR IS NOW READY FOR STARTUP AND NONE OF THE MALFUNCTION LIGHTS ON THE PANEL SHOULD BE ILLUMINATED.
- _____ 11. START THE COMPRESSOR.
- _____ 12. TURN UNLOAD/AUTO SWITCH TO "AUTO" POSITION.
- _____ 13. CHECK COMPRESSOR STAGE AIR INLET TEMPERATURE.
- _____ 14. CHECK LUBE OIL PRESSURE AND TEMPERATURE GAUGES.

10/05/81

OPERATION

STARTING PROCEDURE

Initial Starting Procedure

To start the compressor after initial installation or overhaul, proceed as follows:

1. Thoroughly clean and dry all piping.
2. To protect the compressor from possible damage resulting from dirty inlet piping, install an inlet duct screen as shown in Figure 1. Locate the screen as close as possible to the compressor making certain that all piping downstream of the screen has been thoroughly cleaned. The screen must conform to the following specifications:

Size 8 x 8 sq mesh, 0.063 dia wire, plain weave (0.062 sq opening)
10 x 10 sq mesh, 0.035 dia wire, plain weave (0.068 sq opening)

Material: AISI 302 or 304 stainless steel

Length of cone: 1.5 times inlet pipe diameter

CAUTION

Remove the screen after 40 to 50 hours of operation.

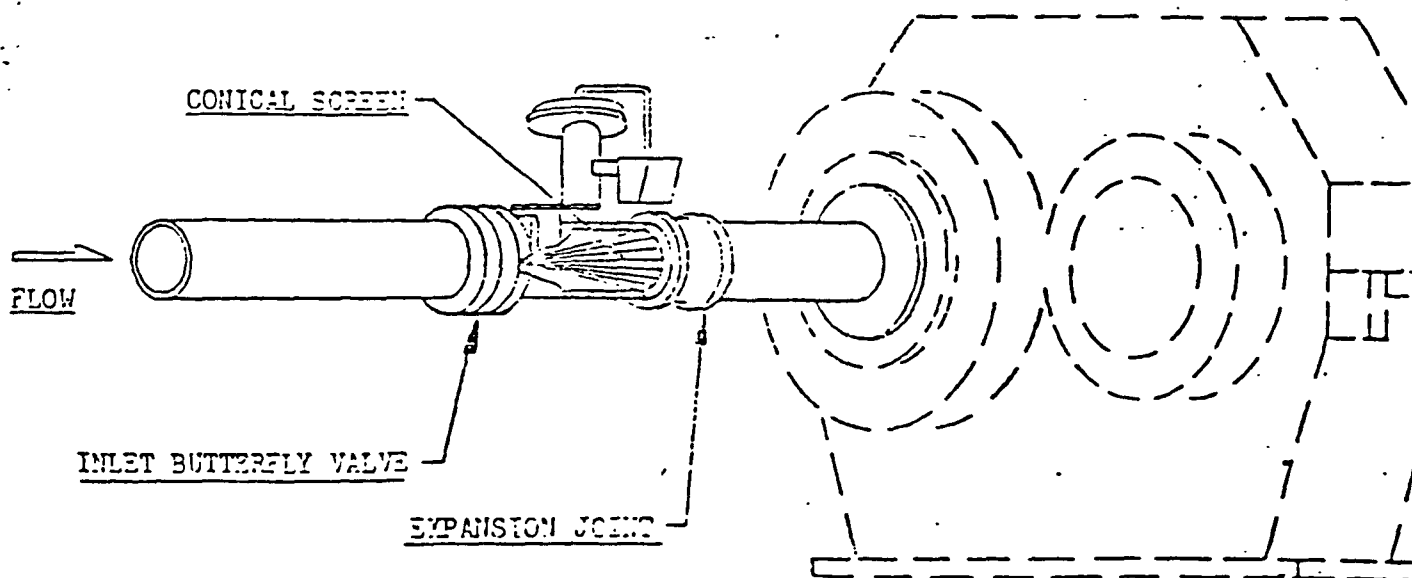
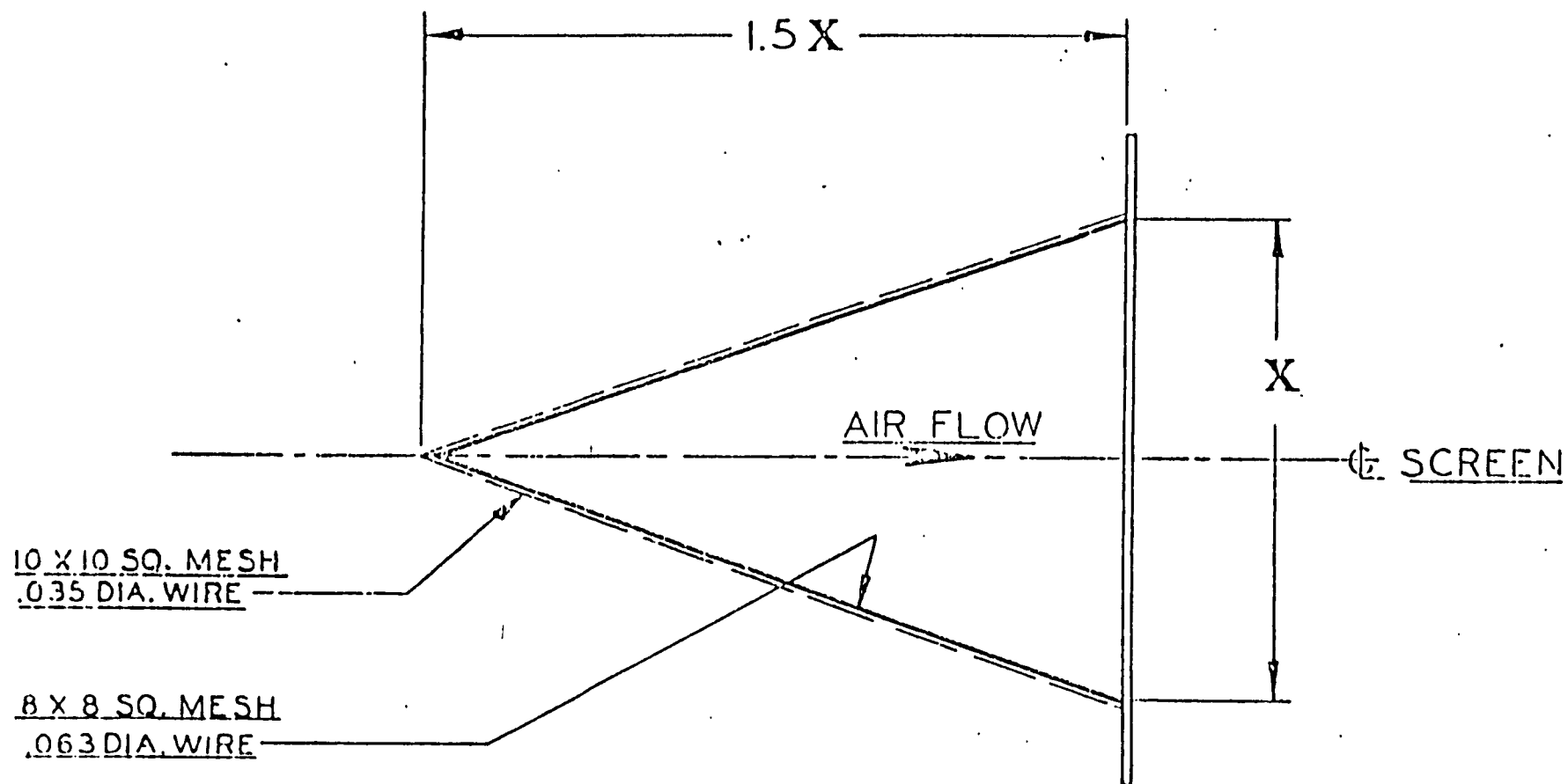


Figure 1. Inlet Screen Arrangement



OPERATION

STARTING PROCEDURE

INITIAL STARTING PROCEDURE

TO START THE COMPRESSOR AFTER INITIAL INSTALLATION OR OVERHAUL, PROCEED AS FOLLOWS:

1. THOROUGHLY CLEAN AND DRY ALL PIPING.
2. TO PROTECT THE COMPRESSOR FROM POSSIBLE DAMAGE RESULTING FROM DIRTY INLET PIPING, INSTALL AN INLET DUCT SCREEN AS SHOWN IN FIGURE 1. LOCATE THE SCREEN AS CLOSE AS POSSIBLE TO THE COMPRESSOR MAKING CERTAIN THAT ALL PIPING DOWNSTREAM OF THE SCREEN HAS BEEN THOROUGHLY CLEANED. THE SCREEN MUST CONFORM TO THE FOLLOWING SPECIFICATIONS:

SIZE: 8 X 8 SQ MESH, 0.063 DIA WIRE, PLAIN WEAVE (0.062 SQ OPENING)
10 X 10 SQ MESH, 0.035 DIA WIRE, PLAIN WEAVE (0.068 SQ OPENING)

MATERIAL: AISI 302 OR 304 STAINLESS STEEL

LENGTH OF CONE: 1.5 TIMES INLET PIPE DIAMETER

C A U T I O N : REMOVE THE SCREEN AFTER 40 TO 50 HOURS OF OPERATION.

FIGURE 1. INLET SCREEN ARRANGEMENT

10/05/81

21.5 FUEL GAS

Fuel gas enters the block at 275 psig and is stepped down to 100 psig by a regulator. Fuel gas is fed to FV-904 (flare) and the Dowtherm furnace (F-501). The fuel gas flow, temperature, and pressure is measured for metering. There is a high and low pressure alarm.

TABLE INDEX FOR UTILITY SYSTEMS

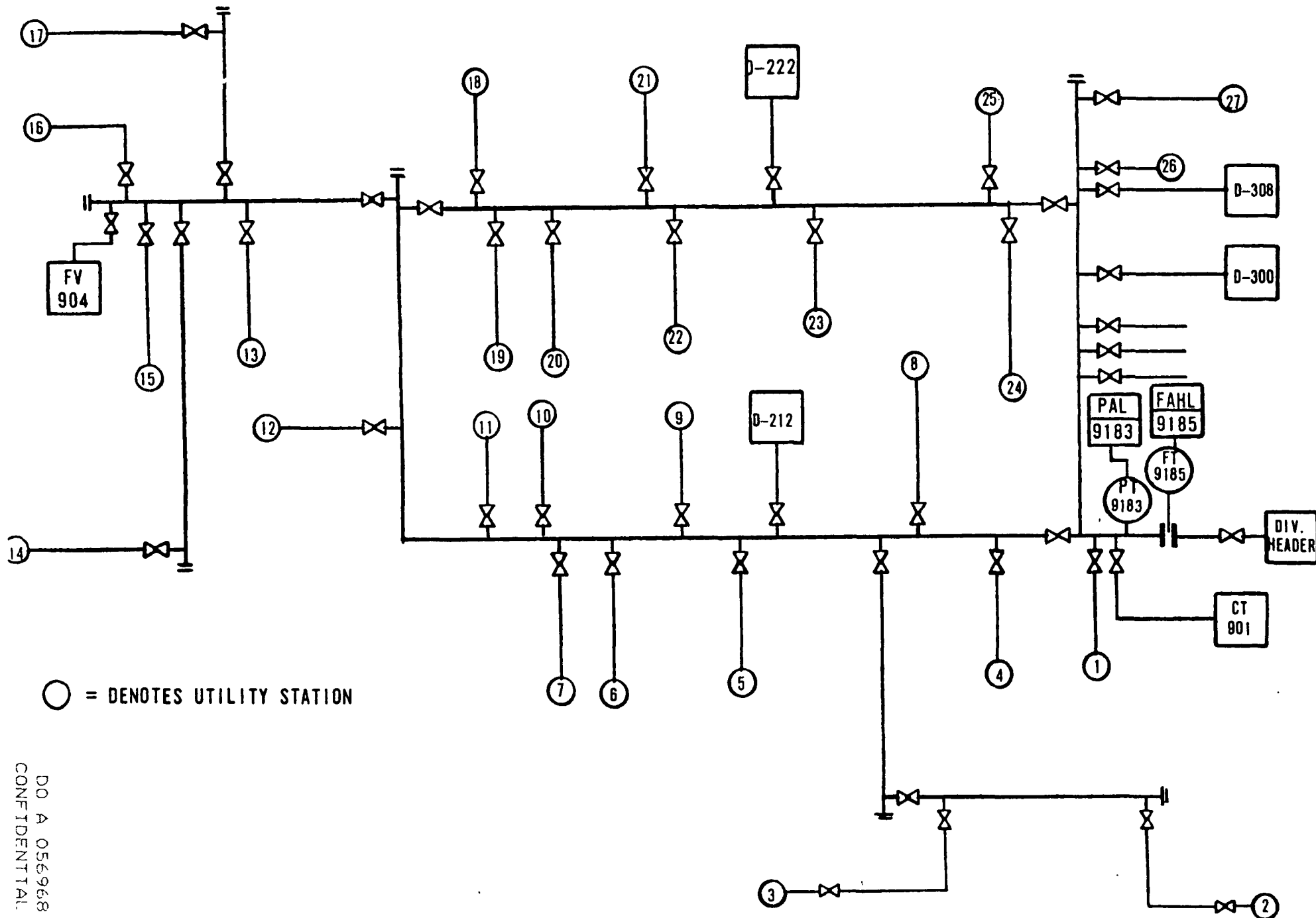
<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
21.1	15 PSIG Control Loops

FIGURE INDEX FOR UTILITY SYSTEMS

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
21.1	Process Water Distribution and Instrumentation
21.2	Nitrogen Distribution and Instrumentation
21.3	235 PSIG Steam Distribution and Instrumentation
21.4	15 PSIG Steam and Condensate System and Instrumentation
21.5	Plant Air Distribution
21.6	Equipment and Instrumentation After Air Compressors
21.7	Oil System on Air Compressors
21.8	Air System on Air Compressors
21.9	Fuel Gas Distribution and Instrumentation

TABLE 21.1
15 PSIG STEAM AND CONDENSATE SYSTEM
CONTROL LOOPS

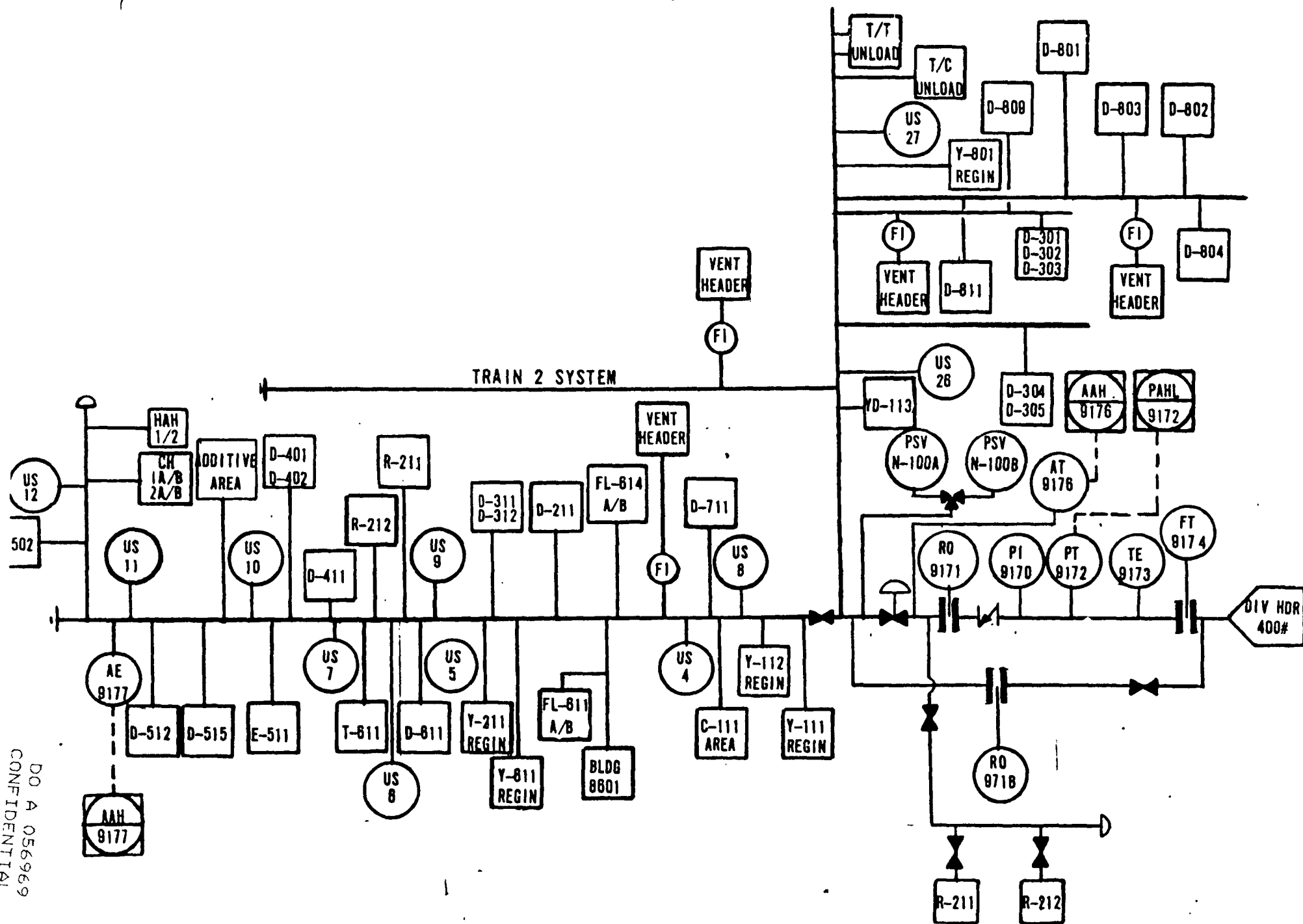
<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
PIC 9148	15 psig header pressure controller.	Receives signal from PT-9148. Valve is air to close. (PV-9148)
LIC 9149	Control level in D-908.	Receives signal from LT-9149. If level is above set point, a signal is sent to LV-9149A and condensate is sent to the division power plant. If level is below set point, a signal is sent to LV-9149B and condensate is received from the division power plant. Both valves are air to open.
LIC 9147	Controls level in D-907.	Receives signal from LT-9147. Valve (LV-9147) is air to open.



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PROCESS WATER SYSTEM

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NITROGEN DISTRIBUTION TRAIN 1

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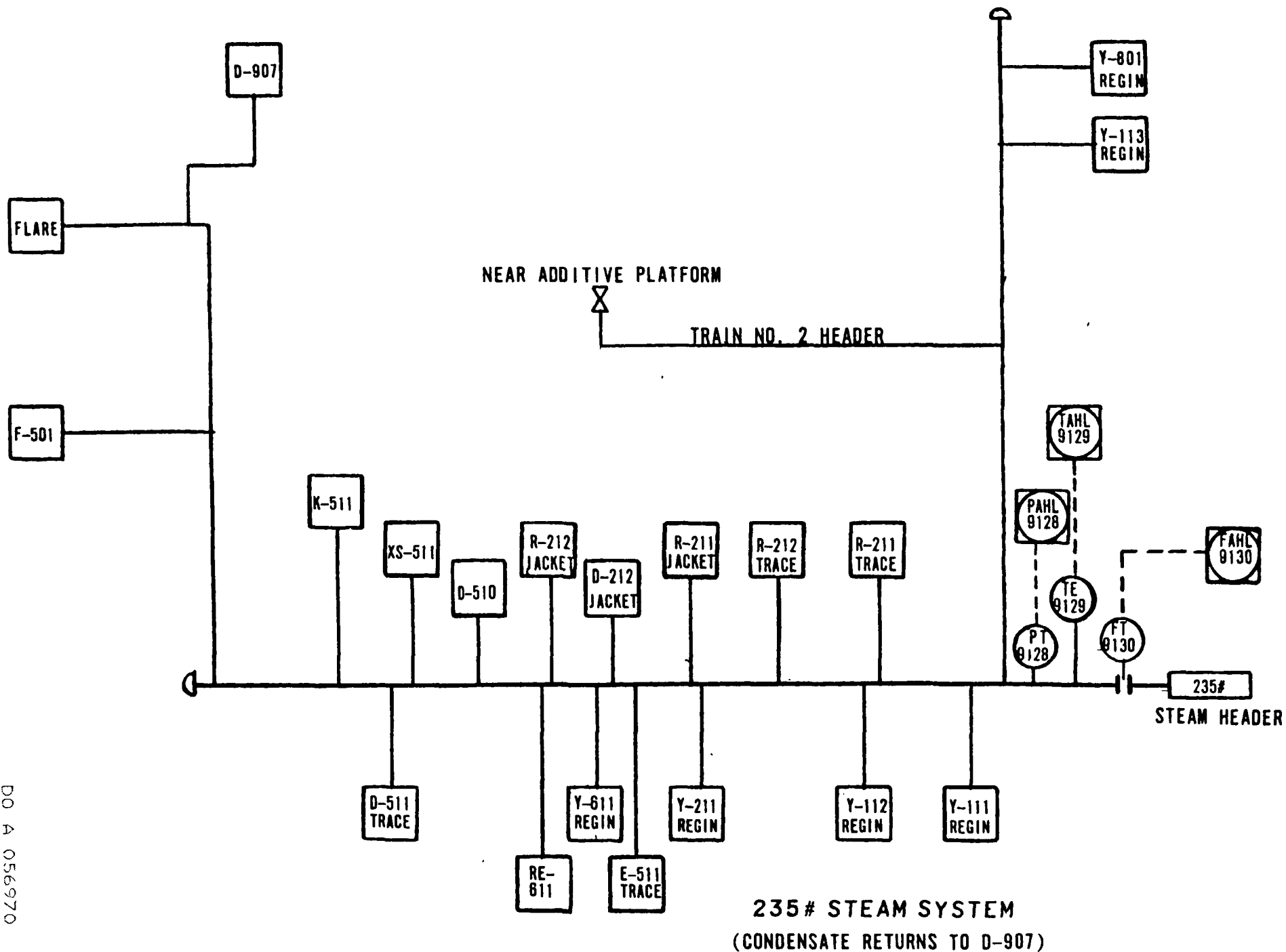
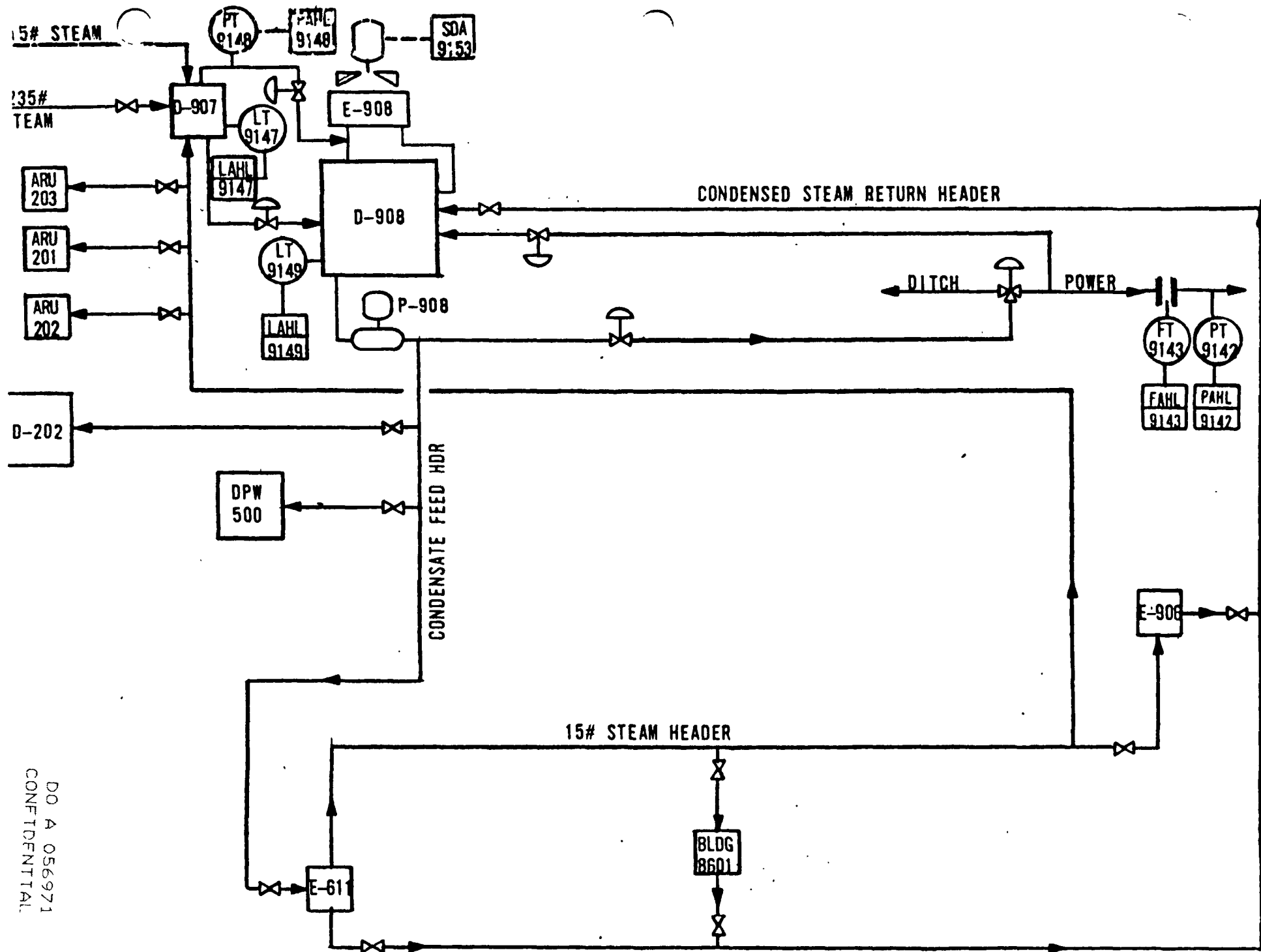


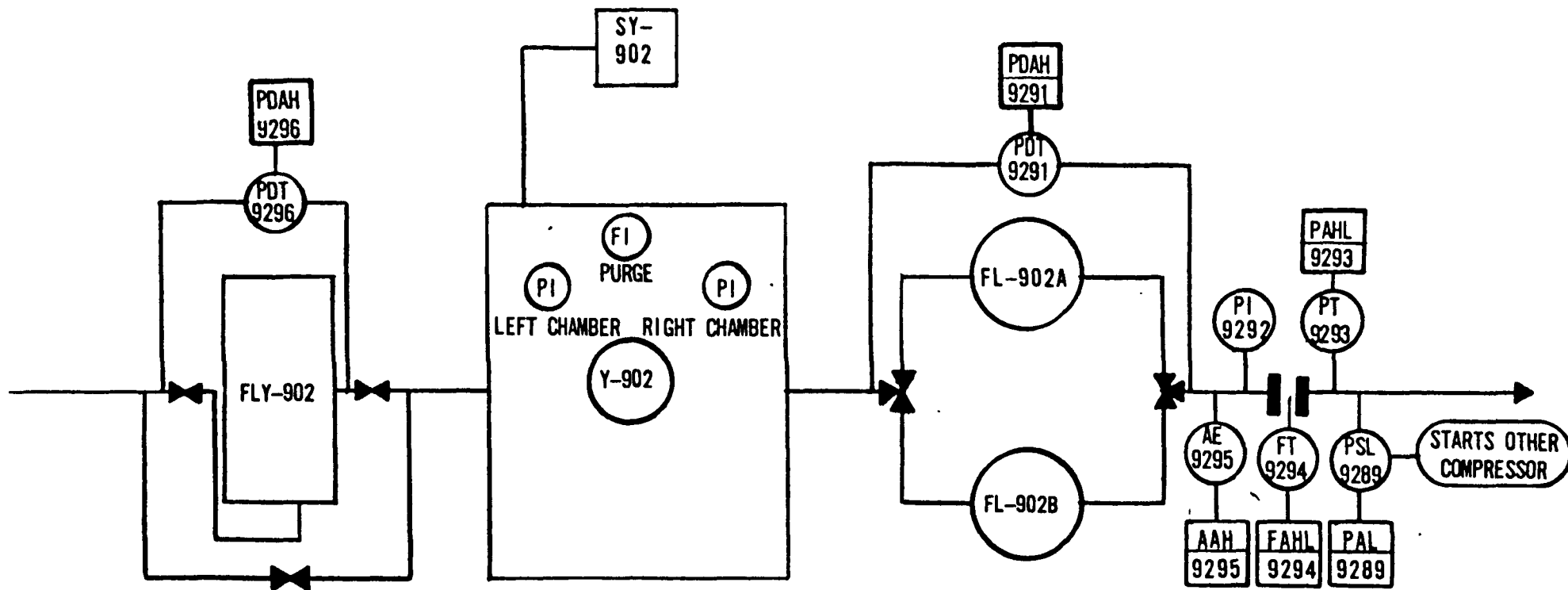
FIG. 21.3



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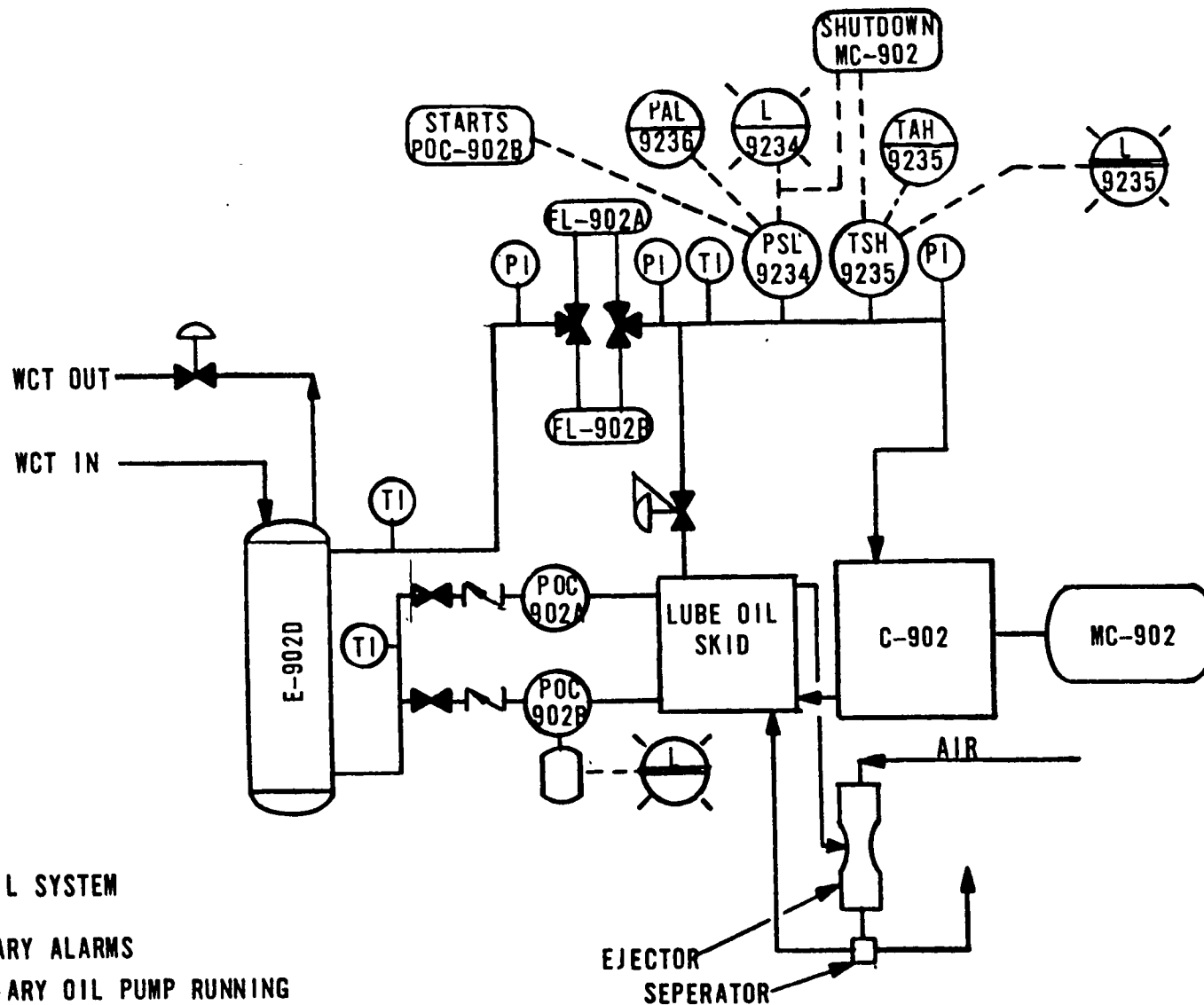
FIG 21 A

15# STEAM SYSTEM



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FIG. 21.6



OIL SYSTEM

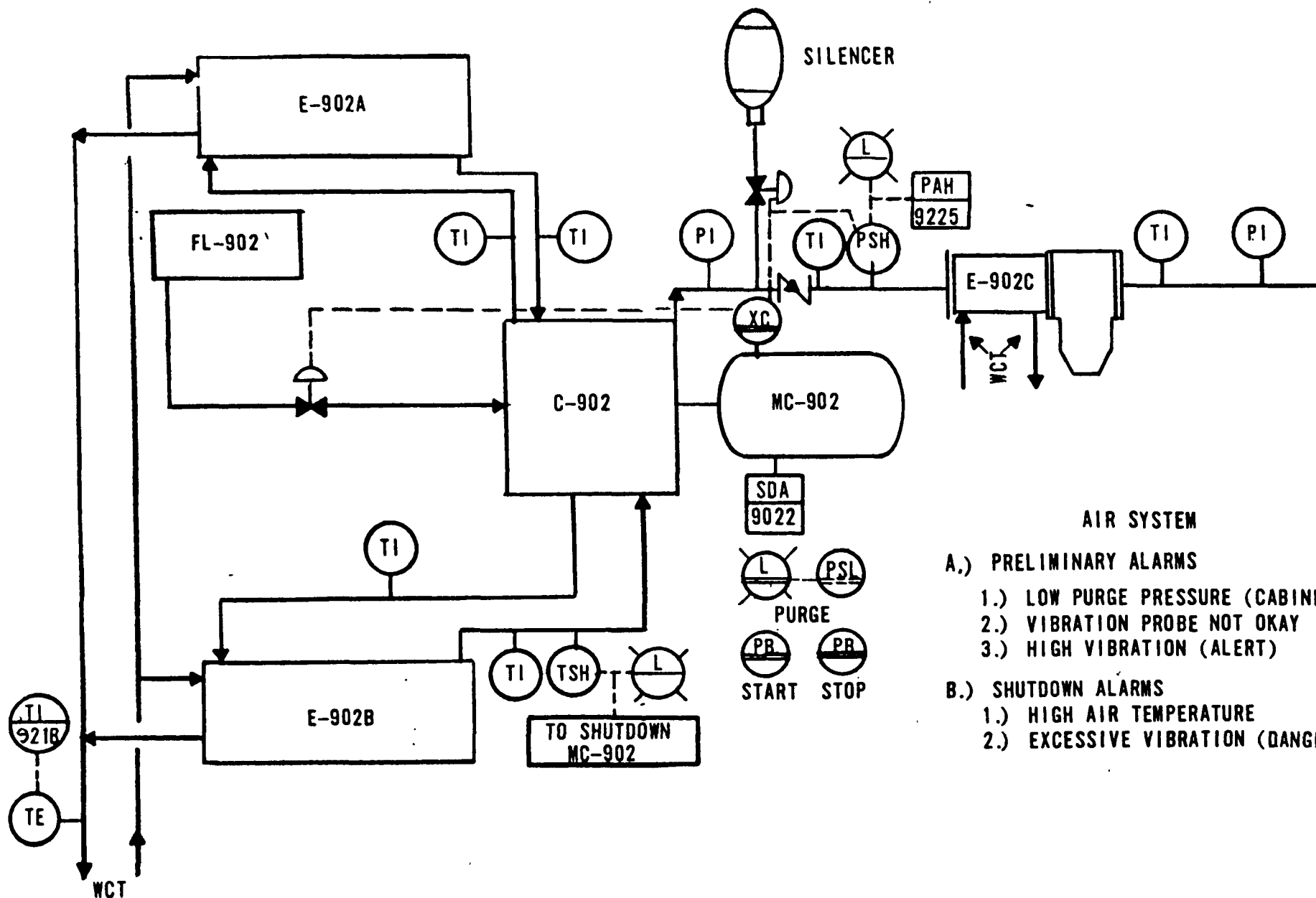
A.) PRELIMINARY ALARMS

- 1.) AUXILLIARY OIL PUMP RUNNING

B.) SHUTDOWN ALARMS

- 1.) LOW OIL PRESSURE
- 2.) HIGH OIL TEMPERATURE

OIL SYSTEM ON C-902



AIR SYSTEM

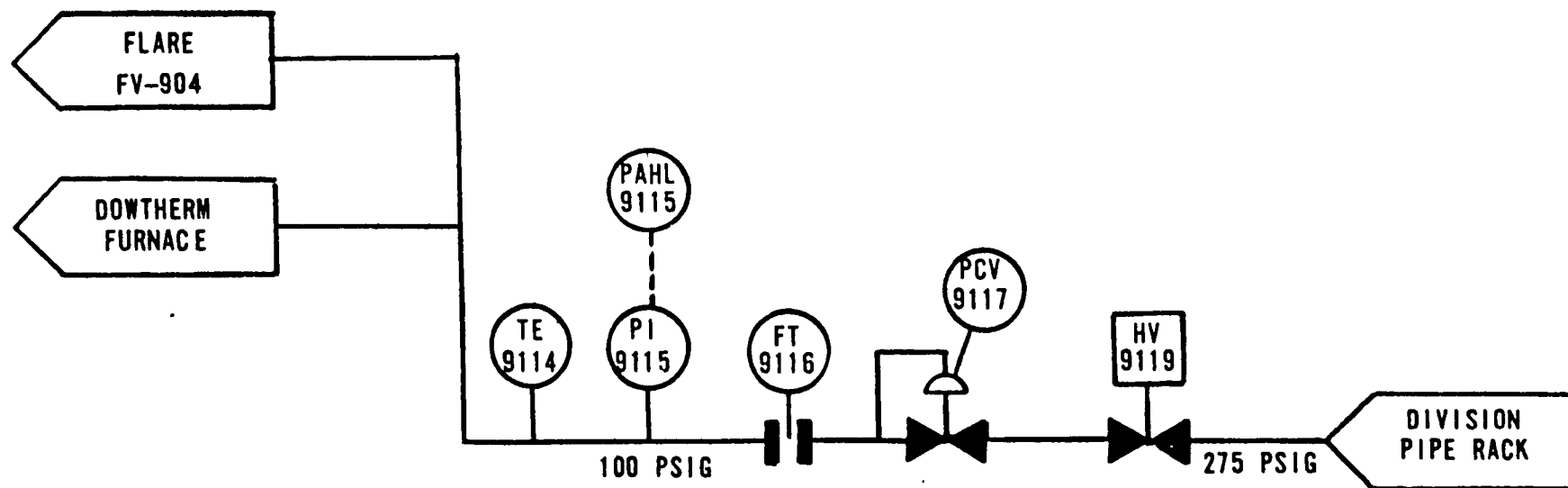
A.) PRELIMINARY ALARMS

- 1.) LOW PURGE PRESSURE (CABINET)
- 2.) VIBRATION PROBE NOT OKAY
- 3.) HIGH VIBRATION (ALERT)

B.) SHUTDOWN ALARMS

- 1.) HIGH AIR TEMPERATURE
- 2.) EXCESSIVE VIBRATION (DANGER)

FIG. 21.8



FUEL GAS

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FIG. 21.9

22. ELECTRICAL SYSTEM

The Dowlex electrical system is unique in the division in that the voltages being used are 575V and 4500V. There are two main feeders coming from the power plant that enter the block on the north-east side. These feeders supply the two substations and various transformers in the block. If necessary the block can be run on either one of the feeders but under normal conditions the electrical load will be shared. There are two substations: Number one is located on the north side of the control room and the other substation, number two, is located just north of the warehouse.

The substations house the 15KV, 4.5KV and 600V switch gear, and various motor control centers (MCC). With the exception of the variable speed drive motors (C-111, C-711, P-511, P-512), this system is designed so that it's possible to operate with a back-up feeder from either Bus.

NOTE: The standby feeders operate automatically on loss of voltage. (See attached one line diagram, figure 22.1) Diagrams of each MCC are included showing the equipment on each MCC bus.

It should be noted that usually all of Train #1's equipment is on MCC 1A and 1B, while Train #2's equipment is on MCC 2A and 2B. The 'A' equipment is on the 'A' bus. The single items are split evenly.

MCC 120 basically carries what is common for both trains such as the solvent storage area.

Substation #2 carries mostly the Dowtherm pumps and product handling equipment such as blowers, rotary feeders, etc.

Inside substation #1 is also MCC-VS A&B. These are for the variable speed equipment in the block.

MCC-VS A

MCC-VS B

MP-511

MP-521

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MCC-VS-A	MCC-VS-B
MP-512	MP-522
C-111	C-121
C-711	C-721

Finally, there are two 4.5KV MCC's. These are MCC-5A and MCC-5B. The following equipment is on these MCC's.

P-901A	C-902
P-901B	C-903
P-901C	

22.1 D. C. SYSTEM

The D. C. power in the block is basically for the operation of the uninterruptable power supply and emergency lighting. Each substation has a 60 cell 125V battery bank. Sub #1 is equipped with 2-100 amps chargers while sub #2 has 2-50 amps chargers. Each system has it's own distribution panels, under voltage alarm, and test circuits.

The uninterruptable power supply (U. P. S.) is located on #1 D. C. distribution bus. The purpose of this equipment is to convert D. C. to A. C. for critical 110V A. C. equipment in the plant. Normal A. C. power for the critical equipment comes from a lighting transformer on MCC-2B.

The equipment on the U. P. S. includes:

- Intercom system and radios
- TDC2000 control system (controllers and operator stations)
- Emergency block valve solenoids
- Gas detectors and their alarm panels

There battery banks are sized for 30 minutes back-up time.

FIGURE INDEX FOR ELECTRICAL

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
22.1	Block Electrical one line
22.2	MCC-1A
22.3	MCC-1B
22.4	MCC-2A
22.5	MCC-2B
22.6	MCC-120
22.7	MCC-1C
22.8	MCC-1D
22.9	MCC-2C
22.10	MCC-2D
22.11	MCC-VS A/B
22.12	ROBICON A/B
22.13	MCC-5A/B
22.14	13.8KV S.G
22.15	U. P. S. Block Diagram
22.16	Substation #1 (Bldg. #8602)
22.17	Substation #2 (Bldg. #8605)

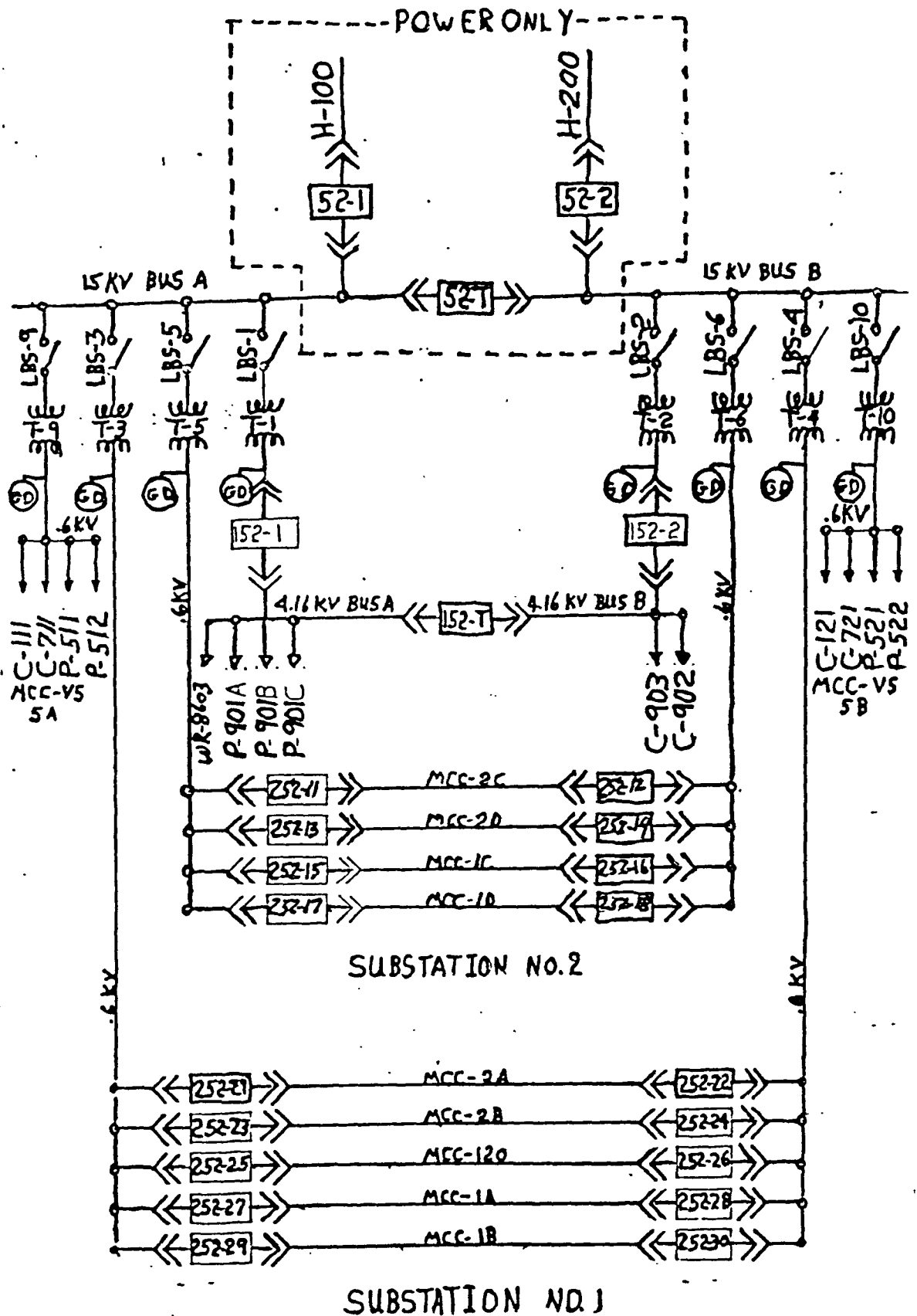


FIG. 22.1

MCC-1A

East						West						
Spare	P-811A Solvent Monomer	P-514A D-514 Bottoms	Spare	Spare	FN-612A E-612 Fan		GR-511 Lube Oil Heater	LP-8603 Lighting Panel		OP-GR511A Oil Pump GR511A		
	P-515A Chilled Solvent								H-111 N ₂ Gas Heater	OP-GR512A Oil Pump GR512A	MX-511 Motor Pelletizer	
VP-512A Vacuum Pump		C-911 Refrig	A-211 Agitator	P-611A T-611 Reflux			P-211A Solvent Feed	P-211C Solvent Feed				XS-511 Motor-511 Extruder
										EF-MP-511 Fan MP-511	SCR-100 Ramsay Variable Speed	CL-511 Classi- fier
										MC LOP C111		
P-519A DTA Return				P-613A T-611 Recircula- tion	SD-511 Pellet Dryer					P-C MEP C-111		FSD-511 SD-511 Fan
	P-612A Solvent Recycle					YB-611 Y-611 - N ₂ Blower						
B-512A Vacuum Booster				P-614A T-611 Bottoms	POX-511 XS-511 Oil Pump					SC-511 MC-511 Screen Changer		
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FIG. 22.2

MCC-2 A														
*** East														
West ***														
T-3 BREAKERS														
T-4 BREAKERS														
Tie Breaker	OC Relays	SP-902A Septic Tank	B-522A Vacuum Booster	P-525A Chilled Solvent	SCR-200 Ramsy Variable Speed	FN-622A E-622 Fan	P-624A T-621 Bottoms		A-307 Agitator	HP-801 HYD Pump	H-122 N ₂ Gas Heater	EF-MC121 Fan MC121	PSC-521 SCRN Changer HYD Pump	LP-8608 Lighting Panel
		Spare	A-221 Agitator	POX-521 XS-521 Oil Pump										
					VP-522A Vacuum Pump	P-621A T-621 Reflux	FSD-521 SD-521 Fan	A-321 Agitator	P-221A Solvent Feed	P-221C Solvent Feed		Spare	XS-521 Motor 521 Extruder	
						P-524A D-524 Bottoms		H-121 N ₂ Gas Heater				LP-2101 Lighting Panel		
		Spare		P-622A Solvent Recycle		P-623A T-621 Recircula- tion	YB-621 Y-621 N ₂ Blower				OP-GR521A Oil Pump GR-521A	LP-4201 Lighting Panel	MK-521 Motor-521 Pelletizer	
											OP-GR522A Oil Pump GR-522A	LP-3101 Lighting Panel		
					P-529A OTA Return			P-821A Solvent Monomer			EF-MP521 Fan MP-521	Spare	LP-8604 Lighting Panel	

FIG. 22.4

*** West

MCC-2B

East ***

T-4 BREAKERS										T-3 BREAKERS							
Tie Breaker	OC Relays	SP-902B Septic Tank	SD-521 Pellet Dryer	B-522B Vacuum Pump Booster	VP-522B Vacuum Pump	FN-622B E-612 Fan	YB-122 N2 Blower	FN-121 E-121 Fan	A-421 Agitator	P-520 O-520 Pump	H-221 N2 Gas Heater	BC-8602B Battery Charger	POC-903B Lube Oil Pump C-903	UPS-8602B Uninterruptible Power Supply	OC Relays	Tie Breaker	
		A-222 Agitator	C-921 Regrigeration Unit	P-525B Chilled Solvent						YB-221 N2 Blower		P-721 O-721 Bottoms		P-221B Solvent Feed			P-821B Solvent/ Monomer Pump
						P-624B T-621 Bottoms			GR-521 Lube Oil Heater			P-803B Comonomer Feed	OP-GR521B Oil Pump GR-521B	LP-1101 Lighting Panel			
252-22 BKR MCC-2A				P-622B Solvent Recycle	P-529B DTA Return	P-623B T-621 Recirculation	YB-121 N2 Blower	CL-521 Classified	GR-522 Lube Oil Heater		H-621 N2 Gas Heater	P-802B Comonomer Feed	OP-GR522B Oil Pump GR-522B	LP-8602 Lighting Panel		252-21 BKR MCC-2A	
					P-621B T-621 Reflux				A-526 Agitator				P-804B Swing Solvent Tank	EF-MP522 Fan MP-522	IPT-U601		
252-24 BKR MCC-2B				P-524B O-524 Bottoms		Spare			A-523 Agitator			C-OH-903 Lube Oil Heater C-903	EF-MC721 Fan MC-721	LP-3201 Lighting Panel		252-23 BKR MCC-2B	

FIG. 22.5

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MCC-120

← ← ← West									East → → →
Tie Breaker	OC Relays							OC Relays	Tie Breaker
	252-26							252-25	
DO A 056985 CONFIDENTIAL									
252-26 Breaker MCC 120									252-25 Breaker MCC 120

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FIG. 22.6

MCC-120

← ← ← East									West → → →
	DO A 056986 CONFIDENTIAL	LP-4401 Lighting Panel	FN-901A Cooling Tower 901 Fan		FN-901B Cooling Tower 901 Fan	P-308 D-308 Pump	H-801 N ₂ Gas Heater		
		Spare		YB-801 North East Blower		P-803A Comonomer Feed Pump			
		Spare		P-804A Swing Solvent Tank		P-806B Tank Car Unloading	C-8602A Air Conditioner		
		P-906A Potable Water		P-802A Comonomer Pump		P-801 D-801 Circulation			
		P-906B Potable Water		P-806A Tank Car Unloading		YB-113 Y-113 N ₂ Gas Heater	C-8602B Air Conditioner		
		P-809 Waste Solvent		Spare		H-113 N ₂ Gas Heater			

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FIG. 22.6

South → → →

[illegible]

MCCVS (A)

600V

MCCVS (B)

East					West
Tie Breaker	OC Relays	Tie Breaker	Tie Breaker	OC Relays	Tie Breaker
CKT BKR C-111 Compressor		CKT BKR C-711 Compressor	CKT BKR C-121 Compressor		CKT BKR C-721 Compressor
CKT BKR P-511 Gear Pump		CKT BKR P-512 Gear Pump	CKT BKR P-521 Gear Pump		CKT BKR P-522 Gear Pump

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FIG. 22.11

(A)

ROBICON

(B)

← ← ← East							West → → →
VFD-P-511 Gear Pump		VFD-C-711 Recycle Compressor		VFD-P-521 Gear Pump		VFD-C-721 Recycle Compressor	

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FIG. 22.12

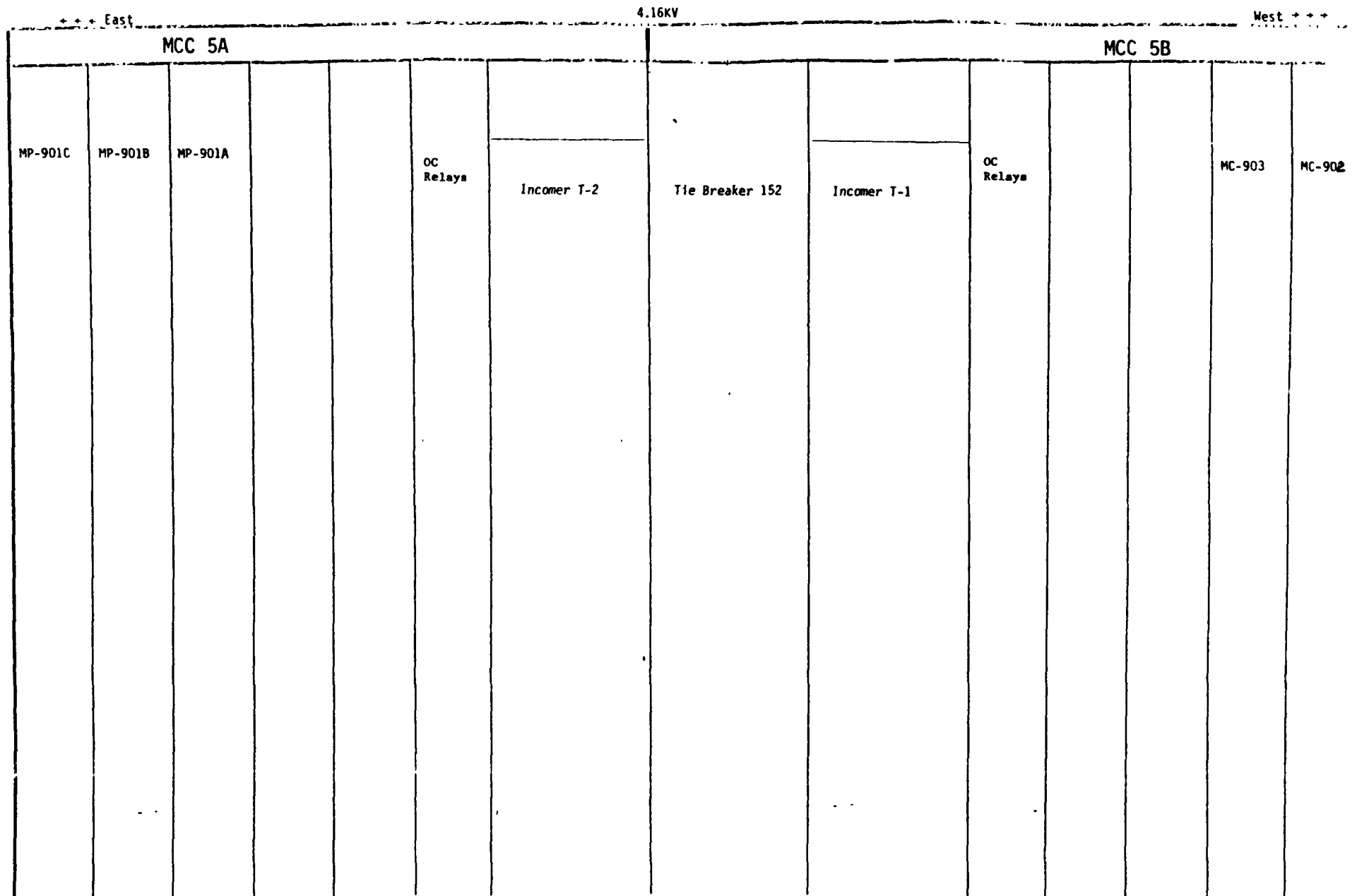


FIG. 22.13

13.8KV

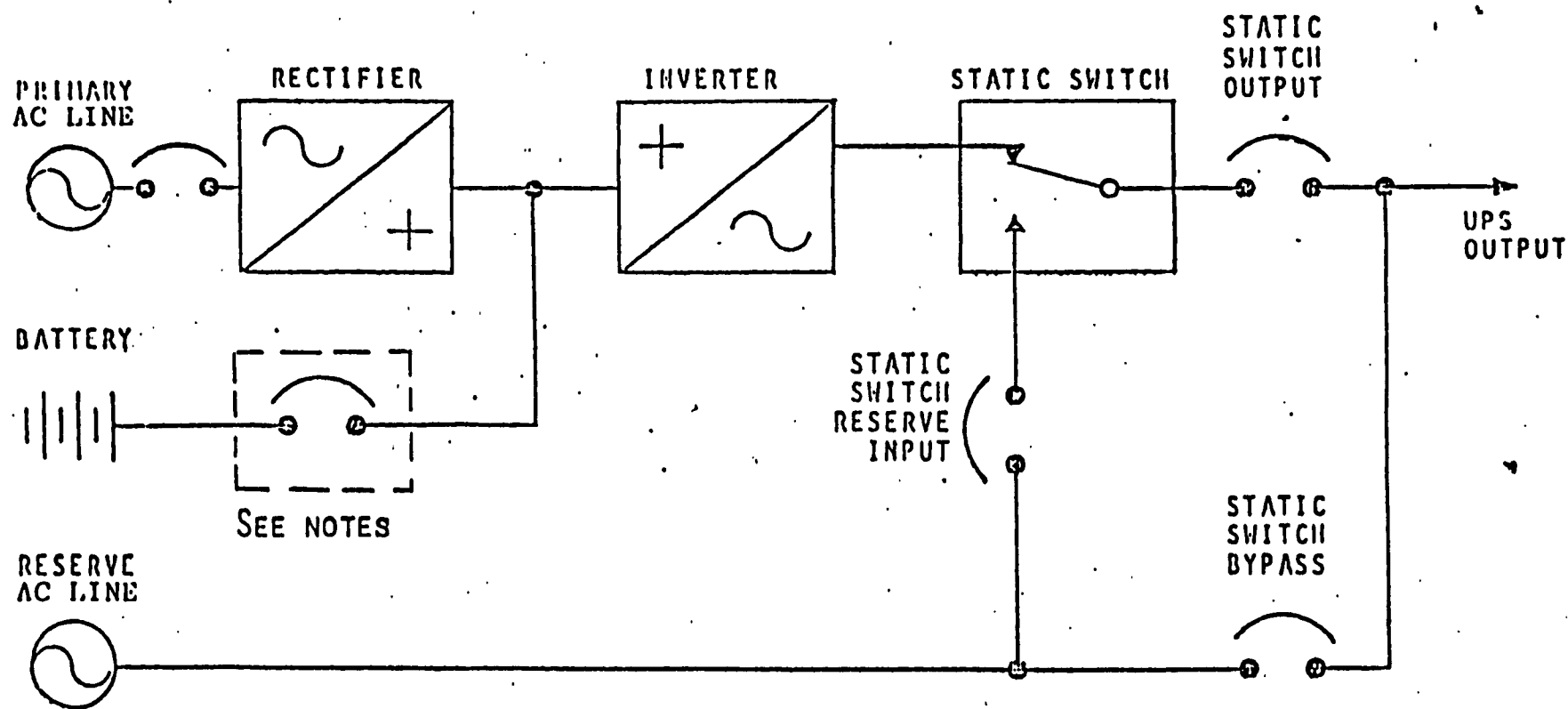
North													South	
T-3 Load BKR Switch	T-7 Load BKR Switch	T-5 Load BKR Switch	T-1 Load BKR Switch	T-11 Load BKR Switch	T-9 Load BKR Switch	52-1	52-T	52-2	T-4 Load BKR Switch	T-8 Load BKR Switch	T-6 Load BKR Switch	T-2 Load BKR Switch	T-12 Load BKR Switch	T-10 Load BKR Switch

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FIG. 22.14

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FIG. 22.15



NOTES:

1. Internally Mounted Circuit Breaker
used with 120 VDC & 240 VDC Battery.
2. Externally Mounted Disconnect Device
(by others) used with 360 VDC Battery.

SYSTEM BLOCK DIAGRAM

FIG. 22.16

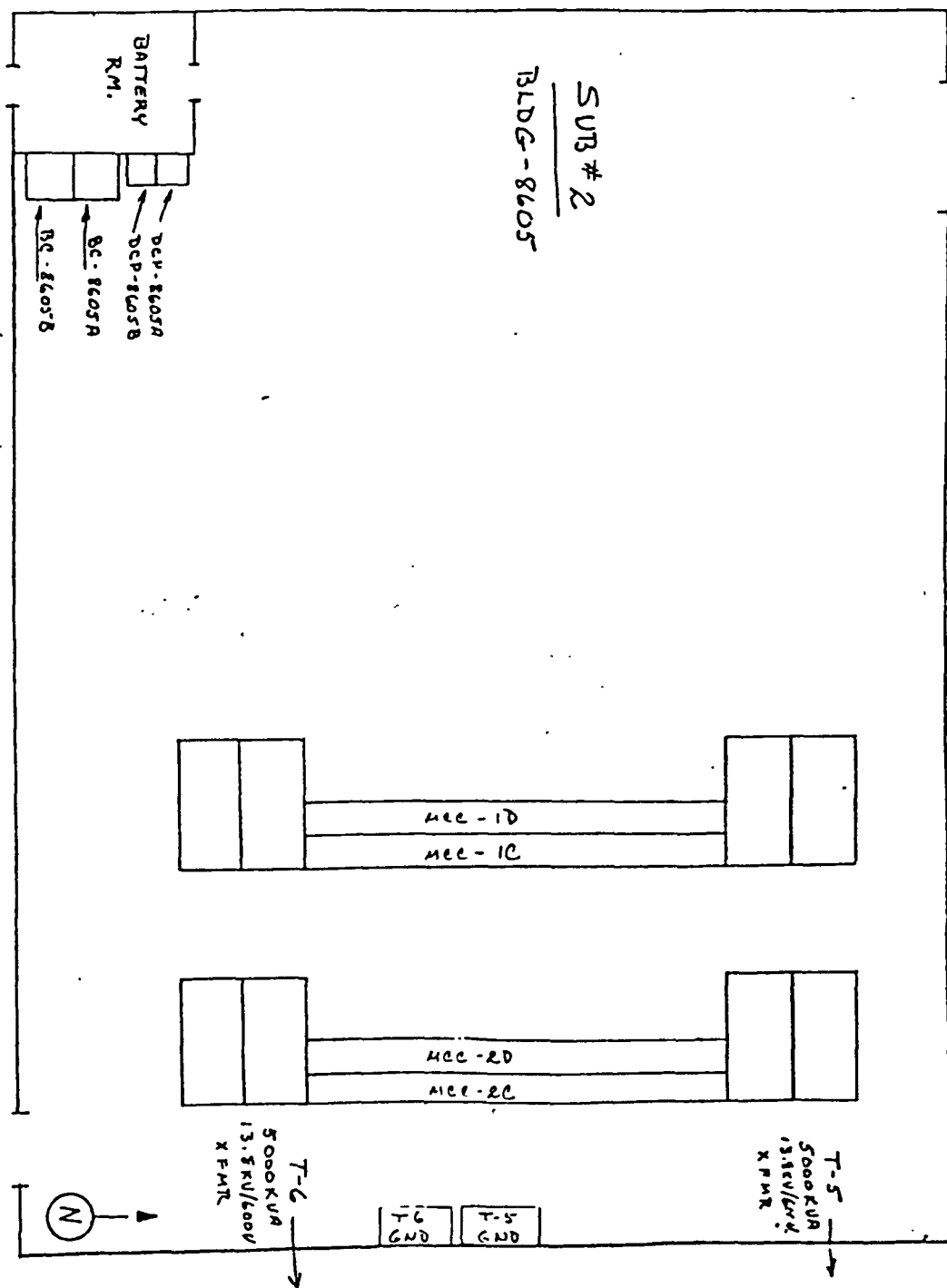
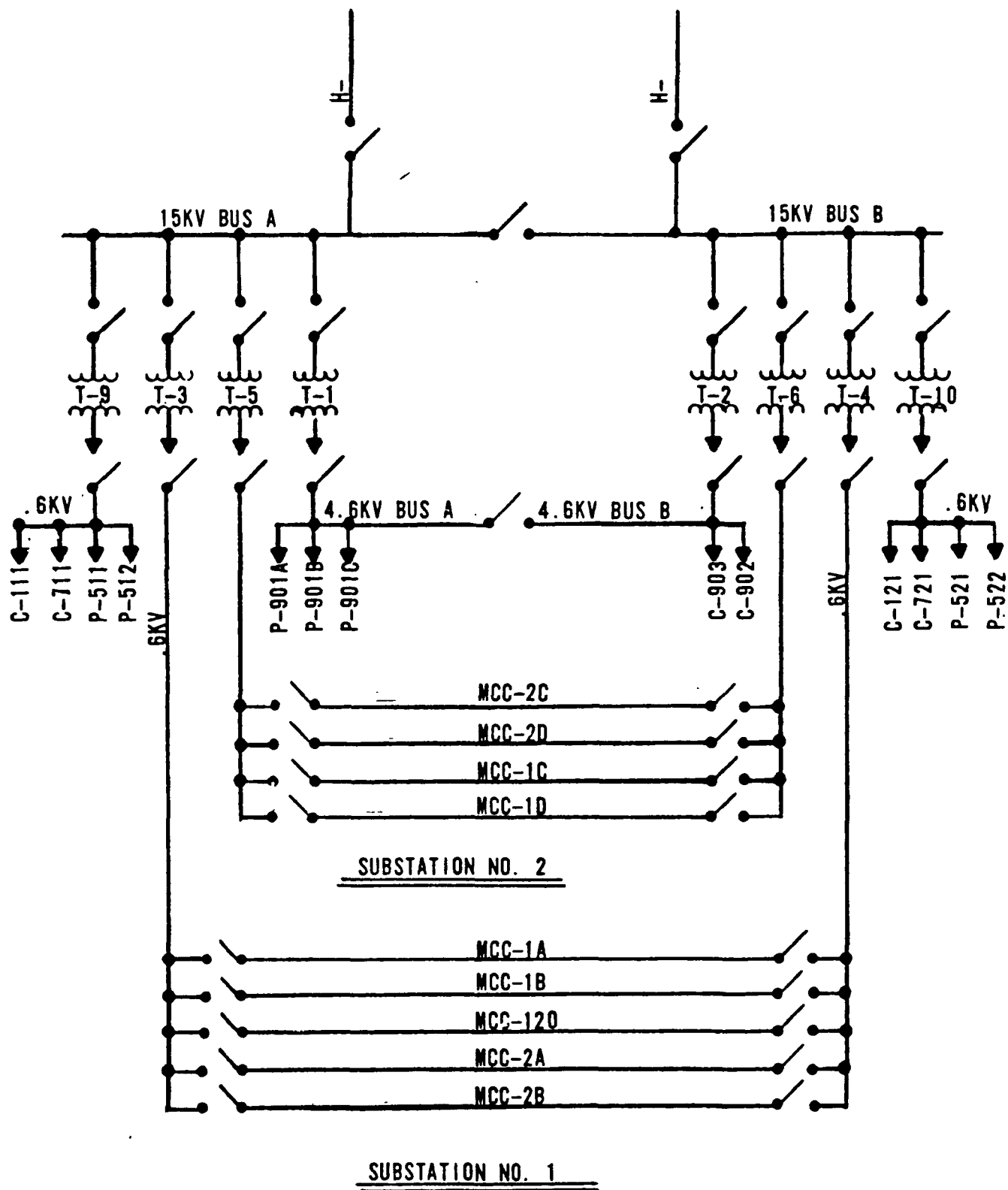
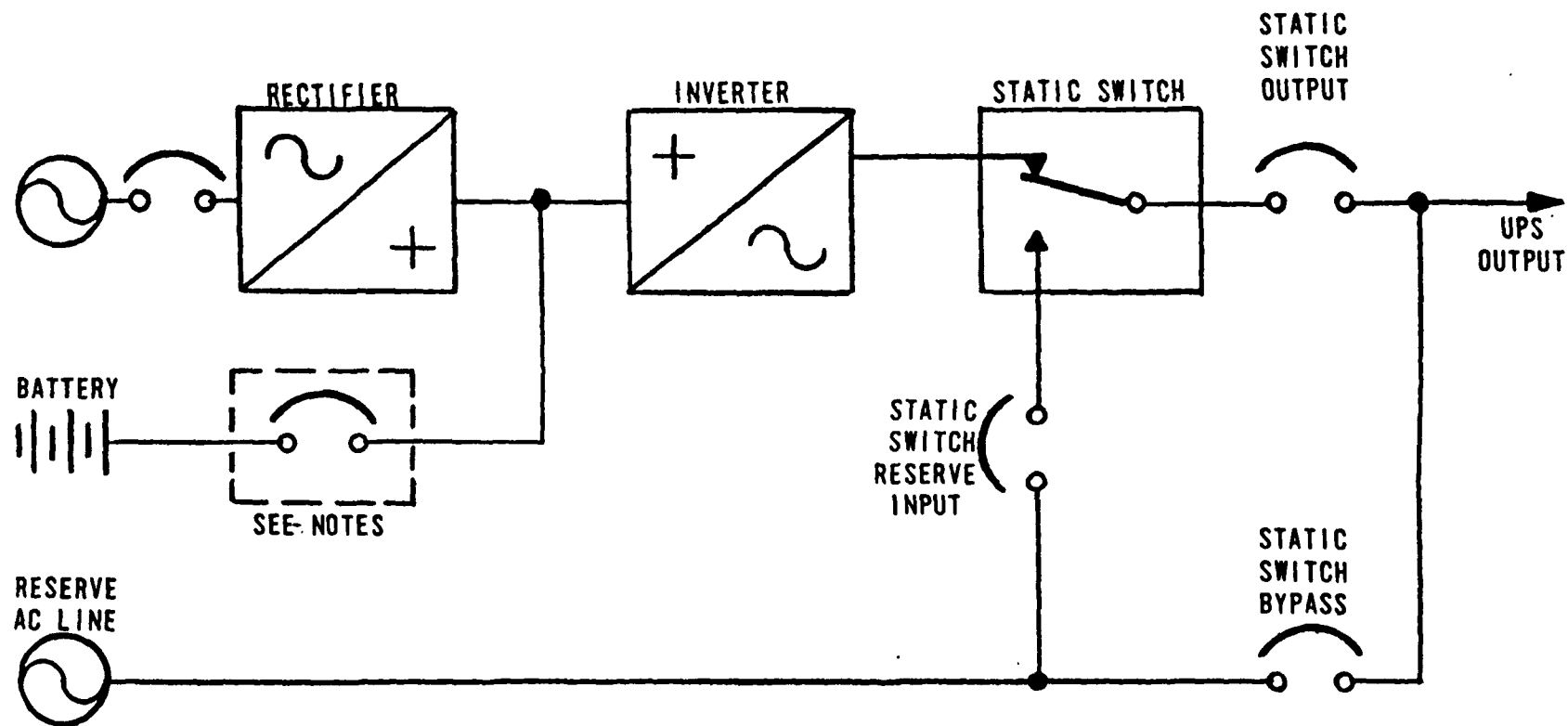


FIG. 22.17



ELECTRICAL ONE LINE DIAGRAM

FIG. 22.1



NOTES:

1. INTERNALLY MOUNTED CIRCUIT BREAKER
USED WITH 120 VDC & 240 VDC BATTERY.
2. EXTERNALLY MOUNTED DISCONNECT DEVICE
(BY OTHERS) USED WITH 360 VDC BATTERY.

U.P.S. SYSTEM BLOCK DIAGRAM

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23. MISCELLANEOUS SYSTEM

23.1 PROPYLENE PURIFICATION

Liquid propylene is supplied from LHC at 250 pounds psig and enters the block through an emergency block valve (see Section 4.1 for properties of propylene). It is used to control density when making high and intermediate density polyethylene.

The propylene will pass through one of Y-113 A or B (propylene purification beds) which are filled with molecular sieve and silica gel for removal of any impurities. The clean propylene then goes to the suction of the P-113 A/B pumps where the pressure is increased to approximately 650 pounds for feed to the reactors on either train 1 or 2. The propylene is added to the ethylene just before it is mixed with the solvent. These pumps are speed controlled to control the propylene flow. Regeneration of the Y-113's is essentially the same as the Y-111's and Y-112's described earlier, with these exceptions:

- A. There are no safety isolation valves on the regeneration system as none are needed. The PSV on YD-113 is large enough.
- B. The beds are preloaded with gaseous propylene which is added through a pressure reducing regulator to the blower loop.
- C. Pressuring up and filling the bed with liquid propylene will be discussed in detail in the safe work procedures manual.

23.2 MINERAL OIL SYSTEM

Mineral oil is used on reactor seals and as a flushing agent for the

hot melt additive system. D-905 is the storage tank and its capacity is _____ gallons. Mineral oil can be recieved in either rail cars or tank trucks.

There are three pumps on the mineral oil system pumping out of D-905. One pumps mineral oil to train #1 reactor seal system, (P-907A to D-213 A&B), the other to train #2, (P-907B to D-233 A&B). There are air operated Graaco pumps capable of pumping 30 gallons per minute at 650 psig. P-907A and B have a tie-in on their discharge in case of a problem with either pump. One pump can pump to both sets of oil systems. P-909 is the other pump and its use is strictly for flushing out lines in the hot melt additive system. This pump is also air operated and capable of pumping 16 gallons per minute at 240 psig. (Figure

Air operated pumps put up a constant pressure at all flow rates including zero flow. Therefore, the mineral oil headers are maintained at constant pressure.

23.3 HYDROGEN TRAILERS

Hydrogen is supplied by three high pressure tube trailers. These trailers are grounded and monitored by a grounding indicator which will alarm if the trailer is not grounded. The hydrogen is stored at 2500 psi and is utilized in the plant at 650 psi. This step down in pressure is accomplished by two pressure control regulators in series. When the hydrogen in the trailer has been consumed, the pressure in the cylinders drops causing a low pressure switch to activate an alarm at the TDC terminal. Two pressure safety valves are located on the process line to guard excess hydrogen pressure. These valves relieve at 900 psig.

The hydrogen is piped into the ethylene feed lines to R-211 and R-212. The hydrogen is added to the polyethylene to raise the melt index by shortening the polyethylene chains.

23.4 FLARE SYSTEM DESCRIPTION

From time to time in the Dowlex plant it will be necessary to vent the process equipment. For example: When a safety valve relieves; when filling a vessel; when maintenance is done (safety valve checks, agitator repairs), or during bed regeneration. These releases, whether intentional or accidental, obviously cannot be allowed to go to the atmosphere for both safety and ecological reasons. It is for this reason that the flare system exists.

23.5 FLARE HEADER SYSTEM

The vent collection header is a 24" carbon steel line. Various size piping branching from different areas of the plant tie into this header. On the end of each branch of the header we have a nitrogen purge. Also referred to as sweep gas, it is used to prevent any leakage of air into the system. The presence of air is hazardous because of possible ignition or explosion in the header. All safety valves that discharge to this system are equipped with permanently installed swing type blinds in the discharge line. The line should be blinded prior to the removal of the safety valve. This minimizes the possibility of leaking air into the system and also protects personnel from blowback should any other valve in the system release. We have an oxygen analyzer on the flare to detect the presence of air. The header and collection piping, knock out drum, and flare were sized so that the combined pressure drop was less than 10 psi. This was done so

that there would be no flow reduction from any relief valve. The header was installed with a uniform slope down towards the knock out drum. This would allow any liquid admitted to the header to drain to the knock out drum (D-904) located at the flare (FV-904). Other drums associated with the flare header are: D-308 catalyst waste drum, and D-212 & D-222 reactor safety knock out drums. The top of these knock-out drums are open to the flare header to vent vapors. Any liquid knocked out in D-904 is pumped to D-809 (waste solvent). The liquid level in D-904 is automatically pumped down by P-904. D-904 has a level transmitter with high and low level alarms. D-904 has a low pressure alarm. A small positive pressure should be kept on the flare header to minimize the possibility of air being sucked in. The vapor goes out the top of D-904 to the flare. We have a high flow alarm on vapor out of D-809 to indicate a safety valve release.

23.6 FLARE STACK

FV-904 is designed to burn any gas releases that enter the flare system. It will burn 88,000 pounds per hour of hydrocarbon with an average molecular weight of 114. FV-904 has a molecular seal to prevent any air from entering the flare system via the flare stack. The flare has a pilot system to ignite the gases as they exit. The pilot should be lit at all times except when we have a high concentration of oxygen in the system. A low temperature alarm on the pilot signals that the pilot is out. We have an emergency block valve to block fuel gas to the pilot and to open the steam valves to the flare. These valves are operated by a hand switch in the control room and are used to snuff the flare in case of any outside

spill that could be ignited by our flare. A fuel gas and air mixture is ignited by a spark plug to light the pilot. The ignited mixture flows through any of three 1" pipes to the pilot. The pipes are located at different points around the pilot ring. The right point would be selected depending on wind direction.

The gases enter the bottom of the flare stack and are bubbled up through water in the bottom of the stack. The water prevents flash back from the flare tip to the vent header. We have a high water level alarm. The flame of the flare is constantly monitored by a remote infra-red detector, which detects smoke intensity and sends a signal to a controller, opening the steam control valves as necessary to control smoke. We have three steam manifolds located near the top of the flare.

MISCELLANEOUS SYSTEMS FIGURE INDEX

<u>FIGURE NUMBER</u>	<u>DESCRIPTION</u>
23.1	Mineral Oil Storage, Pumps, and Instrumentation
23.2	Hydrogen Trailers
23.3	Flare (Vent) Header Distribution
23.4	FV-904 and Instrumentation
23.5	D-904 and Instrumentation

MISCELLANEOUS SYSTEMS TABLE INDEX

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
23.1	Propylene Purification Controllers
23.2	Flare System Controllers

TABLE 23.1

PROPYLENE PURIFICATION CONTROLLERS

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC 1162	To flow control the propylene to reactors	By operating speed controllers SIC 1158 and SIC 1160 that operates pumps P-113 A/B
SIC 1158	To speed control P-113A	By sensing signals from flow controller FIC 1162
SIC 1160	To speed control P-113B	By sensing signals from flow controller FIC 1162

TABLE 23.2

FLARE SYSTEM CONTROLLERS

<u>LOOP CONTROL NUMBER</u>	<u>PURPOSE</u>	<u>OPERATION</u>
FIC 9066	Control smoke emission from flare stack	An 'eye' senses smoke coming from the stack and opens FV-9066 A, B, and C enough to control emission
HS 9056	To snuff flare in an emergency	a) Closes EV-9056A (fuel gas) b) Opens EV-9056B (signal to FV-9066 A, B, and C) (235 PSIG steam)

14

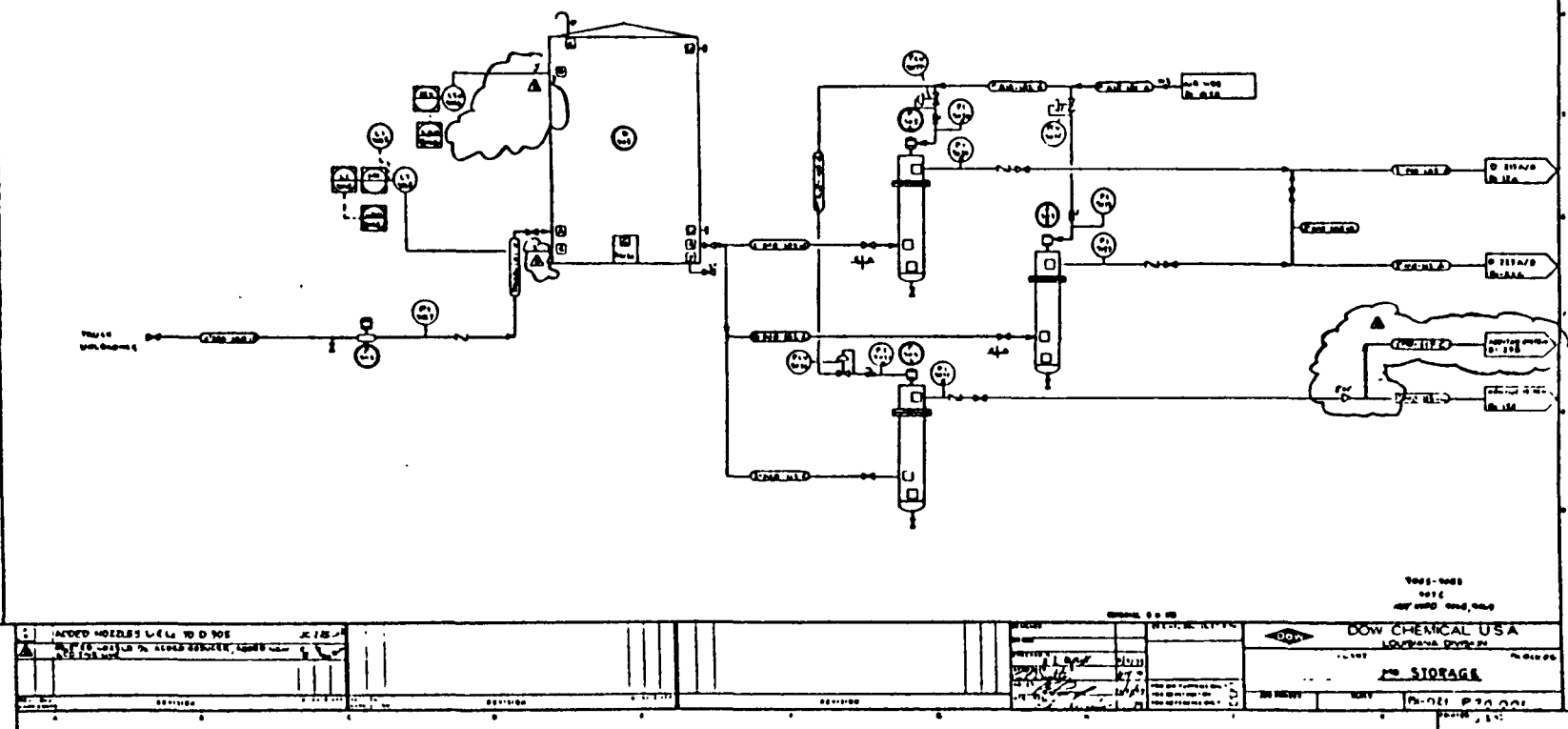
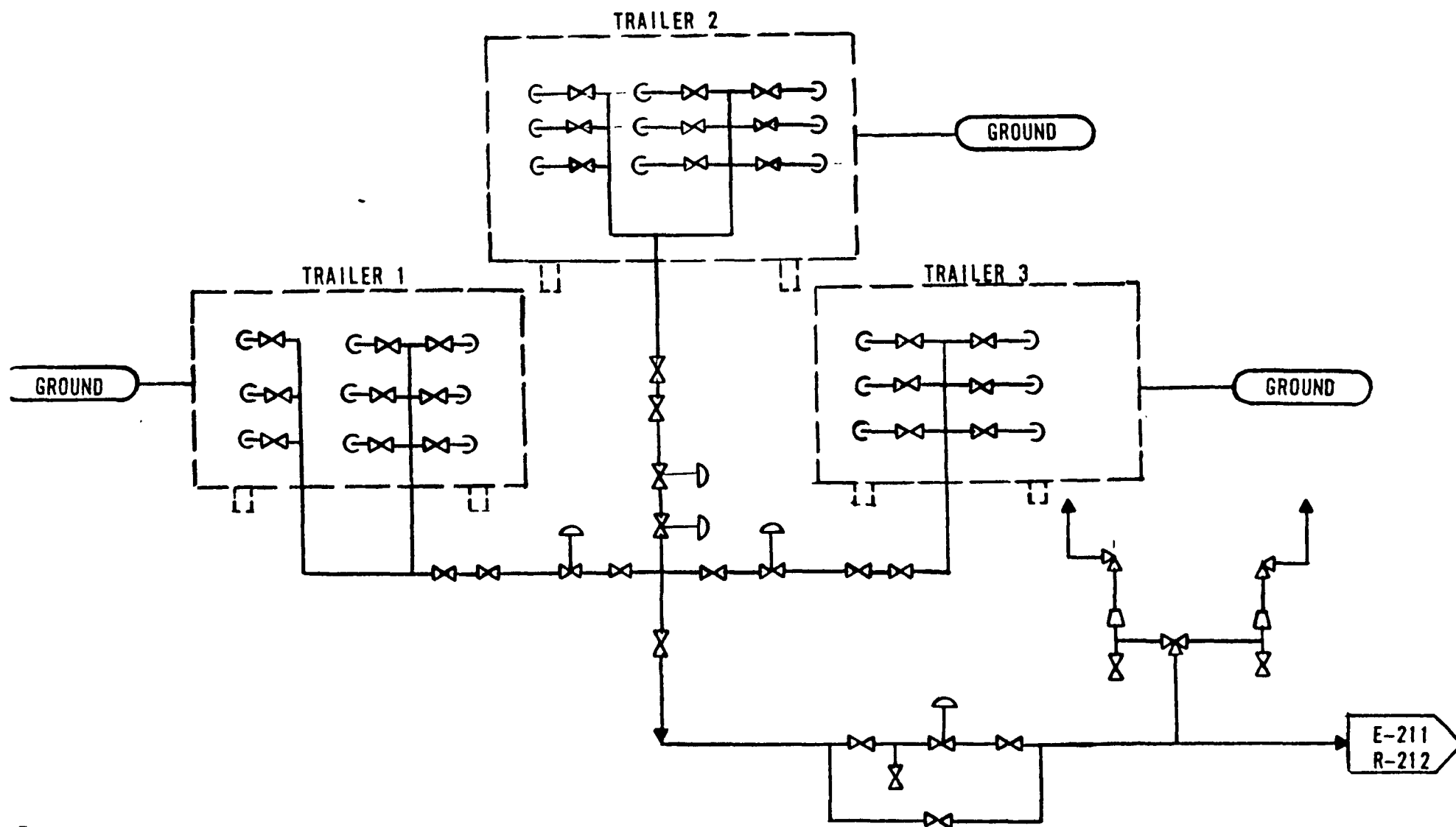


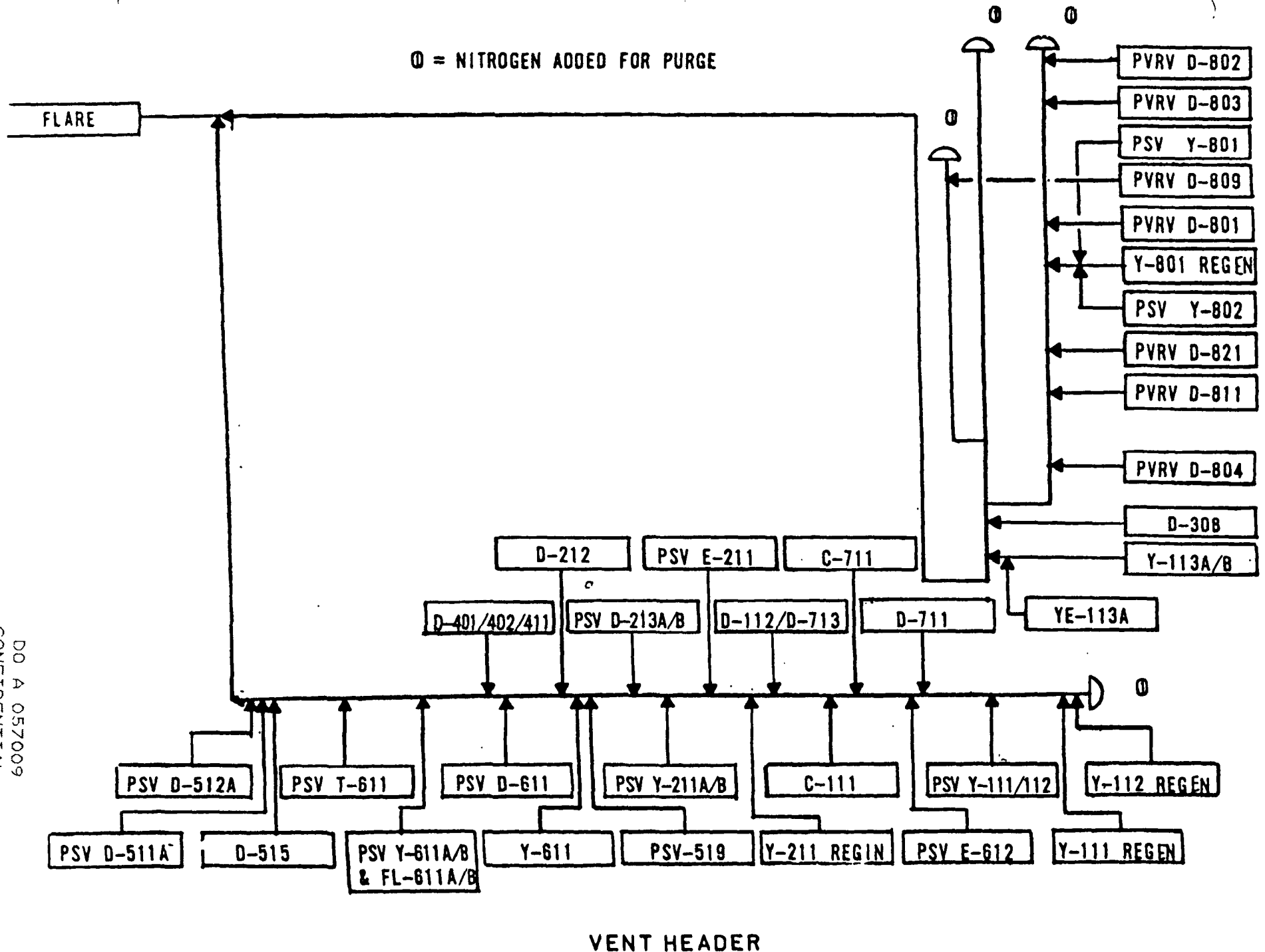
FIGURE 23.1

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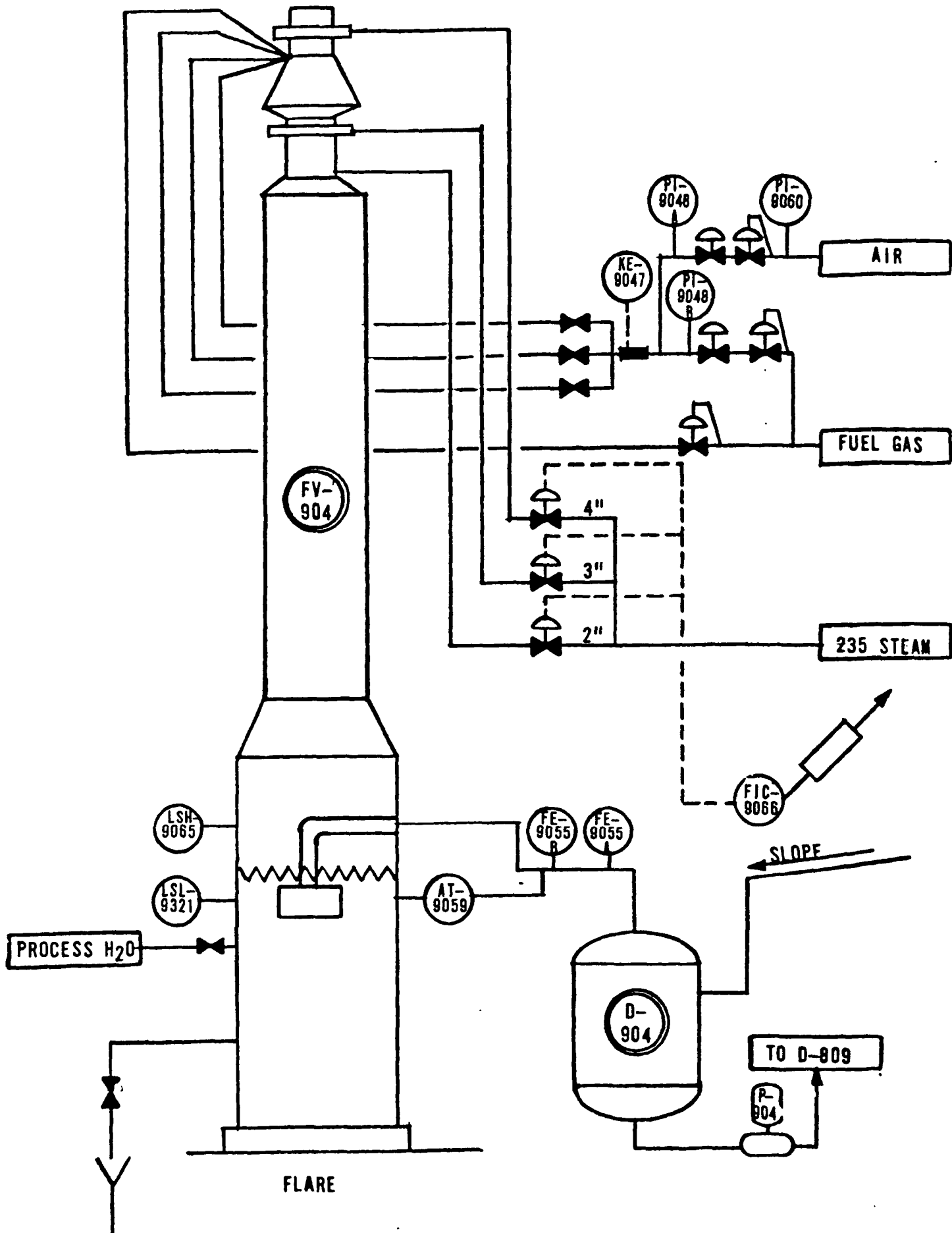


HYDROGEN TRAILERS

⊖ = NITROGEN ADDED FOR PURGE



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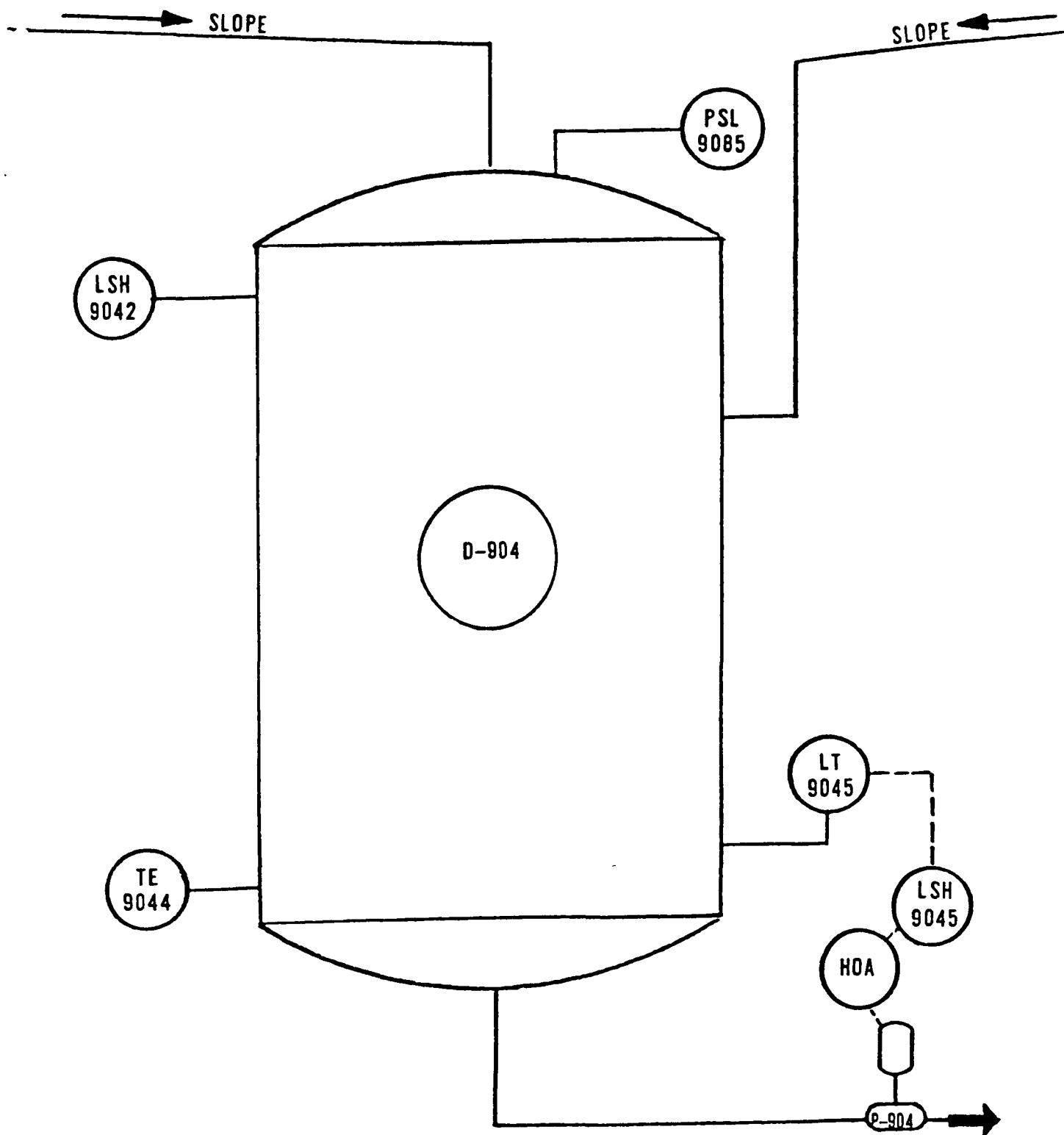


FIG. 23.5

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24. QUALITY CONTROL AND PROCESS ANALYZERS

24.1 QUALITY CONTROL

The Quality Assurance Manual of the Dow Chemical Company states in its introduction "The Dow Chemical Company's Quality Assurance Program supports a philosophy of strict adherence to our own production specifications and quality requirements to which we are committed. Our program also aims to develop a sense of personal responsibility in each employee."

Quality Control is charged with the responsibility for doing the testing and analysis work in raw materials and finished products at each production site to determine compliance to specifications. A list of the tests follows.

Melt Index

The melt index of a polymer is the amount of polymer in grams that will flow through a 0.0825-in. diameter orifice in 10 minutes, at 190°C with a 2.16 kg weight as the driving force. This value is called an I_2 . When a 10 kg weight is used as the driving force and all other conditions remain the same the value is called an I_{10} .

The test serves to indicate the uniformity of the flow rate of a polymer as made by an individual process. As the molecular weight of a polymer increases, the melt index decreases.

$$\frac{I_{10}}{I_2}$$

I_{10} / I_2 is the ratio of flow rates at the two conditions described above. This value gives an indication of molecular weight distribution. As the molecular weight distribution broadens, the I_{10} / I_2 ratio increases.

Density

The density of a polymer is defined as the mass per unit volume expressed in g/cm³ at 23°C. Density is determined by liquid displacement of heptane and is calculated knowing the dry sample weight, the weight of the heptane displaced, and the heptane density at 23°C.

The density of a polymer is a property that can be measured conveniently to identify a material, to follow physical changes in a sample and to indicate degree of uniformity among different sampling units or specimens. Changes in density of a single specimen may be due to changes in crystallinity, thermal history, and composition.

24.1 QUALITY CONTROL, continued

Color

The color of polyethylene is measured on a molded chip using a Gardiner XL 23 Colorimeter. Color is expressed in Whiteness index (WI) units as defined by ASTM E-313-78.

To be considered prime material a resin must meet a minimum color specification set down in the product specification for that product. Color is most often adversely affected by catalyst inefficiencies.

Contamination

Pelletized polyethylene is visually inspected to determine levels of contamination in the product. A sample is spread out on a lighted table designed specifically for the test and inspected for a specified length of time. Inspection is done for abnormalities such as off color, poor granulation, oxidation, dirt, and cross contamination.

Cross Contamination

Cross contamination occurs when two different products are inadvertently mixed. On visual inspection, it will often be evident when it appears as a mixture of granulation types or of granules of different opacity. Other tests for cross contamination include molded sheet, film preparation, melt index, iodine staining or melt scatter and infrared determination.

Sieve Analysis

A sieve analysis is a measurement of the particle size distribution of polyethylene pellets conducted with multiple sieves.

Each product must meet a Granulation Number specified for that product on the product specification. A Granulation Number is the designation of a standard product as to the shape (type of cut) and size.

A material will have to conform to a stated specification in order to qualify as a given Granulation Number. The specification includes type of cut and a maximum amount retained on each sieve.

Apparent Density (Bulk Density)

The bulk density of a product is the weight per unit volume. A cylinder of known weight and volume is filled with polyethylene pellets, leveled off, and weighed. The bulk density thus determined provides a useful index of performance of polyethylene pellets with respect to their handling in packaging and fabrication.

24.1 QUALITY CONTROL, continued

Volatiles

The volatiles content in polyethylene made by the solution process is mainly retained hydrocarbon reaction medium. Volatiles content is determined by weight loss after heating in vacuo at elevated temperatures. It is expressed as a weight %.

Gel Count

In blown polyethylene film, gels are small globular masses that have not blended into the surrounding material. Gels affect appearance and production of film as well as physical properties and performance of the finished product.

Film is blown on a lab film rig and inspected for gels. A gel specification as set down in the product specification must be met before material can be shipped to the customer.

UV Analysis

Products which contain UV inhibitor must be analyzed for levels of additive present. A sample is pressed into a thin film and analyzed on an instrument which measures UV absorption. The quantity of inhibitor present is read from a UV absorption VS concentration curve.

X-Ray Fluorescence

An x-ray fluorescence analyzer is used to detect levels of Si and Ca in polyethylene pellets. SiO_2 and CaCO_3 are used as anti-blocking agents in film grade resins.

Differential Scanning Calorimetry

Levels of antioxidant in polyethylene are estimated by a differential scanning calorimeter (DSC) isothermal induction time procedure.

The presence of antioxidant suppresses the rate of oxidative degradation of the polymer at elevated temperatures in an oxygen atmosphere. Once the antioxidant is consumed, the onset of degradation of polymers is observable by DSC as an exothermic peak on a time based isothermal plot. The elapsed time from the introduction of oxygen to the beginning of the polymer degradation exotherm is known as the oxidative induction time (OIT). The quantity of antioxidant is read from an OIT vs. concentration plot.

24.1 QUALITY CONTROL, continued

Cooling Tower Water Tests

Cooling tower water is tested to monitor effectiveness of the treatment and to adjust levels accordingly.

The water is tested for Calcium, orthophosphate, total Chlorine, ph and conductivity.

Raw Material Identification

All purchased raw materials will be identified by in-house lab analysis before being used in production. Records will be maintained on every lot of material used on the plant site.

24.2 PROCESS ANALYZERS

The following is a list of the various analyzers and their locations within the Dowlex process.

TABLE 24.1

<u>Tag</u>	<u>Stream Analyzed</u>	<u>Components</u>	<u>Type</u>
AE 1008	Ethylene to and from silica gel and molecular	CO ₂ / Methanol	Beckman Model 6750 Chromatograph
AE 1009	Incoming ethylene	H ₂ O	Ondyne Model DY-1405 Moisture Analyzer
AE 1010	Ethylene after silica gel beds	H ₂ O	Ondyne Model DY-1405 Moisture Analyzer
AE 2184	Solvent to P-211 A/B/C	H ₂ O	Ondyne Model DY-1405 Moisture Analyzer
AE 2179	Solvent to P-211 A/B/C	Octene	Teledyne No. 514 Infrared Analyzer
AE 2218	Ethylene to Reactor 1	H ₂	Beckman Model 6/50 Chromatograph
AE 2232	Ethylene to Reactor 1	C ₃ H ₆	Beckman Model 6750 Chromatograph
AE 2251A	Reactor 1 effluent to static mixer or Reactor 2	Viscosity	Dynatrol CL-10DVT-4 Viscosity Detector
AE 2251B	Reactor 1 effluent to static mixer or Reactor 2	Viscosity	Dynatrol CL-10DVT-4 Viscosity Detector

(Continued)

TABLE 24.1

<u>Tag</u>	<u>Stream Analyzed</u>	<u>Components</u>	<u>Type</u>
AE 2285A	Reactor 2 effluent to static mixer	Viscosity	Dynatrol CL-10DVT-4 Viscosity Detector
AE 2285B	Reactor 2 effluent to static mixer	Viscosity	Dynatrol CL-10DVT-4 Viscosity Detector
AE 6033	E-612 solvent stream to D-611	Octene	Teledyne No. 514 Infrared Analyzer
AE 6050	Solvent from Y-611 to Y-211	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 6062	Solvent from FL-611 to Y-611	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 6064	Solvent from Y-611 to Y-211	Octene	Teledyne No. 514 Infrared Analyzer
AE 8002	Solvent leaving D-801	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 8006	Solvent leaving Y-801	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 8027	Octene leaving D-802	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 8041	Octene leaving D-803	H ₂ O	Ondyne DY-1405 Moisture Analyzer
AE 8049	Octene leaving Y-802	H ₂ O	Ondyne DY-1405 Moisture Analyzer
PHE 9017	Cooling Tower water sump	ph	Leeds & Northrup Series 7079 ph Transmitter

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(Continued)

TABLE 24.1

<u>Tag</u>	<u>Stream Analyzed</u>	<u>Components</u>	<u>Type</u>
AE 9018	Cooling Tower water from header to Cooling Tower sump	Corrosion	Petrolite Model M-3011-E Corrosion Rate Instrument
AE 9019	Cooling Tower water from sump to header	Conductivity	Leeds & Northrup No. 4909-10-33-091-7-01 Conductivity Measurement Cells
AE 9059	Vent gas to flare	O ₂	Taylor OA-541AA10600-1- (512)(701) Paramagnetic O ₂ Analyzer
AE 9144	Condensate from D-908 to condensate return	Conductivity	Leeds & Northrup No. 4909-10-33-088-7-01 Conductivity Measurement Cells
AE 9176	Nitrogen from division header	O ₂	Taylor OA-541AA10600-1 (512)(701) Paramagnetic O ₂ Analyzer
AE 9295	Air from FL-902 to air header	Dew Point	Ondyne DY-1405 Dew Point Analyzer
AE 5002	DTA stack gas to atmosphere	O ₂	Taylor OA-541AA10600-1 (512)(701) Paramagnetic O ₂ Analyzer
AE 2001	Chill water to D-202		Petrolite Model M-3011-E Corrosion Rate Instrument

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25. COMPUTER AND CONTROL SYSTEMS

25.1 CONTROL SYSTEMS

The control system Dowlex uses to monitor and control the process is the TDC 2000 by Honeywell. "TDC" means total distributed control which allows the actual control of the process to be distributed among the different components in the system. This is advantageous because communication between the operator station and the controller can fail, yet the controller will continue to perform its function. All of the Dowlex controllers are located in the controller file room.

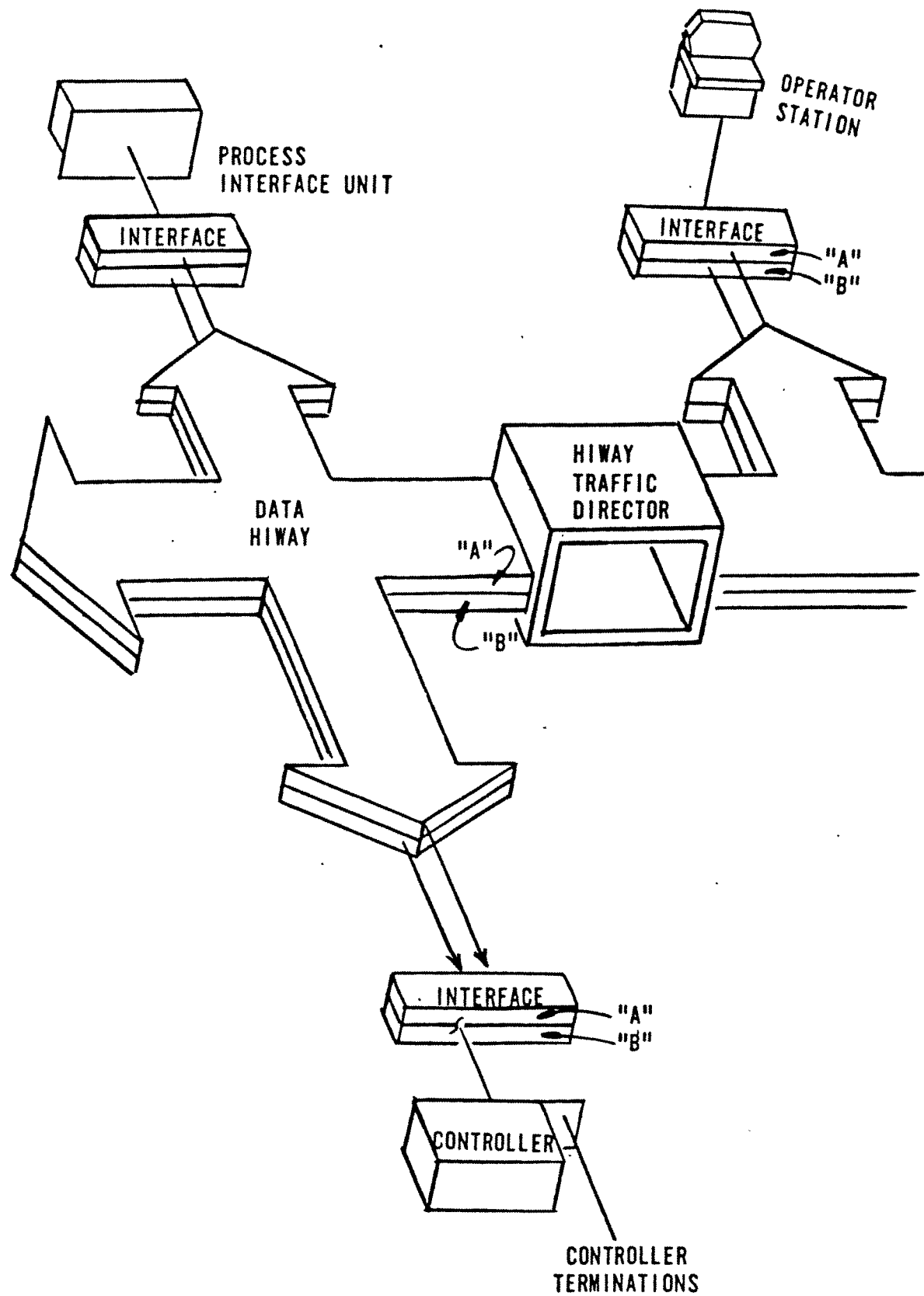
The five basic components of the TDC 2000 system are these: (See Figure 25.1)

1. Data Hiway
2. Hiway Traffic Director
3. Operator Station
4. Controllers
5. High and Low Level Process Interface Units (PIU's)

The data hiway is a coaxial transmission cable which allows all of the hardware components to communicate with each other. The data hiway needs a means of controlling the flow of information so it has a Hiway Traffic Director. This director can handle 63 units connected to the hiway including the computer, controller, operator stations, etc. There are two data hiways and the system will switch automatically if one hiway cable is disconnected. Each controller can control 8 different control loops.

The operator station is a keyboard and color CRT, primarily used to receive controller information concerning the process and display it to the operator. It also will allow the operator to tell the controller what changes to make in the process. Controller variables such as gain, reset and alarm points can also be changed at the operator station. The operator station replaces conventional control panels.

High and low level PIU's are used for accepting inputs only such as thermocouples, flow indications, pressure indications, etc. Each PIU can accept 64 inputs and reads them 8 at a time in a multiplex mode.



TDC 2000 SYSTEM

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COMPUTER/INSTRUMENTATION SYSTEM

The control/information system at the Dowlex® Plant consists of four components - a Honeywell TDC-2000 system, a PDP-11/44, a PDP-8E, and a Modicon 584. The operator interfaces directly to the TDC System and the two PDP computers by means of CRT's. All outputs and inputs to and from the field will come through the TDC System or the Modicon 584. The interconnections of these four components are shown in Figure 1.

TDC-2000

The TDC-2000 will provide the basic instrumentation for the process. All continuous process information and continuous control will come through this system. The components of this system are four operator stations, three high level process interface units (HLPIU), three low level process interface units (LLPIU), twenty-eight controller files, two data hiways, a line printer, and three strip charts.

The HLPIU's provide inputs from the process for all analog signals, except thermocouples, that are not used for control such as pressure indications, flow indications and analyzer indications. These units are also used for digital inputs to show status of limit switches and whether pumps are running or not.

The LLPIU's are used to provide input from the process of all thermocouples.

The controller files are used to provide all the continuous control for the process. These units provide the same type of control as conventional instrumentations with a process input signal, a control point, and a process output signal going to a valve. These files can also do some things in addition to conventional instrumentation - such as adding together two

TDC-2000 (continued) --

signals, and allowing signals to be controlled automatically or manually. All these options are used in the system at the Dowlex[®] Plant.

The four operator stations are used to communicate to the HLPIU's, LLPIU's, and the controller files. The data hiway is the link that connects the operator stations to these units. The operator stations are configured (set up) such that two units are dedicated to Train I and two units are dedicated to Train II. All systems that are common to both trains will be displayed on all operator stations. The operator can view the process through these operator stations; he can change set points for his control loops; and he can place his controllers on manual, automatic or computer control. Through the operator stations the board operator observes and controls the process.

The strip charts are used to record any eight points that the operator selects from one of two operator stations, either Train I or Train II. The line printer is used to print alarms, if the operator chooses, from one of two operator stations.

PDP-8E

The PDP-8E provides some sophisticated process control which the TDC-2000 is incapable of providing. This computer is connected to the data hiway of the TDC System and is capable of reading any information on the hiway. This means it can read any information in the HLPIU's, LLPIU's, and the controller files. The operator communicates to the PDP-8 through a black and white CRT - through which he enters set points for the loops he has on computer control.

PDP-8E (continued) --

Some of the items that are on computer control and the reason for them are as follows:

THE DESCRIPTION FOLLOWING WILL ONLY BE OPERATIONAL IF THE CONTROLLER FILES ARE SET UP FOR COMPUTER CONTROL BY THE BOARD OPERATOR.

1) Ethylene Flow to the Reactors

The operator will enter the pounds per hour flow which he wants for the reactor. The PDP-8 will read the temperature and pressure of the ethylene flow and calculate what reading on the flow orifice is needed to give the flow rate required. The PDP-8 will then send the set point required to the controller file.

2) Hydrogen Flow to the Reactor

The control is identical to the ethylene flow to the reactor in that the board operator enters the pounds per hour hydrogen flow required.

3) Solvent Flow to the Reactor

The operator will enter the amount of ethylene conversion he desires in the reactor. The computer will look at the ethylene flow rate, the reactor temperature, the reactor feed temperature, the water flow on the jacket and the temperature rise of the jacket water to determine the set points of the Solvent. This set point then can be sent to the controller file.

4) Octene Flow to the Reactor

The PDP-8 will need the target density and target melt index from the PDP-11. The PDP-8 will look at target conversion in the reactor (from the solvent control program), production rate

PDP-8E (continued) --

Items on computer and reason for them (continued)

4) Octene Flow to the Reactor (continued) --

of the reactor, concentration of Octene before and after the addition point, and temperature of the Octene and reactor, and then calculate the set point of the Octene. This set point will then be sent to the controller file.

5) ATE Ratio Control to Premix

There is no operator entry. The PDP-8 will attempt to maximize catalyst efficiency by increasing or decreasing ATE pump speed based on production rate and catalyst usage.

6) Calcium Stearate/Irganox Control

The PDP-8 will read from the PDP-11 the percent Calcium Stearate and percent Irganox in D-411 or D-421. The computer will read the catalyst usage (premix) on the train and calculate the amount of Calcium Stearate needed to neutralize this catalyst. It will then send a set point to the stearate pumps to pump the desired level of stearate. The computer will also not let too little or too much Irganox be added to the product.

7) Hot Melt Additives

The computer will read the target additive level for the type of material being produced from the PDP-11. The board operator will need to tell the PDP-8 which drum the hot melt additive will come from. The computer will then control the amount of

PDP-8E (continued) --

Items on computer and reason for them:

7) Hot Melt Additives (continued) --

additive based on the production rate of the polyethylene and level drop in additive tank.

8) Side Arm Extruder

The PDP-8 will determine what the target level of additives is to be as well as from which hopper the additives are coming from the PDP-11. The PDP-8 will control the speed of the side arm extruder based on the production rate of polyethylene and the weight drop in the additive hopper.

9) Shut Off Flows to Reactors

On loss of Solvent or Ethylene flow to a reactor, the computer will shut off all Solvent, Ethylene, Hydrogen, Octene, Catalyst, and Stearate flows to the reactor.

10) Reduce Rates Quickly

On the operator's command to the PDP-8, all flows to the reactor will be reduced quickly to the amount specified by the board operator. Quickly means less than five seconds.

MODICON 584

The Modicon 584 is the control computer for all batch type operations in the Plant. There is no operator interface directly to the Modicon. All operator commands to the Modicon come from the PDP-11.

Modicon 584 (continued) --

The Modicon controls all seven of the Material Handling (transfer) Systems from the emptying of the check hoppers through the loading of hopper car and bagging silos. The Modicon also controls the regeneration of the molecular sieve and silica gel beds, the mixing of catalyst, and the transfer of Stearate and Catalyst from the bulk tanks to the day tanks. A more detailed look at these systems follows in the PDP-11 discussion.

PDP-11

The PDP-11 has two distinctly different functions. One is to gather and display information for the operator. The other is to be the operator's source of control for the batch-type control functions.

The PDP-11 does no control directly. The operator needs to furnish certain information to the computer which then furnishes the information to the Modicon 584 to start the control action. The following systems are controlled by the Modicon through the PDP-11.

1) Transfer System

The operator begins control action initially by setting up a lot of material in an HMB hopper. The board operator must give this lot a lot number, a type number, a target weight and a reactor. Each hour the board operator must tell the computer to which blender (HMB) the check hopper (CH's) on each train must be transferred. After each blender is filled, the operator must give commands to blend the hopper and to transfer the hopper to either a million pound hopper (HS), a half-million hopper (H), a bagging hopper (HB), or a hopper car loading hopper (HL). This transfer must be previously approved by a warehouse operator.

PDP-111) Transfer System (continued) --

The warehouse operator, in addition to giving approved destinations by means of the PDP-11, also has control of the transfers from the million pound hoppers and the half-million pound hoppers to the bagging and hopper car hoppers. These transfers can be made by the board operator if the warehouse operator has given approval.

An additional transfer can be made by the board operator. He can unload hopper cars to the additive hoppers (HAS) or to certain blenders. He can also transfer additive from the HAS hoppers to the additive hoppers (HA) on each train.

A more detailed procedure for the transfer systems can be found at the end of this section.

2) Regeneration System

The board operator will initiate the regeneration system after the outside operator has approved the bed for regeneration. The regeneration will be initiated by entering which bed to regenerate. This will cause the computer to tell the Modicon to begin the heating cycle for the bed. After the heating cycle, the computer will start the cooling cycle. When the cooling cycle is finished on Solvent beds, the computer will check the level in the knock-out drum and alarm that there is still level there, or, if no level, will alarm operator that the regeneration is finished. On ethylene and propylene beds after the cooling cycle, the computer will alarm that the pre-load cycle is ready. The outside operator will line up the pre-load line and the computer will continue through the pre-load cycle. When this is over, the computer will alarm that the regeneration is complete.

PDP-11 (continued) --3) Catalyst Mixing

Before mixing can be started, the concentration of catalyst components (Magnesium Alkyl and Aluminum Alkyl) must be available to the PDP-11 as well as the order of addition of the Catalyst components. To start a batch of catalyst mixing, the board operator must enter which section of D-301 that the Magnesium Alkyl will come from. The PDP-11 will then instruct the Modicon on each step of the Catalyst mixing and alarm the operator when the mix is complete.

4) Transfer of Catalyst and Calcium Stearate

The board operator must enter the vessel he wishes to come from and the vessel he wishes to go to. The PDP-11 will then instruct the Modicon to make that transfer.

All these control from the PDP-11 will have checks and alarms not enunciated on these brief descriptions. A more detailed description follows at the end of this section.

In addition to the control work, the PDP-11 will also process information for the board operator and others. Some of these items are:

a) Paymeter Calculations

The PDP-11 will calculate and store on an instantaneous, hourly, daily, and monthly basis all incoming raw material and utilities usage as well as polyethylene production. This information will be sent daily to the Division's computer by the Secretary.

PDP-11

Information for the board operator (continued) --

b) Raw Material Balance

The PDP-11 will calculate and display instantaneous, daily, hourly, and monthly ethylene yields, and the conversion energy for each train. It will also display instantaneous inventory levels and print out inventory at month's end.

c) Status Sheets and Displays

The status of different pieces of equipment, such as feed and recycle compressors, the pelletizers and gear pumps, the Dowtherm furnace, the ARU's and the reactors, will be displayed to enable the operator to determine in what state of readiness they are in for start-up. Also the Louisiana PICS system will be used to display areas of the Plant to show their status at any time.

d) Status of Lots in Process

There will be displays of all lots being produced at any time with their properties such as weight, melt index, density, additive level, etc. Also a status of all hoppers with their weight and types, will be displayed at any time. When a lot has been finished in a HMB (blender), all data for this lot will be printed out to be put in the lot folder. This data will include the physical properties of the lot (i.e. -- melt index, density, additive levels) and also the plant conditions during the production of the lot (such as reactor conditions, devolatilization conditions, catalyst efficiency). In addition to the

PDP-11

Information for the board operator:

d) Status of Lots in Process (continued) --

printing of this data, the data will be stored in the computer for future reference. The lot data will also include identification of which manufacturers batches the additives came from that are in the polyethylene.

5) Type-Target File

There will be a file in the PDP-11 which will show all products made in the Plant with the targets for all the physical measurable parameters (melt index, density, color, additives, volatiles, etc.)

6) Operating Discipline

The emergency procedures and job procedures will be in the PDP-11 for display and hard copy. There will also be text written to tell operators what to try in case of certain problems or alarm conditions.

7) Miscellaneous Duties

There will be lists of activities to be done in the Plant at periodic intervals. These may be done weekly, monthly, quarterly, or yearly. Each week these duties will be printed out and the responsible person will check that they are done and then it will be entered back into the computer that these jobs were completed.

This is the essence of the computer/instrumentation system at Dowlex®.

Ron Gast
Production Supervisor
Dowlex® Plant

11/10/81

pb

26. ECOLOGY

Before permission was granted to build the Dowlex plant, certain requirements concerning pollutant emissions set by the Environmental Protection Agency (EPA) and administered by the Louisiana Air Quality Control Commission had to be met. These requirements are presented in the following text and tables.

The bulk of the emissions from Dowlex will be hydrocarbon. This is due to the evaporative losses of residual hydrocarbons carried by the pellets. These emissions come from hoppers and storage silos, and are vented to the atmosphere using an air purge system to prevent hazardous build-up of flammable vapors.

No current federal New Source Performance Standards are applicable to this process, but we will still be subject to emission regulations and compliance with federal requirements pertaining to the Prevention of Significant Air Quality Deterioration.

Dowlex low pressure system along with its high efficiency catalysts allows the plant to operate at reduced amounts of ethylene dissolved in the polymer. Ethylene losses will be less than one ton per year.

Table 26.1 and Table 26.2 list where, what kind, and how much pollutants will be emitted.

ECOLOGY TABLE INDEX

<u>TABLE NUMBER</u>	<u>DESCRIPTION</u>
26.1	Potential Air Emissions
26.2	Sources of Hydrocarbon Emissions at Dowlex
26.3	Indentification of Emission Sources as Specified in Environmental Protection Agency's Air Permit

TABLE 26.2

SOURCES OF HYDROCARBON EMISSIONS AT DOWLEX

ROUTINE OPERATION

D-801	<u>Hydrocarbon (HC) Storage</u>
D-802	
D-803	3 in operation at one time
D-804	N ₂ pad
D-805	HC vented due to fluctuation in vapor
D-809	space vent connected to flare system
D-811	

Molecular Sieves

Y-111	
Y-801	HC vented only during regeneration
Y-802	Vent connected to flare system

F-501	<u>Dowtherm Furnace</u> - 475 scfm natural gas
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D-502	<u>DTA Storage Drum</u>
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Process Equipment Handling Finished Polymer

SD-511	H-1	HS-1	
CH-1A	H-2	HS-2	
CH-1B	H-3	HS-3	
HMB-1A	H-4	HS-4	
HMB-1B	H-5	HS-5	
HMB-1C	H-6	HS-6	
	H-7		
	H-8		

Amount of HC emission for each item will vary with operating conditions. However, total emissions from all items should be fairly constant and based on pounds of polymer produced.

Best approximation show 480 ppm/lb. polymer

NON-ROUTINE OPERATION

EMERGENCY VENTS

All process vessels and equipment will be protected from over-pressure by relief valves. The valves will discharge into a vent header system which connects to a flare (exception D-801 through D-804, D-809, D-811 ERV's vent to atmosphere).

TABLE 26.3

IDENTIFICATION OF EMISSION SOURCES
AS SPECIFIED IN EPA AIR PERMIT

<u>IDENTIFICATION NUMBER</u>	<u>NAME AND DESCRIPTION OF SOURCE</u>
86-1 to 86-6	HMB-1 A/B/C and HMB-2 A/B/C Blender
86-7	CH-1 A/B Check Hopper
86-8	CH-2 A/B Check Hopper
86-9	SD-511 Shaker Dryer
86-10	SD-521 Shaker Dryer
86-11 to 86-18	H-1 to H-8 Maker Hopper
86-19 to 86-24	HS-1 to HS-6 Storage Silos
86-25	F-501 Dowtherm® Furnace
86-26	Flare

27. EQUIPMENT LIST

A-211 Agitator for R-211 - Lightnin
212 PO# 5012 gear reduction ratio
 20.7 to 1 output speed 84.4 RPM
 Driver: 1750 RPM 200hp electric motor
 Agitator has 4 pitched blades

A-305 Agitator for catalyst mix - Lightnin
 PO# 5012A gear reduction ratio
 5.0 output speed 233 RPM
 Driver: 1150 RPM 1hp electric motor
 Has dual propellers with 3 blades.

A-306 Agitator for catalyst hold tank - Lightnin
A-307 PO# 5012A gear reduction ratio
 20.8 output speed 55.5 RPM
 Driver: 1170 RPM 2hp electric motor.
 Agitator has dual impellers with 4 blades.

A-311 Agitator for catalyst feed tank - Lightnin
 PO# 5012A gear reduction ratio
 5.0 output speed 350 RPM
 Driver: 1750 RPM 1/2hp electric motor
 Has dual propellers with 3 blades.

A-401 Agitator for calcium stearate mix - Lightnin
402 PO# 5012A
 Same as A-306 - A-307.

A-411 Agitator for calcium stearate feed - Lightnin
421 PO# 5012A gear reduction ratio
 5.0 output speed 350 RPM
 Driver: 1750 RPM 1hp electric motor
 Has dual propellers with three blades

A-513 Agitator for hot melt additives - Lightnin
A-516 PO# 5012A gear reduction ratio
523 5.0 output speed 350 RPM
526 Driver: 1750 RPM 1/3hp electric motor
 Has dual propellers with 4 blades

ARU Absorption refrigeration units - Carrier
201 PO# 5510
202 Model #16JB068
203 Refrigeration Capacity - 500 tons
 Absorber section
 Design pressure - full vacuum
 Evaporator section
 Design pressure - full vacuum
 Condenser section
 Design pressure - full vacuum
 Generator section
 Design pressure - full vacuum

B-501 Dowtherm furnace air blower
 PO# 5004
 Type:
 Direct driven by
 CFM inlet suction -
 Normal suction pressure - atmosphere
 Normal discharge pressure -

B-512 Vacuum pump booster blowers - M. D. Pneumatics
 A&B PO# 5055
 Type: M-D positive displacement rotary
 522 V-Belt driven by 10 hp electric motor
 A&B CFM inlet suction - 1100
 Normal suction pressure - 5 mm Hg absolute
 Normal discharge pressure - 30 mm Hg absolute

BAC-7 Hopper car unloading - M. D. Pneumatics
 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 200 hp electric motor
 CFM inlet suction - 2260
 Normal suction pressure - 11.9 psia
 Normal discharge pressure - 22.9 psia

(BACP Check hopper transfer
 1,2,&12 PO# 5013
 Type: Centrifugal Hoffman
 Shaft driven by 100 hp electric motor
 CFM inlet suction - 1550
 Normal suction pressure - atmosphere
 Normal discharge pressure - 23.7 psia

BACP Transfer for blenders - M. D. Pneumatics
 3&4 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 200 hp electric motor
 CFM inlet suction - 2550
 Normal suction pressure - 14.7 psia
 Normal discharge pressure - 25.5 psia

BACP-5 Transfer for 600,000 lb. storage hoppers
 (H-1 thru H-8) - M. D. Pneumatics
 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 200 hp electric motor
 CFM inlet suction - 2550
 Normal suction pressure - 14.7 psia
 Normal discharge pressure - 25 psia

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BACP-6 Transfer for 1 million lb. hoppers, HS-1 thru HS-6 to
 hopper loading or hopper bagging - M. D. Pneumatics
 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 200 hp electric motor
 CFM inlet suction - 2550
 Normal suction pressure - 14.7 psia
 Normal discharge pressure - 25 psia

BACP
 10 & 11 HUH to check hopper transfer
 20 & 21 PO# 5037
 Type: Centrifugal Hoffman
 Shaft driven by 50 hp electric motor
 CFM inlet suction - 1538
 Normal suction pressure - 14.7 psia
 Normal discharge pressure - 17.5 psia

BACV-5 Transfer from H's - M. D. Pneumatics
 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 100 hp electric motor
 CFM inlet suction - 5170
 Normal suction pressure - 11.5 psia
 Normal discharge pressure - 14.7 psia

BACV-6 Transfer for 6,000 lb. hoppers, H-1 thru H-8 to hopper
 loading or hopper bagging - M. D. Pneumatics
 PO# 5013
 Type: positive displacement rotary
 V-Belt driven by 100 hp electric motor
 CFM inlet suction - 5170
 Normal suction pressure - 11.5 psia
 Normal discharge pressure - 18.7 psia

BPA-1,2&3 Hopper purge air
 PO# 5014
 Type: Centrifugal Hoffman
 Shaft driven by 200 hp electric motor
 CFM inlet suction - 7000
 Normal suction pressure - 14.7 psia
 Normal discharge pressure - 18.7 psia

C-111 Ethylene feed compressor
 121 PO# 5002
 Type: Ingersoll - Rand
 Direct driven reciprocating compressor, single stage
 Motor - 350 hp 500 RPM variable speed 575 volts
 Rated capacity - 30,000 pounds per hour
 Inlet pressure - 395 pounds
 Discharge pressure - 671 pounds

C-711 Ethylene recycle compressor
721 PO# S5002
Type: Ingersoll-Rand, 3 stage, direct drive,
reciprocating compressor
Motor: 350 hp, 500 RPM, variable speed
Rated capacity: 4500 pounds/hour with 10 psia, first stage
Inlet pressure: Discharge pressure:

C-902 Air compressor
PO# 5033
Type: Joy, 3 stage, centrifugal air compressor
Motor: 800 hp direct drive
Rated capacity: 3000 CFM

C-911 Freon compressor
PO# 5038
Type: Frick Model RWB 40 rotary screw compressor
Motor: 125 hp, 575 volts, 3600 RPM
Rated capacity: 90 tons

CH-1A&B Check hoppers
2A&B PO# S5511 Allied
Type: Aluminum 17 ft. 4 in. high,
12 ft. in diameter mounted on weigh cells
Rated capacity: 40,000 pounds each
Weight empty: 3,365 pounds

CL-511 Rotex classifier
PO# 5029
Capacity: 35,000 pounds per hour
Motor: 3 hp, 1750 RPM, belt driven

CT-901 Cooling tower
PO# 9007
Type: Research - Cottrell, counter flow, induced-draft
Rated capacity: 18,500 gpm
Inlet water temperature: 104°F
Outlet water temperature: 87°F
Heat load: 157 MMBTU/HR

D-111 Ethylene knock out drum
121 PO# S5515
Size: 3'6" ID., 8' seam to seam
Total volume: 576 gallons
Weight empty: 5,593 pounds
Design pressure: 510 psig at 350°F

D-202 Chill water storage tank
PO# S5517
Size: 10' O.D., 10' tall
Total volume: 5,875 gallons
Weight empty: 7,788 pounds
Design pressure: atmospheric at 200°F

D-212 Reactor safety valve knock out drum
 222 PO# 5510
 Size: 7'6" I.D., 12' seam to seam
 Total volume: 4,000 gallons
 Weight empty: 10,300 pounds
 Design pressure: 102 psig at 500°F

D-213 Reactor mineral oil seal pots
 223 PO# S5514
 A&B Size: 8-5/8" O.D., 3'6" seam to seam
 Total volume: 9.1 gallons
 Weight empty: 239 pounds
 Design pressure: 1000 psig at 212°F

D-300 HCl weigh tank
 PO#
 Size:
 Total volume:
 Weight empty:
 Design pressure:

D-301 Magnesium alkyls storage - 3 sections A/B/C
 A,B&C PO# S5513
 Size: 10' I.D., 34' seam to seam
 Total volume: 21,164 pounds
 Weight empty: 35,200 pounds
 Design pressure: 123 psig at 500°F

D-302 Triethyl aluminum storage
 PO# S5513
 Size: 10' I.D., 18' seam to seam
 Total volume: 12,000 gallons
 Weight empty:
 Design pressure: 123 psi at 500°F

D-303 Zinc alkyls storage
 PO# S5513
 Size: 10' I.D., 18' seam to seam
 Total volume: 12,000 gallons
 Weight empty:
 Design pressure: 123 psi at 500°F

D-304 Titanate storage
 PO# S5516
 Size: 2' x 5'
 Total volume: 126 gallons
 Weight empty: 600 pounds
 Design pressure: 170 psig

D-305 Catalyst mix drum
PO# S5527
Size 6' X 10'
Total volume - 2,371 gallons
Weight empty - 10,430 pounds
Design pressure - 128 PSIG

D-306 Pre-mix catalyst hold tanks
307 PO# S5516
Size - 6' X 10'
Total volume - 2,371 gallons
Weight empty - 4000 pounds
Design pressure - 128 PSIG

D-308 Waste catalyst collection drum
PO# S5516
Size 6' X 10'
Total volume - 5,000 gallons
Weight empty - 4,000 pounds
Design pressure - 128 PSIG

D-311 Catalyst feed drums
321 PO# S5516
Size 3'6" I.D. 6'6" seam to seam
Total volume - 475 gallons
Weight empty - 1,900 pounds
Design pressure - 131 PSIG

D-312 ATE feed drums
322 PO# S5514
Size 2' O.D. 9' seam to seam
Total volume - 215 gallons
Weight empty - 1,353 pounds
Design pressure - 170 PSIG

D-401 Calcium stearate mix tanks
402 PO# 5512
Size 9'6" I.D. 10'3" seam to seam
Total volume - 5,435 gallons
Weight empty - 10,307 pounds
Design pressure 114 PSIG

D-411 Calcium stearate feed drum
421 PO# S5516
Size 3' I.D. 8'8" seam to seam
Total volume - 458 gallons
Weight empty - 1,700 pounds
Design pressure - 121 PSIG

D-500 Dowtherm flash drum
PO# S5512
Size 12' I.D. 22'6" seam to seam
Total volume -19,037 gallons
Weight empty - 40,400 pounds
Design pressure - 102 PSIG and full vacuum

D-502 Dowtherm make-up drum
PO# S5517
Size 16' O.D. 16' tall
Total volume - 24,000 gallons
Weight empty - 16,607 pounds
Design pressure 36" of water at 500°F

D-510 Water heater for hot melt additive
520 PO# S5514
Size 3' I.D. 6' seam to seam
Total volume - 317 gallons
Weight empty - 1,300 pounds
Design pressure - 121 PSI at 450°F

D-511 First devolatilizer
521 PO# S5508
Size 12' X 33'
Total volume - 28,000 gallons
Weight empty -
Design pressure - 100 PSI at 650°F

D-512 Second devolatilizer
522 PO# S5525
Size 12' X 24'11 3/4"
Total volume - 21,150
Weight empty -
Design pressure - full vacuum/100 PSI at 650°F

D-513 Hot melt additives
523 PO# S5510
Size 3' O.D. 5'3" seam to seam
Total volume - 285 gallons
Weight empty -
Design pressure - 139 PSI at 500°F

D-514 Solvent knock out drum vacuum system
524 PO# S5515
Size 2' O.D. 5' seam to seam
Total volume - 118 gallons
Weight empty - 900 pounds
Design pressure - full vacuum/180 PSI at 400°F

D-515 Vacuum pump discharge knock out drum
 525 PO# S5515
 Size 4' I.D. 8' seam to seam
 Total volume - 877 gallons
 Weight empty - 2693 pounds
 Design pressure - 115 PSI at 350°F

D-516 Hot melt additives
 526 PO# S5510
 Size 2' I.D. 3' seam to seam
 Total volume - 75 gallons
 Weight empty -
 Design pressure - 209 PSI at 500°F

D-517 Hot melt additives high flow
 527 PO# S5519
 Size 6" Sch80 pipe 15'9" tall
 Total volume - 23 gallons
 Weight empty -
 Design pressure - Sch120 pipe at 650°F

D-518 Hot melt additives low flow
 528 PO# S5519
 Size 3" Sch80 pipe 13' tall
 Total volume - 4.8 gallons
 Weight empty -
 Design pressure - Sch120 pipe at 650°F

D-519 Dowtherm knock out on E-511
 529 PO# S5515
 Size 4' I.D. 6' seam to seam
 Total volume - 689 gallons
 Weight empty - 3,258 pounds
 Design pressure - full vacuum/115 PSI at 650°F

D-611 Solvent recovery drum
 621 PO# S5512
 Size - 8'6" I.D. 15' seam to seam
 Total volume - 6,368 gallons
 Weight empty - 15,220 pounds
 Design pressure - 127 PSI at 500°F

D-711 Ethylene recovery drum
 721 PO# S5514
 Size 3' I.D. 5' seam to seam
 Total volume - 264 gallons
 Weight empty - 1,100 pounds
 Design pressure - 121 PSI at 450°F

D-712 722	C-711 2nd stage suction PO# S5002 Size - 16" O.D., 60" high Total volume - 52 gallons Weight empty - 450 pounds Design pressure - 140 psig at 350°F
D-713 723	C-711 3rd stage suction PO# S5002 Size - 12-3/4" O.D., 42" high Total volume - 23 gallons Weight empty - 300 pounds Design pressure - 325 psi at 350°F
D-801	Solvent storage PO# S5517 Size - 16' X 16' Total volume - 24,000 gallons Weight empty - 16,314 pounds Design pressure - 36" water and (2oz.vac)
D-802	Octene storage PO# S9006 Size - 28' X 28' Total volume - 129,000 gallons Weight empty - 47,000 pounds Design pressure - 36" water and (2oz.vac)
D-803	Octene Storage tanks PO# S9006 Size - 28' diameter 28' height Total volume - 129,000 gallons Weight empty - 47,600 pounds Design pressure - 36" water and 2 oz. vac Design temperature - 400°F
D-804	Solvent swing tank PO# S5517 16' diameter 16' height Total volume - 24,000 gallons Weight empty - 16,315 pounds Design pressure - 36' water Design temperature - 400°F
D-809	Waste solvent tank PO# S5517 Size - 16' diameter 16' height Total Volume - 24,000 gallons Weight empty - 16,225 pounds Design pressure - 36" water Design temperature - 400°F

D-811 Solvent/Octene storage tank - Train One
821 PO# S5517
Size - 16' diameter 16' height
Total volume - 24,000 gallons
Weight empty - 15,500 pounds
Design pressure - 36" water
Design temperature - 400°F

D-901A Cooling tower inhibitor tank
PO# S5040
Size 11' length 4' diameter
Total volume - 1000 gallons
Weight empty - 280 pounds
Design pressure - ambient
Design temperature - ambient

D-901B Cooling tower dispersant tank
PO# S5040
Size - 11' length
Total volume - 1000 gallons
Weight empty - 280 pounds
Design pressure - ambient
Design temperature - ambient

D-904 Flare knock out drum
PO# S5512A
Size - 10'6" seam to seam 8' diameter
Total volume - 4000 gallons
Weight empty -
Design pressure - 113 PSI
Design temperature - 500°F

D-905 Mineral oil storage drum
PO# S5517
Size - 10' diameter 13' height
Total volume - 5900 gallons
Weight empty - 8152 pounds
Design pressure - 36" water
Design temperature - 400°F

D-907 Condensate flash drum
 PO# S5514
 Size - 8' seam to seam 30 7/8" diameter
 Total volume - 476 gallons
 Weight empty - 2280 pounds
 Design pressure - 121 PSI
 Design temperature - 450°F

D-908 Condensate storage tank
 PO# S5517
 Size - 10' seam to seam 10' diameter
 Total volume - 5,880 gallons
 Weight empty - 7,714 pounds
 Design pressure - 36" water
 Design temperature - 220°F

D-911 Oil separator from freon compressor (C-911)
 921 PO# S5038
 Description - a horizontal three stage separator with oil carry-over not to exceed 2 PPM by weight of oil circulated also with replaceable coalescence type oil filters as the final stage. The unit also has oil level sight glasses, dual safety valves and an oil heater that can be replaced with unit in service.

DPW-500 Primary pellet water tank
 PO# S5520
 Size 10' X 10' X 8'
 Total volume - 5,964 gallons
 Weight empty -
 Design pressure and temperature - atmospheric at 200°F

DPW-501 Pellet basket
 PO# S5520
 Size - 10'6" total height X 4' square
 Total volume - N/A (168ft³/1,257 gallons)
 Weight empty
 Design pressure and temperature - atmospheric at 150°F

E-111 C-111 discharge cooler
 121 PO# S5008
 Size - 8' X 6'7"
 Weight empty - 11,714 pounds
 Design pressure and temperature tube side - 750 psi @ 300°F (Ethylene)
 Number of tubes: 135 - A-179 - Tube O.D. 1", 14 gage, 8' long
 Total flow tube side - 30,000 pounds/hour
 FAN - Westinghouse 7.5 hp 575V "V" belt driven

E-210 Feed cooler (cooling tower water)
 220 PO# S5502
 Size - 28' long by 4'5" in diameter
 Weight empty - 18,100 pounds
 Design press/temp tube side - 750 PSI @ 250°F (process)
 Design press/temp shell side - 150 PSI @ 200°F (water)
 Number of tubes: 498 - 90-10 CuNi - 3/4" O.D., 14 BWG
 Total flow tube side - 166,667 pounds/hour

E-211A/B Feed chillers (chill water)
 221A/B PO# S5502
 Size - approx. 20' long X 30" in diameter
 Weight empty - 15,300 pounds
 Design press/temp tube side - 750 PSI @ 250°F (process)
 Design press/temp shell side - 150 PSI @ 200°F (water)
 Number of tubes: 648 - 90-10 CuNi - 3/4" O.D., 14 BWG
 Total flow tube side - 166,667 pounds/hour

E-500/501 Seal fluid heat exchanger
 PO# S5036
 Size - 64 1/8" long 6" diameter
 Weight empty -
 Design press/temp tube side - 125 PSI @ 375°F (water)
 Design press/temp shell side - 125 PSI @ 600°F (Dowtherm)
 Number of tubes: 24 - 90-10 CuNi - 3/4" O.D., 5' long
 Total flow tube side/shell side - 20,000/3625 pounds/hour

E-502 Dowtherm storage condensor
 PO# S5008
 Size - approx. 8' X 6'8"
 Weight empty - 5,199 pounds
 Design press/temp tube side - 10 PSI @ 650°F (Dowtherm)
 Total flow tube side - 40,000 pounds/hour
 Number of tubes: 80 (Data) A-179 Tube O.D. 1 1/2" 8' long
 Fan- Westinghouse 10 hp/575 volt "V" belt driven

E-511 Devolatilizer preheater
 521 PO# S5504
 Size - 32' flange to flange X 50" diameter
 Weight empty - 72,300 pounds
 Design press/temp tube side - 750 PSI @ 650°F (process)
 Design press/temp shell side - 100 PSI @ 650°F (Dowtherm)
 Number of tubes: 3714 (Data) 5A-179 O.D. 1/2" 32' long
 Total flow tube side/shell side - 147,020/113,626 pounds/hour
 Expansion joint - Inconel 600 (2 per unit)

E-512 Plate heater exchanger
 522 PO# S5506
 Size - Approximately 14' long by 5' in diameter
 Weight empty - 31,000 pounds
 Design press/temp process - 1000 psig at 650°F
 Number of plates - 26,000
 Total flow - 30,000 pounds per hour (process)
 Design press/temp Dowtherm - 100 psig at 650°F
 Number of tubes: 408 - 304 SS - O.D. 5/8", 9'4" long

E-513A Vacuum cooler (cooling tower water)
523A PO# S5503
Size - 7' long 42" diameter
Weight empty - 14,100 pounds
Design press/temp tube side - 100 PSIG @ 550°F (process)
Design press/temp shell side - 150 PSIG @ 350°F (water)
Number of tubes - 1485 90-10 CuNi 3/4" O.D. 7' long
Total flow tube side/shell side - 4070/78,146 pounds/hour

E-513B Vacuum cooler (chill water)
523B PO# S5503
Size - 7' long 42" diameter
Weight empty - 12,800 pounds
Design press/temp tube side 100 PSIG @ 550°F (process)
Design press/temp shell side 100 PSIG @ 350°F (water)
Number of tubes - 1485 90-10 CuNi 3/4" O.D. 7' long
Total flow tube side/shell side - 4,070/16,449 pounds/hour

E-514 Vacuum condenser (freon)
524 PO# S5503
Size - approx. 4' long 47" diameter
Weight empty - 6,700 pounds
Design press/temp tube side - 100 PSIG @ 550°F (process)
Design press/temp shell side - 100 PSIG @ 200°F (freon)
Number of tubes - 1031 A-179 3/4" O.D. 4' long
Total flow tube side - 4070 pounds/hour

E-515 Seal liquid cooler (chill water)
525 PO# S5518
Size - 36-3/4" x 35-3/4"
Weight empty - 485 pounds
Design press/temp cold side - 150 PSIG @ 200°F (water)
Design press/temp hot side - 100 PSIG @ 250°F (solvent)
Number of plates - 58 (Monel)
Total flow cold side/hot side - 40,000/16,867 pounds/hour

E-516 Seal liquid chiller (freon)
526 PO# S5524
Size - 11' long 19' I.D.
Weight empty - 5000 pounds
Design press/temp tube side - 100 psig at 250°F (Solvent)
Design press/temp shell side - 150 psig at 250°F (Freon)
Number of tubes - 104 Tube O.D. .750 in. gage 14 8' long

E-517 Pellet water cooler
527 PO# S5502
29'2" long 29" diameter
Weight empty - 15,800 pounds
Design press/temp tube side - 100 PSIG @ 350°F (pellet water)
Design press/temp shell side - 150 PSIG @ 350°F (cooling tower)
Number of tubes - 384 (Data) 90-10 CuNi 1" O.D. 24' long
Total flow tube side/shell side - 440,000/1,186,243 pounds/hour

E-611 Steam generator
621 PO# S5502
Size - 24'6" long 70" diameter
Weight empty - 29,000 pounds
Design press/temp tube side - 100 PSIG @ 550°F (solvent)
Design press/temp shell side - 150 PSIG @ 450°F (steam)
Number of tubes - 484 U-tubes (Data) A-179 1" O.D. 40' U long
Total flow tube side/shell side - 151,046/8061 pounds/hour

E-612 Solvent cooler
622 PO# S5008
Size - approx. 34' long X 19' wide
Weight empty - 126,830 pounds
Design press/temp tube side - 100 PSIG @ 550°F (solvent)
Number of tubes - 528 (Data) A-214 1" O.D. 34' long
Total flow tube side - 151,046 pounds/hour
Fan - Westinghouse 30 hp 575 volt "V" belt driven

E-617 Recycle solvent cooler
627 PO# S5502
Size - approx. 20' 8½" long 24" diameter
Weight empty - 7200 lb.
Design press/temp tube side - 150 psig / 300°F (solvent)
Design press/temp shell side - 150 psig / 250°F (cooling tower)
Number of tubes - 246 1 inch 14 Bwg 90-10 Cu-Ni
Total flow tube side/shell side - 300,000 lb/hr / 245000 lb/hr

E-711 1st stage cooler (C-711)
721 PO# S5002
Size - 12' long 8-5/8" diameter
Weight empty - 450 pounds
Design press/temp tube side - 150 psi at 300°F
Design press/temp shell side - 150 psi at 150°F
Number of tubes - 61 90-10 CuNi 5/8" O.D. 12' long
Total flow tube side/shell side - 4635 lbs/hr, water 32 gpm

E-712 2nd stage cooler (C-711)
722 PO# S5002
Size - 12' long, 8-5/8" diameter
Weight empty - 450 pounds
Design press/temp tube side - 300 psi at 250°F
Design press/temp shell side - 150 psi at 150°F
Number of tubes - 16 U Steel 3/8" O.D. 10' long
Total flow tube side/shell side - ethylene 4635 lbs/hr, water 22 gpm

E-906 Potable water heater (safety shower system)
PO# S5064
Design - The shell is made of steel rated at 150 psig, coil of cupro nickel. Potable water on shell side is heated with 15 pounds of steam in coil. Temperature control of water is adjustable from -110°F to 185°F.

F-501 (cont'd)
minimum liquid temperature 550 °F; maximum differential
pressure 3 psi.

FL-502 Dowtherm Filter
PO# L5066
Model No. - 26798-SFG-7-3-2-2F
Process basis flow - 50 gpm
Particle size - 5 microns
Maximum operating pressure - 60 psig
Maximum operating temperature - 575°F, allowable press. drop
10 psi
Description - fiberglass disposable cage unit element
Filter shell - design press 150 psig
design temp 650°F

FL-510 Pellet Water Filter
520 PO# L5006
Model No. - FS-1300-8
Process basis flow - 1000 gpm
Particle size retain - 200 micron minimum
Maximum operating press - 80 psig
Maximum operating temp - 150°F
Filter shell - design press - 150 psig
design temp -

FL-611 Recycle Solvent Filters
A/B PO# L5009
621 Model No. - 914945/L59M5368FD-C150
Process basis flow - 300,000 lb/hr
Particle size - 5 microns
Maximum operating press - 85 psig
Maximum operating temp - 120°F allowable press drop 5 psi
Description - 30" length cotton disposable cage unit elements
Filter Shell - design press - 150 psig
Design temp - 350°F

FL-614 T-611 Bottoms Filter
A/B PO# L5009
624 Model No. - 914947/015LH20-1F-C150
Filter basis flow - 10 gpm
Particle size - 5 microns
Maximum operating press - 60 psig
Maximum operating temp - 347°F, allowable press drop 5 psi.
Description - 20" length fiberglass elements
Filter Shell - design press - 150 psig
design temp - 450°F

FL-901 Cooling Tower Filter
 PO# L5063
 Model No. - HD841 multi-media
 Filter basis flow - 770 gpm
 Maximum operating press - 70 psig
 Maximum operating temp - amb. allowable press drop 30 psig
 Description - sand filter
 Filter Shell - design press. - 125 psig
 design temp - 100°F

FN-901 Fan for C.T. 901
 A/B PO# L9007
 Model No. - XT
 Motor size - 125 hp, 2 speed single winding 1800/900 RPM
 Enclosure - explosion proof
 Description - 8 blades with vibration safety switch

K-511 Pelletizer
 521 PO# L5048 Werner - Pfleiderer
 Drive Motor size - 100 hp, variable speed A.C.
 Output capacity - 35,000 lbs/hr
 Die Plate Description - approx. 900 holes 0.125" diameter
 die plate design for Dowtherm (Flow)
 Die Face - 1/8" thick
 Cutter Description - retractable knife shaft and cutter head,
 maximum 12 cutter knives.
 Rotor Speed - 800 RPM's maximum

SC-511 Screen Changer - Werner - Pfleiderer
 521 Type - Swz 1900
 Description - oval self-supporting actuation with 27 screen
 elements 2700 sq. cm. of total screen area.
 Hydraulic system press - 2300 psig maximum

P-113 Propylene Pump
 A/B PO# L5067
 Manufacturer - Union Pump Co.
 Model No. - TX-10 1 X 1-5/8
 Capacity normal 600 gph, maximum 1200 gph, minimum 100 gph
 Suction press - 200 pgs, discharge press - 700 psig, min.
 suction press - 60 psig
 Motor - 10 hp, 1780 RPM's, Frame - 215T, Enclosure - exp.
 proof, Make - Seimans - Allis

P-202 Chilled Water Pumps
 A/B PO# L5016
 Manufacturer - Goulds Pumps, Inc.
 Model No. - 3196XLT 6X8-15
 Capacity - 2280 gpm, max at 50°F pumping temp.
 Suction press 14.7 psia, discharge press - 77.5 psia, Diff-
 erential press 628 psi
 Motor - 100 hp, 1750 RPM, frame - 405T, enclosure - TEFC
 Make - Reliance

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P-211 Solvent Pumps
A/B/C PO# L5023
Manufacturer - Sundstrand (Sundyne)

P-221 Model No. - LMV-311
Capacity - 230 gpm each
Suction press - 15 psia, discharge - 665 psia
Differential press - 650 psi
Motor - 200 hp, 3550 RPM, frame - 445 hp, enclosure - TEFC
Make - Reliance

P-308 D-308 Pump (Catalyst waste)
PO# L5016
Manufacturer - Goulds Pumps, Inc.
Model No. - 3996MT 3X4-10
Capacity - 170 gpm
Suction psia - 14.7, discharge press - 34.2 psia,
Differential press - 19.5 psi
Motor 5 hp, 1750 RPM, frame - 184 TC, enclosure - TEFC
Make - Reliance

P-311 Premix Catalyst Pumps
A/B/C PO# L5025
Manufacturer - Milton Roy

P-321 Model No. - OMR2-71-140T milroyal
Capacity - 0 to 64 gph
Discharge press - 750 psi maximum
Motor - 1 hp

P-312 Sidestream Pumps (ATE)
A/B/C PO# L5025
Manufacturer - Milton Roy

P-321 Model No. - DMR2-62-142T milroyal
A/B/C Capacity - Normal 12.8 gph, maximum 25.5, minimum 0
Discharge press - normal 550, maximum 750, minimum 500 psig

P-322 Motor - hp, 50-1750 RPM maximum, frame - 56C,
A/B/C enclosure - Exp proof
Make - T. B. Woods

P-401 D-401/402 Circulation pumps
P-402 PO# L5016
Manufacturer - Gould Pumps, Inc.
Model No. - 3996 ST 1½ x 2/8
Capacity - 40 gpm
Suction press - 74.7 psia, discharge - 91.7 psia
Differential press - 17.0 psia
Motor - 2 hp, 1750 RPM, frame - 145TC, enclosure - TEFC
Make - Reliance

P-411 421	Calcium Stearate Feed Pumps PO# 5025 Manufacturer - Milton Roy Model No. DMR2-91-140T Milroyal Capacity - Normal - 45 gpm, maximum - 90 gpm, minimum - 0 Suction press - , discharge press - normal 500 psig, maximum - 750, minimum - 500 psig Motor - 3hp, 50-1750 RPM, maximum, frame - 215 foot mount, enclosure - Ex proof
P-500 A/B/C	Dowtherm Circulation Pumps PO# L5016 Manufacturer - Union Model No. - UNILIGN 6X6-18VL Capacity - 1000 gpm Suction press - 34.5 psia, discharge press - 113.43 psia differential press - 78.93 psi Motor - 100 hp, 1750 RPM, Frame - 405LP, Enclosure - TEFC Make - Reliance
P-501 A/B/C	F-501 Feed Pumps PO# L5016 Manufacturer - Union Model No. - UNILIGN 6X8 13VL Capacity - 1250 gpm Suction press - 34.0 psia, discharge - 86.5 psia, differ- ential press - 52.5 psi Motor - 75hp, 1750 RPM, frame - 365LP, enclosure - TEFC Make - Reliance
P-502 A/B	Dowtherm Make-up Pump PO# L5016 Manufacturer - Goulds Pumps, Inc. Model No. - 3996 ST 1½X2-8 Capacity - 100 gpm Suction press - 14.7 psia, discharge press - 94.7 psia, differential press - 80 psi Motor - 15 hp, 3550 RPM, Frame - 254TC, Enclosure - TEFC, Make - Westinghouse
P-510 P-520	D-510 circulation pumps (Hot H₂O) PO# L5016 Manufacturer - Union Pump Co. Model No. - UNICHEM 1½X2X7 VCM Capacity - 40 gpm Suction press - 52.4 psia, discharge press - 122.1 psia, differential press - 69.7 psi Motor - 7½ hp, 3500 RPM, Frame - 213LP, Enclosure - TEFC Make - Reliance

P-511	D-511 & D-512 Gear Pumps
512	PO# L-5001
521	Manufacturer: Scbewaing Tool & Eng. Co. (Dow designed)
522	Type: 34" high press gear
	Capacity: 40,000 lb/hr
	Discharge press: 4015 psia
	Differential press: 4000 psi
	Speed: 20 RPM max, 2 RPM min.
	Motor: 500 hp, 1800 variable speed A.C.
	Make: Fuji
P-514	D-514 Bottoms Pump
A/B	PO#
524	Manufacturer: Viking Pump
	Model No.: K4123R
	Capacity: 55 gpm
	Suction: 5 mmHg Discharge press: 60 psia
	Differential press: 60 psi
	Motor: 7.5 hp, 1800 RPM Frame: 213T Enclosure: TEFC
	Make: U.S. Motors, TYPE TCE
P-515	D-515 Bottoms Pump
A/B	PO# L-5016
525	Manufacturer: Goulds Pumps, Inc.
	Model No.: 3996 MT 1½X2-10
	Capacity: 100 gpm
	Suction press: 14.8 psia Discharge press: 109.4 psia
	Differential press: 94.6 psi
	Motor: 20 hp, 3500 RPM Frame: 256TC Enclosure: TEFC
	Make:
P-519	Dowtherm Return Pumps
A/B	PO# L-5016
529	Manufacturer: Union
	Model: Unilign 3X4-8½VL
	Capacity: 340 gpm
	Suction press: 34.5 psia Discharge press: 104.5 psia
	Differential press: 70.0 psi
	Motor: 25 hp, 3550 RPM Frame: 284LP Enclosure: TEFC
	Make: Reliance
P-611	T-611 Reflux Pump
A/B	PO# 5016
621	Manufacturer: Goulds Pumps, Inc.
	Model: 3996MT1½X2-10
	Capacity: 100 gpm
	Suction press: 24.7 psia Discharge press: 131.7 psia
	Differential press: 107 psi
	Motor: 20 hp, 3500 RPM Frame: 256CT Enclosure: TEFC
	Make: Westinghouse

P-612	Solvent Recycle Pumps
A/B	Manufacturer: Union
622	Model: 4X6-11VCM
	Capacity: 875 gpm
	Suction press: 24.7 psia Discharge press: 113.8 psia
	Differential press: 89.1 psi
	Motor: 75 hp, 3550 RPM Frame: Enclosure TEFC
	Make:
P-613	T-611 Recirculation Pump
A/B	Manufacturer: Goulds Pumps, Inc.
623	Model: 3996MT4X6-13
	Capacity: 770 gpm
	Suction press: 18 psia Discharge press: 58 psia
	Differential press: 40 psi
	Motor: 40 hp, 1780 RPM Frame: Enclosure: TEFC
	Make:
P-614	T-611 Bottoms Pump
A/B	PO# L-5058
624	Manufacturer: Union
	Model: 1½X2X7 VCM Unichem
	Capacity: 15 gpm
	Suction press: 58 psia Discharge press:
	Differential press:
	Motor: 3 hp, 3500 RPM Frame: 183LP Enclosure: TEFC
	Make: S.A.
P-711	D-711 Bottoms Pump
721	PO# L-5058
	Manufacturer: Union
	Model: 1½X2X7 VCM Unichem
	Capacity: 10 gpm
	Suction press: 24.7 psia
	Motor 3 hp, 3500 RPM Frame: 182LP Enclosure: TEFC
	Make: S.A.
P-801	D-801 Circulation Pump
	PO# L-5016
	Manufacturer: Goulds Pumps, Inc.
	Model: 3996 ST 2X3-6
	Capacity: 250 gpm
	Suction press: 14.7 psia Discharge press: 46.5 psia
	Differential press: 31.8 psi
	Motor: 10 hp, 3500 RPM Frame: 215TC Enclosure: TEFC
	Make: Westinghouse

P-802
A/B

D-802 Pumps
PO# L-5016
Manufacturer: Goulds Pumps, Inc.
Model: 3996 ST 2X3-6
Capacity: 250 gpm
Suction press: 14.7 psia Discharge press: 52.5 psia
Differential press: 37.8 psi
Motor: 10 hp, 3500 RPM Frame: 215TC Enclosure: TEFC
Make: Westinghouse

P-803
A/B

D-803 Pumps
PO# L-5016
Manufacturer: Goulds Pumps, Inc.
Model: 3996 MT 1½X2-10
Capacity: 45 gpm
Suction press: 14.7 psia Discharge press: 105.7 psia
Differential press: 91.0 psi
Motor: 15 hp, 3600 RPM Frame: 254TC Enclosure: TEFC
Make: Westinghouse

P-804
A/B

Swing Solvent Tank Pumps
PO# L-5016
Manufacturer: Goulds Pumps, Inc.
Model: 3996 MT 2X3-10
Capacity: 250 gpm
Suction press: 14.7 psia Discharge press: 66 psia
Differential press: 51.3 psi
Motor: 15 hp, 3500 RPM Frame: 254TC Enclosure: TEFC
Make: Westinghouse

P-806
A/B

Tank Car Unloading Pump
PO# L-5016
Manufacturer: Goulds Pumps, Inc.
Model: 3996 MT 3X4-10
Capacity: 200 gpm
Suction press: 14.7 psia Discharge press: 36.5 psia
Differential press: 21.8 psi
Motor: 5 hp, 1750 RPM Frame: 184TC Enclosure: TEFC
Make: Reliance

P-809

Waste Solvent Pump
PO# L-5016
Manufacturer: Goulds Pumps, Inc.
Model: 3996 MT 3X4-10
Capacity: 250 gpm
Suction press: 14.7 psia Discharge press: 34.4 psia
Differential press: 19.7 psi
Motor: 7.5 hp, 1750 RPM Frame: 21BTC Enclosure: TEFC
Make: Reliance

P-811 Solvent/Monomer Pumps
 A/B PO# L-5016
 821 Manufacturer: Goulds Pumps, Inc.
 Model: 3996 MT 2X3-10
 Capacity: 250 gpm
 Suction press: 14.7 psia Discharge press: 66.0 psia
 Differential press: 51.3 psi
 Motor: 15 hp, 3500 RPM Frame: 254TC Enclosure: TEFC
 Make: Westinghouse

P-900 Water Treatment Chemicals
 A/B PO# L-5040
 Manufacturer: Betz
 Model: A111-95B
 Capacity: Normal: 12 gpd Maximum: 24 gpd Minimum: 1.0 gpd
 Suction press: atmos. Discharge press: 5 psig
 Motor: 1 amp full load current

P-901 Cooling Water Pumps
 A/B/C PO# L-5016
 Model: 3415M 16X18-22G
 Capacity: 9250 gpm
 Suction press: 14.7 psia Discharge press: 79.9 psia
 Differential press: 65.2 psi
 Motor: 500 hp, 1180 RPM Frame: Enclosure: WP-1
 Make: Toshiba

P-904 D-904 Pump
 PO# L-5016
 Manufacturer: Goulds Pumps, Inc.
 Capacity: 50 gpm
 Suction press: 14.7 psia Discharge press: 58.7 psia
 Differential press: 44 psi
 Motor: 7.5 hp, 3500 RPM Frame: 213TC Enclosure: TEFC
 Make: Reliance

P-906 Potable Water Pumps
 A/B PO# L-5016
 Manufacturer: Goulds Pumps, Inc.
 Model: 3996 ST 1½X2-6
 Capacity: 50 gpm
 Suction press: 45 Discharge press: 80
 Motor: 5hp, 3500 RPM Frame: 184TC Enclosure: TEFC
 Make: Westinghouse

P-907 Mineral oil pumps for Seal Pots
 A/B PO# L-5027
 Manufacturer: Graco, Inc.
 Model: 205-626
 Capacity: 30 gph
 Air actuated pump; required air flow - 36 CFM Discharge
 press: 650 psig, Liquid inlet size: 1½" MNPT, liquid
 outlet size: ¾" MNPT, Air inlet size: 3/8" FNPT

R-211 Reactor
 212 PO# L-5505
 221 Manufacturer: Raleigh Beard
 222 Model:
 Size: 10'0" ID Vessel - 10'9" jacket
 Total volume: 3915 gal
 Wt Empty: Wt. Full: Operating press shell:
 500 psig
 Operating press jacket: 255 psig Operating temp shell: 428°F/220°C
 Operating temp jacket: 401°F/205°C Design press shell 750 psig
 jacket 275 psig
 Design temp shell: 650°F jacket: 650°F

RE-611 T-611 Reboilers
 621 PO# L-5503
 Size: Shell ID 27.0 in. 367 tubes 8 ft length
 Total flow: shell side 2130 lb/hr steam tube side 172760 lb/hr
 process Tube Data A-179
 Max operating temp: Shell side-382°F Tube side-351°F
 Max operating press: Shell side - 185 psig
 Design temp: Shell side-500°F Tube side-650°F
 Design press: Shell side-300 psig Tube side-100 psig

SD-511 Centrifugal Pellet Dryer
 521 PO# L-5031
 Manufacturer: Gala Industries
 Capacity: 35,000 lb/hr
 Inlet water rate: 880 gpm
 Motor: 15 hp

T-611 Dewax Column
 621 Flow rate: liquid - 200 gpm Vapor - 180,000 lb/hr.
 Bottom section: Liquid - 500 gpm Vapor - 180,000 lb/hr
 Operating press: 17 psig Operating temp - 350°F
 Design press: 100 psig Design temp - 650°F
 Packing one 10' section 3½" Monel pall rings
 one 10' section 2" Monel pall rings

XS-511 Additive Extruder
 521 PO# L-5003
 Manufacturer: NRM Corporation
 Model: 3½" Special Pacemaker III
 Capacity: 25 lb/hr min. to 375 lb/hr max.
 Discharge press: 400 psig
 Motor: 75 hp, 1750 RPM Enclosure: TEFC

Y-111 Ethyl Regenerate Beds (silica gel)
A/B PO# S-5521
Y-121 Size: 17' seam to seam
A/B Wt. Empty: 19,231 lbs. Wt. Full: 42,097 lbs.
Design pressure/temp: 535 psig @ 650°F
Total volume: 2742 gallons

Y-112 Ethylene Regenerate Beds (molecular sieves)
A/B PO# S-5521
Y-122 Size: 17' seam to seam
A/B Wt. Empty: 19,231 lbs. Wt. Full: 42,097 lbs.
Design press/temp: 535 psig @ 650°F
Total volume: 2742 gallons

Y-113 Propylene regenerate beds (silica gel & molecular sieves)
A/B PO# S-5526
Size: 10' seam to seam 2' inside diameter
Wt. Empty: Wt. Full:
Design press/temp: 402 psig @ 650°F
Total volume:

Y-211 Solvent regenerate beds (molecular sieves)
A/B PO# S-5521
Y-221 Size: 12'6" seam to seam
A/B Wt. Empty: 7,765 lbs. Wt. Full: 29,010 lbs.
Design press/temp: 167 psig @ 500°F
Total volume: 2547 gallons

Y-611 Solvent regenerate beds (silica gel)
A/B PO# S-5521
Y-621 Size: 12'6" seam to seam
A/B Wt. Empty: 7765 lbs. Wt. Full: 29,010 lbs.
Design press/temp: 167 psig @ 500°F
Total volume: 2547 gallons

Y-801 Solvent storage regenerate beds (silica gel)
PO# S-5521
Size: 10' seam to seam 3' inside diameter
Wt. Empty: 2927 lbs. Wt. Full: 7,703 lbs.
Design press/temp: 153 psig @ 500°F
Total volume: 581 gallons

Y-802 Octene regenerate beds (silica gel)
PO# S-5521
Size: 10' seam to seam 3' inside diameter
Wt. Empty: 2,927 lbs. Wt. Full: 7,703 lbs.
Design press/temp: 153 psig @ 500°F
Total volume: 581 gallons

Y-902 Air Dryers (active alumina)
A/B PO# S-5047
Size: approx. 7' x 4' x 9.5'
Weight empty: 1050 pounds
Design press/temp: 150 psig at 450°F
Volume: 3000 scfm

YB-111 Nitrogen blower for Y-111 A/B
121 PO# S-5005
Model: G5050-HMOD
60 hp motor 3600 RPM
Inlet SCFM - 1379 at 50 psia 100°F
Outlet 5 psid or 65 psia

YB-112 Nitrogen blower for Y-112
122 PO# S-5005
Model: G5050-HMOD
60 hp motor 3600 RPM
Inlet SCFM - 1379 at 60 psia 100°F
Outlet 5 psid or 65 psia

YB-211 Nitrogen blower for Y-113
221 PO# S-5005
Model: G5050-HMOD
60 hp motor 3600 RPM
Inlet SCFM 1379 at 60 psia 100°F
Outlet 5 psid or 65 psia

YB-611 Nitrogen blower for Y-611
621 PO# S-5005
Model: G5050-HMOD
60 hp motor 3600 RPM
Inlet SCFM 1379 at 60 psia 100°F
Outlet 5 psid or 65 psia

YB-801 Nitrogen blower for Y-801
 PO# S-5005
Model: H5015-HMOD
15 hp motor 3600 RPM
Inlet SCFM 345 at 60 psia 100°F
Outlet 5 psid or 65 psia

YH111/121	Heater	Y111	PO# S-5041
YH112/122		Y112	
YH113		Y113	
YH211/221		Y211	
YH611/621		Y611	
YH801		Y801 & Y802	

	<u>Inlet Temp</u>	<u>Outlet Temp</u>	<u>Opr Press</u>	<u>N₂ Flow</u>	<u>Input kw</u>
YH111	350	550	50	1250	94
112	350	550	50	1250	94
113	350	550	50	90	6
211	350	550	50	920	65
611	350	550	50	1325	94
801	350	550	50	301	22

EA's Air conveying coolers for System 3, 4, 5, 6 and 7
 PO# S-5056
 Manufacturer: Exchanger, Inc.
 Model: C-225-81M12
 Inlet size: 12"
 Outlet size: 12"
 Description: Removable Fin Tube Bundle
 Coil connection inlet: 2-1/8" O.D.
 outlet: 2-1/8" O.D.
 Housing; fabricated aluminum
 Normal air operated pressure: 25.5 psig
 Inlet temperature: EA's 3 & 4, 260°F outlet temp 140°F maximum
 EA's 5 & 6, 256°F outlet temp 140°F maximum
 EA 7, 281.5°F outlet temp 140°F maximum

G-511/512 Gearboxes (P-511, 512, 521 and 522)
 521/522 PO# L-5072
 Manufacturer: Horsburgh & Scott Co
 Gear ratio: 90/1 Single Helica Gears
 Service factor: 1.75
 AGMA ratings: 500 ph at 1800 RPM input
 Torque at maximum continuous speed: 131,300 lb. ft.
 Lubrication system: 2 oil pumps and 2 filter system
 Oil pump motors: Westinghouse 2 hp, 1200 RPM, 3 phase, 575 volts
 Frame - 184TC
 Heat Exchanger: BASCO #06024-54;
 Water flow rate of 20 gpm at 90°F
 Oil Heaters (2): 2 kw each with maximum watt density of
 5 watts per square inch.
 575 volts A.C., 3 phase

MX-212 Static Mixers
 222 PO# S-5045
 Manufacturer: Koch
 Size: 30'4½" long - 18" diameter
 Process design pressure: 750 psig
 Design temperature: 450°F
 Maximum pressure drop: 30 psi
 Number of elements: 20
 Jacket design pressure: 300 psig
 Design temperature: 65°F
 Diameter: 20"

MX-512 Static mixer
 522 PO# S-5045
 Manufacturer: Koch Eng.
 Size: 22 ft.
 Process design pressure: 4000 psia
 Process design temperature: 550°F
 Number of elements: 11
 Maximum pressure drop: 1000 psi
 Jacket design pressure: 235 pound steam service

YD-
 111/121 K.O. Drum
 112/121 PO# S-5523
 211/611 Design pressure: 144 psig
 Design temperature: 550°F
 Weight empty: 744 pounds
 Size seam to seam: 5 ft.
 Diameter: 2 ft.

YE-
 111/121 Regeneration coolers
 A/B/C PO# S-5059
 112/122 Type: Fintube (24)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	150 psig
Total flow -	5535 lbs/hr	62900 lbs/hr
Process -	Nitrogen	Cooling tower water

YE-
 111/121 Steam regeneration heaters
 D/E/F PO# S-5059
 112/122 Type: Fintube (36)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	300 psig
Total flow -	5535 lbs/hr	375 lbs/hr
Process -	Nitrogen	Steam

YE-
 211/221 Regeneration coolers
 A/B/C PO# S-5059
 Type - Fintube (24)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	100 psig
Total flow -	4073 lbs/hr	46300 lbs/hr
Process -	Nitrogen	Water cooling tower

YE-
211/221
D/E

Steam regeneration heaters

PO# S-5059

Type: Fintube (36)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	300 psig
Total flow -	4073 lbs/hr	285 lbs/hr
Process -	Nitrogen	Steam

YE-
611/621
A/B/C/D

Regeneration coolers

PO# S-5059

Type: Fintube (24)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	150 psig
Total flow -	5867 lbs/hr	66700 lbs/hr
Process -	Nitrogen	Cooling tower water

YE-
611/621
E/F/G

Steam regeneration heaters

PO# S-5059

Type: Fintube (36)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	300 psig
Total flow -	5867 lbs/hr	398 lbs/hr
Process -	Nitrogen	Steam

YE-801A

Regeneration cooler

PO# S-5059

Type: Fintube (24)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	150 psig
Total flow -	1333 lbs/hr	15150 lbs/hr
Process -	Nitrogen	Cooling tower water

YE-801B

Steam regeneration heater

PO# S-5059

Type: Fintube (36)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	300 psig
Total flow -	1333 lbs/hr	91 lbs/hr
Process -	Nitrogen	Steam

YE-113A	Regeneration cooler	
	PO# S-5059	
	Type: Fintube (24)	
	Design temperature -	Shell Side 650°F
	Design pressure -	100 psig
	Total flow -	421 lbs/hr
	Process -	Nitrogen
		Tube Side 550°F
		150 psig
		3329 lbs/hr
		Cooling tower water

YE-113B	Steam regeneration heater	
	PO# S-5059	
	Type: Fintube (36)	
	Design temperature -	Shell Side 650°F
	Design pressure -	100 psig
	Total flow -	421 lbs/hr
	Process -	Nitrogen
		Tube Side 550°F
		300 psig
		29 lbs/hr
		Steam

VP-512A/B Vacuum Pumps
P.O.#

YE-113A Regeneration cooler
PO# S-5059
Type: Fintube (24)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	150 psig
Total flow -	421 lbs/hr	3329 lbs/hr
Process -	Nitrogen	Cooling tower water

YE-113B Steam regeneration heater
PO# S-5059
Type: Fintube (36)

	Shell Side	Tube Side
Design temperature -	650°F	550°F
Design pressure -	100 psig	300 psig
Total flow -	421 lbs/hr	29 lbs/hr
Process -	Nitrogen	Steam

VP-512A/B Vacuum Pumps
P.O.#