

Piping & Instrument Diagrams

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Communication for Engineers

- Verbal

Assignments, Instructions, updates

- Written

Reports, Procedures, Specifications

- Mathematical

Calculations, data, Performance statistics

- Symbolic

Designs, Process Documentation

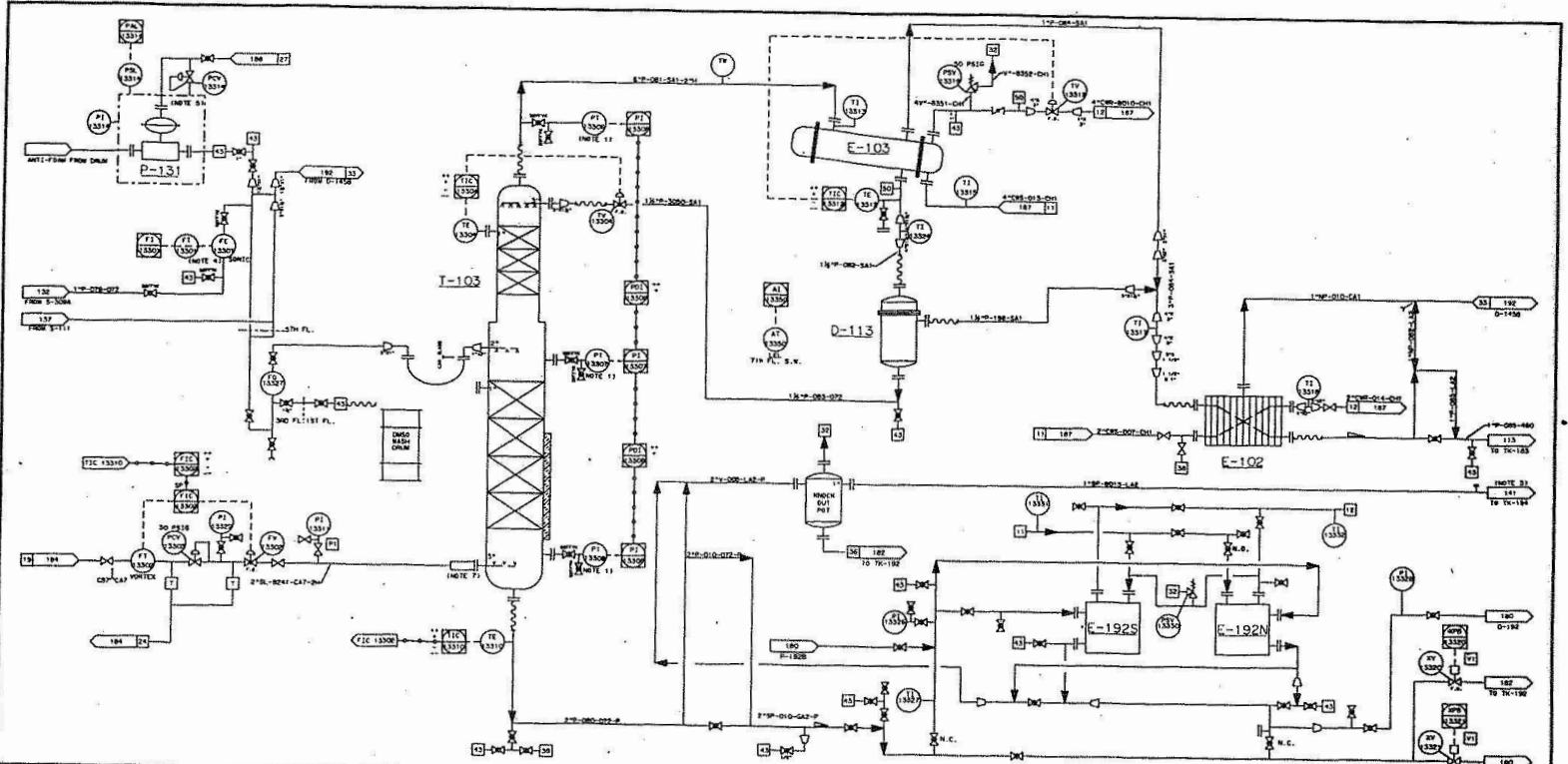
Drawings are Engineering's

INTERNATIONAL LANGUAGE

engineers all over the world can understand them

TYPES of DRAWINGS

- **P**rocess **F**low **D**iagrams: What a Process Does
- **P**iping & **I**nstrument **D**iagrams: How it works
- Layout Drawings: How it looks
- Mechanical Drawings: |
| How to build it
- Construction Drawings: |

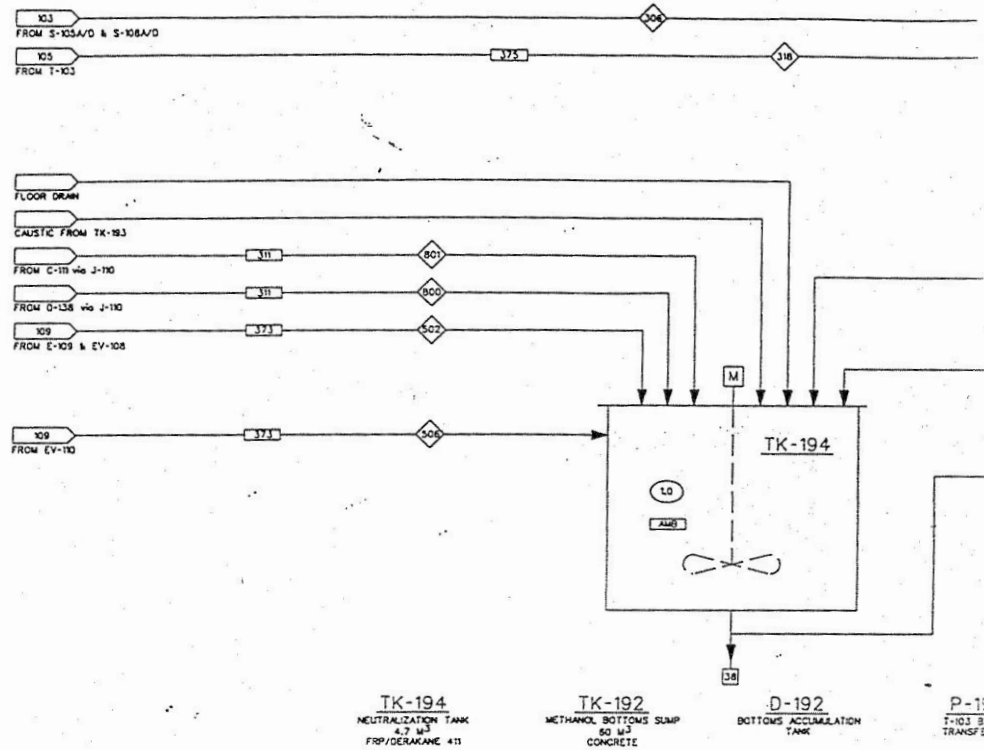


- L [] COOLING WATER SUPPLY
- E [] COOLING WATER RETURN
- C [] WATER-DEMINERALIZED
- E [] WATER-COAGULATED
- C [] WATER-CITY
- N [] WATER-OF THE PROTECTION
- H [] WATER-RIVER
- D [] DRY DISCONNECT
- [] STEAM
- [] STEAM
- [] STEAM
- [] CHILLED WATER SUPPLY
- [] CHILLED WATER RETURN
- [] CONDENSATE (HIGH PRESS)
- [] CONDENSATE (LOW PRESS)
- [] ROOM AIR
- [] AIR-PLANT
- [] AIR-INSTRUMENT
- [] NATURAL GAS
- [] NITROGEN
- [] BLEED
- [] TO ATMOSPHERE
- [] NITROGEN PAGING
- [] EMERGENCY VENT
- [] SEWER-SANITARY
- [] SEWER-PROCESS
- [] SEWER-NONCONTACT
- [] SORRAIN
- [] SAMPLE
- [] SAMPLE WITH COOLER
- [] SPURDINET
- [] ROSE CONNECTION
- [] QUICK DISCONNECT
- [] HOT OIL SUPPLY
- [] IONIZED H₂O
- [] TEMPERED H₂O SUPPLY
- [] TEMPERED H₂O RETURN
- [] VACUUM
- [] PRESSURE TAP PLUGGED

NOTES

- 1. SPECIALTY CERAMIC PRESSURE TRANSDUCER.
- 2. PUSHS INTO LINE FROM E-103 BEFORE FLASHING TO TC-104.
- 3. POSITIVE LIFTING FROM THE 1500' LOCATED IN THE VERTICAL RISE.
- 4. A 60MM BRASS STC IS PERMITTED IN THE CONNECTION.
- 5. STEAM BRANGER IS TO BE INSTALLED W/ GLASS NOZZLE AND C.S. CONNECTION.

ITEM NO.	ITEM NO.	ITEM NO.	ITEM NO.	ITEM NO.	ITEM NO.
100	101	102	103	104	105
106	107	108	109	110	111
112	113	114	115	116	117
118	119	120	121	122	123
124	125	126	127	128	129
130	131	132	133	134	135
136	137	138	139	140	141
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160	161	162	163	164	165
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238	239	240	241	242	243
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790	791	792	793	794	795
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934	935	936	937	938	939
940	941	942	943	944	945
946	947	948	949	950	951
952	953	954	955	956	957
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970	971	972	973	974	975
976	977	978	979	980	981
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988	989	990	991	992	993
994	995	996	997	998	999
1000	1001	1002	1003	1004	1005



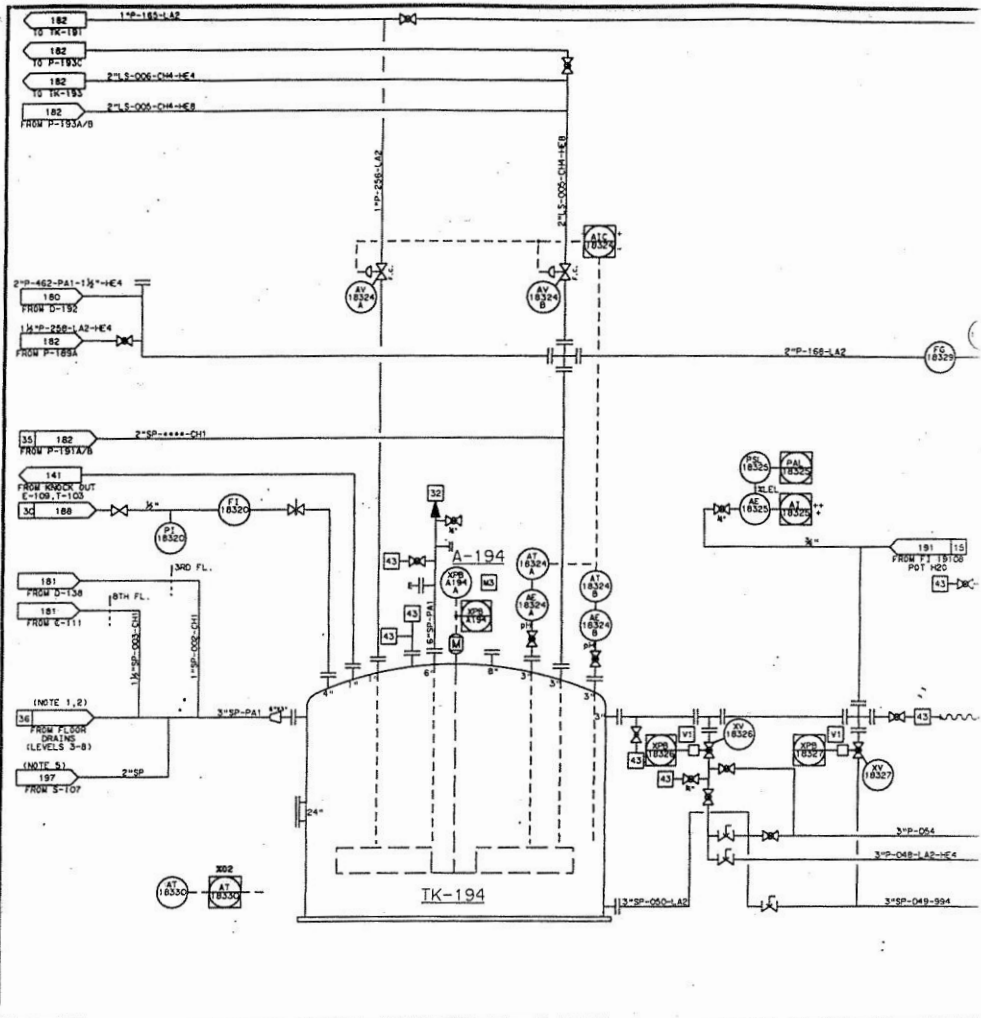
TK-194
NEUTRALIZATION TANK
4.7 M³
FRP/DERAKANE 411

TK-192
METHANOL BOTTOMS SUMP
50 M³
CONCRETE

D-192
BOTTOMS ACCUMULATION
TANK

P-103
TRANSFER

STREAM IDENTIFICATION NO.		308	318	502	506	500	501		
STREAM DESCRIPTION		CONDENSED ZnCl ₂ /H ₂ O	T-103 METHANOL BOTTOMS	E-109 CONDENSATE	EV-110 DISTILLATE	HOTWELL D-136 TO TK-194	C-111 TO TK-194		
#	COMPONENTS FORMULA	KG/HR	WT %	KG/HR	WT %	KG/HR	WT %	KG/HR	WT %
1	ZINC CHLORIDE ZnCl ₂	31.4	25.5	TRACE					
2	WATER H ₂ O	81.4	66.2	103.2	98.7				
3	DL-α-TOCOPHEROL C ₅₅ H ₉₀ O ₂			0.3	.02				
4	INDOXYLAMINE HYDROCHLORIDE C ₁₃ H ₁₇ N ₂			4.3	0.4				
5	IMPURITIES ---	4.1	3.3	5.0	0.4				
6	HYDROGEN CHLORIDE HCl	6.1	5.0	2.0	0.4	0.01	0.0		
7	METHANOL CH ₃ OH			1.0	0.1				
8	HEPTANE C ₇ H ₁₆	TRACE							
9	SODIUM HYDROXIDE NaOH			1.5	2.6				
10	ACETIC ANHYDRIDE (CH ₃ CO) ₂ O			13.7	23.5	0.44	.33	0.02	.2
11	VITAMIN E ACETATE C ₃₁ H ₅₀ O ₂			TRACE		0.01	0.0		
12	ACETIC ACID CH ₃ COOH			43.0	73.9	6.84	5.2	0.36	2.6
TOTAL KG/HR		123	105.9	58.2	TRACE	132.81	13.42		
TOTAL MOLS									
PHASE		LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID		
WT. % SOLIDS		24.7	----	----	----	----	----		
VISCOSITY (mPa-s or cp)		1.0	.9	.01	.7	.9	.9		
DENSITY (KG/HR) (NOTES 1 & 2)		~1000	~1000	1042	870	1002	1001		
MOLECULAR WEIGHT (KG/MOL)		24.3	18.7	87.2	472	18.7	18.4		
FLOW RATE @ P.T. (M ³ /HR) (NOTE 3)		0.02	1.17	.06	.007	0.13	0.01		



L	11 COOLING WATER SUPPLY	13 STEAM	15 AIR-PLANT	17 SEWER-SANITARY	19 QUICK DISCONNECT	NOTE 1. SEE... 2. TBA... 3. XS 1... 4. S-10... 5. PSV
L	12 COOLING WATER RETURN	14 STEAM	16 AIR-INSTRUMENT	18 SEWER-PROCESS	20 HOT OIL SUPPLY	
G	13 WATER-DEMINERALIZED	15 STEAM	17 NATURAL GAS	19 SEWER-NONCONTACT	21 HOT OIL RETURN	
G	14 WATER-COAGULATED	16 CHILLED WATER SUPPLY	18 NITROGEN	20 DRAIN	22 DEIONIZED H ₂ O	
E	15 WATER-CITY	17 CHILLED WATER RETURN	19 BLEED	21 SAMPLE	23 TEMPERED H ₂ O SUPPLY	
N	16 WATER-FIRE PROTECTION	18 CONDENSATE (HIGH PRESS)	20 TO ATMOSPHERE	22 SAMPLE WITH COOLER	24 TEMPERED H ₂ O RETURN	
N	17 WATER-RIVER	19 CONDENSATE (LOW PRESS)	21 NITROGEN PADDING	23 PUMP/OUT	25 VACUUM	
D	18 DRY DISCONNECT	20 ROOM AIR	22 EMERGENCY VENT	24 HOSE CONNECTION	26 PRESSURE TAP PLUGGED	
ITEM NO.	C-191	P-190	P-296	ITEM NO.		
SERVICE	ZINC FILTER VACUUM PUMP	FILTRATE PUMP	HCL TOTE PUMP	SERVICE		
TEMP. °F	AMBIENT	AMBIENT	---	SH. DES. PSIG/°F		
SG @ P.T.	---	1.05	---	TU. DES. PSIG/°F		
DES. CFM	280 CFM	20	---	SURFACE S.F.		
DES. DIFF. PSI	20" Hg	---	---	SHELL MATERIAL		
MATERIAL	---	S1-Fg	---	TUBE MATERIAL		
HORSEPOWER	20	8	---	INSULATION		

Uses of P&IDs

- Develop Operational methodology
- Develop Safety Philosophy and Design
- Develop Control Philosophy
- Basis for Control Programming
- Communication Document for Project

Uses of P&IDs

- Serves as Design Basis for:
 - Equipment Design
 - Piping Design
 - Estimating
 - Purchasing
- Used to evaluate construction progress
- Training basis for Operational Personnel

Characteristics of P&IDs

- Grouped by specific sections of the process
- Schematic; NOT a scaled layout
- Clear; uncluttered
- Systematic; uniform
- Usually confidential
- Revised often with Revisions clearly identified

Elements of a P&ID

- Equipment & valves identified
- Instrumentation type & location identified
- Path between instruments & control devices indicated
- Piping size and type identified for all lines

Identification of Equipment

- Identification by type
 - w/ specific code designation..ie TK
 - w/ a specific standardized shape
- Identification by number
 - w/ specific item number...ie TK 101
- Identification by name
 - w/ what the unit is called.. ie methanol tank

5.5 Equipment Identification

5.5.1 Equipment shall be identified with an classification code letter and a das followed by a number The equipment code and number shall be shown adjacent to the equipment it designates on the PFD.

5.5.2 Equipment Classification

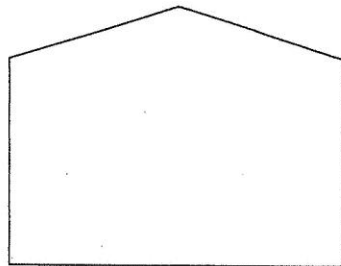
<u>Code</u>	<u>Equipment</u>
A	Agitators, Mixers
BL	Blowers, Fans
C	Compressors
CF	Centrifuges
CT	Cooling Towers
CV	Conveyers
CY	Cyclones
D	Drums, (surge vessels, KO pots)
E	Heat Exchangers
F	Filters
G	Grinders, Mills, Crushers
H	Direct Fired Heaters
J	Jets, Ejectors, Eductors
M	Motors
P	Pumps
R	Reactors
RU	Refrigeration Units
S	Separators, Decanters
SC	Screens
SM	Static Mixers
T	Towers (distillation, extraction, scrubbing)
TK	Storage Tank
VP	Vacuum Pump
X	Misc. & Special Equip.

5.5.3. Equipment Numbers

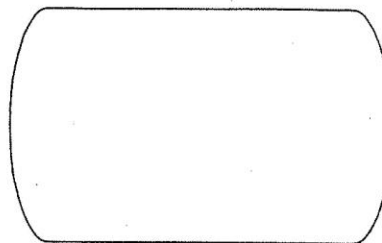
Each identifiable item of equipment shall be assigned a 2 or 3 digit number. Items numbers may be grouped by division of the process
 i.e. Reaction ----100 to 199
 Distillation- 200 to 299
 Storage -----300 to 399

5.6. Equipment Symbols

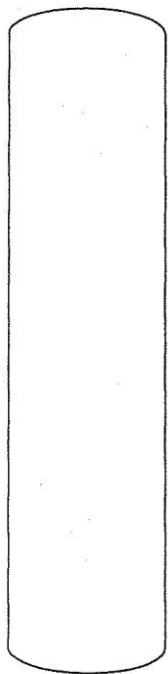
See Attached Figures



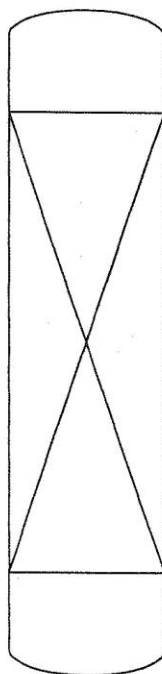
TK STORAGE TANK - VERTICAL



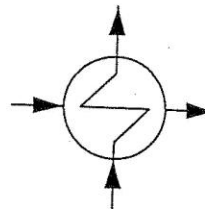
TK STORAGE TANK - HORIZONTAL



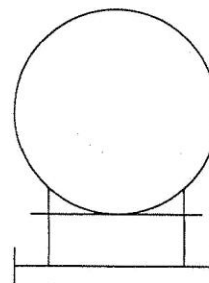
T COLUMN /TOWER



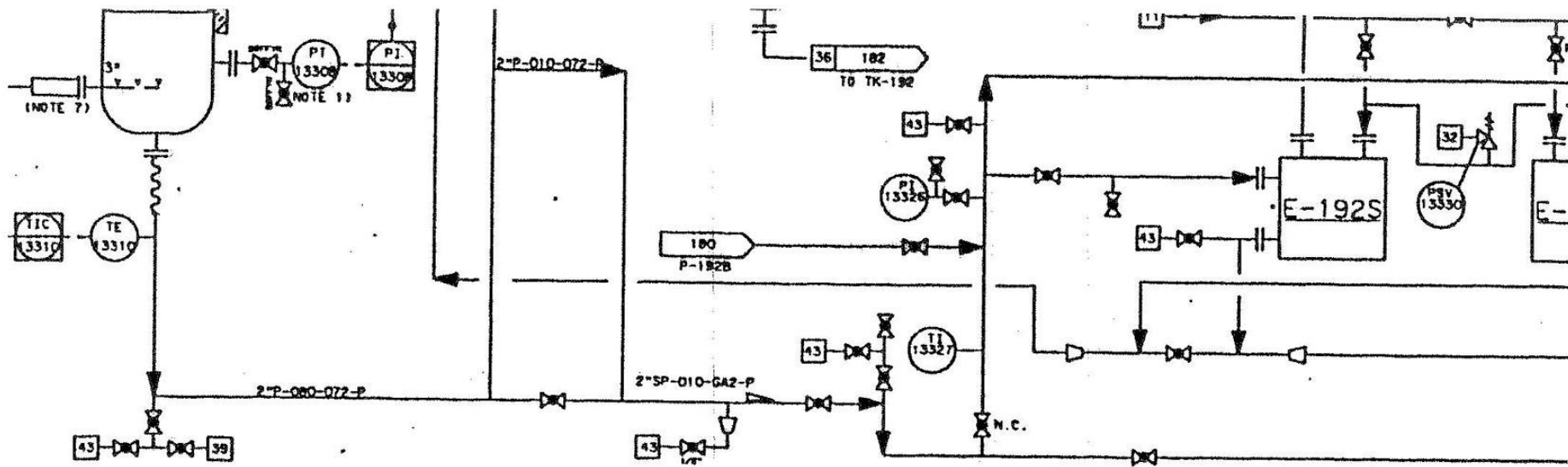
T PLACKED COLUMN /TOWER



E EXCHANGERS - ALL TYPES



T TANK CAR



- | | |
|-----------------------|-------------------------------------|
| 35 SEWER-SANITARY | 43 QUICK DISCONNECT |
| 36 SEWER-PROCESS | 44 HOT OIL SUPPLY |
| 37 SEWER-NONCONTACT | 45 HOT OIL RETURN |
| 38 DRAIN | 46 DEIONIZED H ₂ O |
| 39 SAMPLE | 47 TEMPERED H ₂ O SUPPLY |
| 40 SAMPLE WITH COOLER | 48 TEMPERED H ₂ O RETURN |
| 41 PUMPOUT | 49 VACUUM |
| 42 HOSE CONNECTION | 50 PRESSURE TAP PLUGGED |

NOTES

- SPECIALTY CERAMIC PRESSURE TRANSMITTER.
- FUSES INTO LINE FROM E-109 BEFORE FLOWING TO TK-194.
- PROVIDE LIQUID SEAL LEG WITH FE 13301 LOCATED IN THE VERTICAL RISER.
- P-131 IS LOCATED INSIDE A PLASTIC ENCLOSURE.
- ALARMS WHEN OIL IS PRESENT IN LINE.
- STEAM SPARGER IS SCH. 40 HASTALLOY W/GLASS NOZZLE AND C.S. CONNECTION.

	E-102	E-103	E-192V/S		ITEM NO.	D-113	T-103		
	METHANOL SUBCOOLER	METHANOL STRIPPER CONDENSER	COOLER		SERVICE	METHANOL REFLEX DRUM	METHANOL STRIPPER		
"F	75/113	100/212			SIZE DIA x T.T.	1'-0"X2'-0"	1'-6"X40'-0"		
"F	75/113	75/200	75/212		DES. PSIG/ °F	---	---		
	57	334	60		OP. PSIG/ °F	8"W.C./149	8"W.C./212		
	GRAPHITE	C.S.			CAP FULL	20 LITER	---		
	GRAPHITE	304 S.S.	TEFLON		MATERIAL	GLASS	GLASS		
	---	---			INSULATION	NONE	8		

Valve Identification

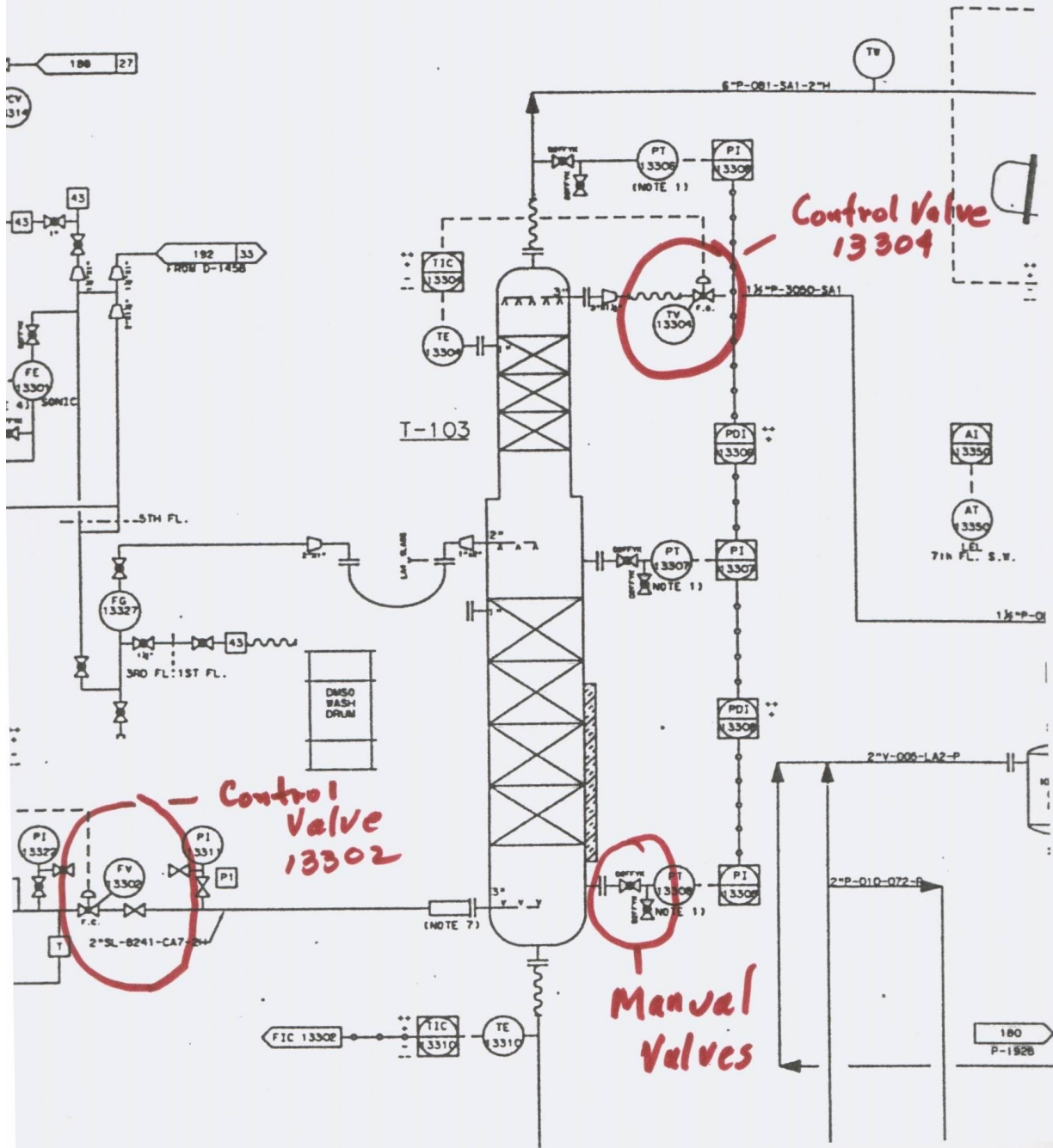
- Identification by type

Date

PIPING & INSTRUMENT DIAGRAM

 GATE VALVE	 GLOBE VALVE	 PLUG VALVE	 BALL VALVE
 DIAPHRAGM VALVE	 NEEDLE VALVE	 QUICK OPENING VALVE	 CHAIN OPERATED VALVE
 Y-VALVE	 ANGLE VALVE	 FLUSH BOTTOM TANK VALVE	 BUTTERFLY VALVE
 BEVEL GEAR OPERATED VALVE	 3-WAY VALVE	 BLEEDPORT BALL VALVE	 BLEEDPORT PLUG VALVE
 VEE BALL VALVE	 4-WAY VALVE	 CHECK VALVE	 RELIEF VALVE
 RUPTURE DISC	 DAMPER VALVE	 NON-RETURN VALVE	 PINCH VALVE
 SAMPLE CONNECTION	 PIV POST INDICATOR VALVE	 EF EXCESS FLOW VALVE	 FOOT VALVE
 CSO CAR SEAL OPEN	 CSC CAR SEAL CLOSED	 JACKETED VALVE	

VALVE SYMBOLS



Instruments

- Instruments may be: Indicators
or Part of a control system
- Instruments often have several components:
 - sensing elements
 - transmitters
 - control elements

Some Instrument Designations

P = pressure

I = indicator

T = Temperature

C = controller

F = Flow

S = switch

L = Level

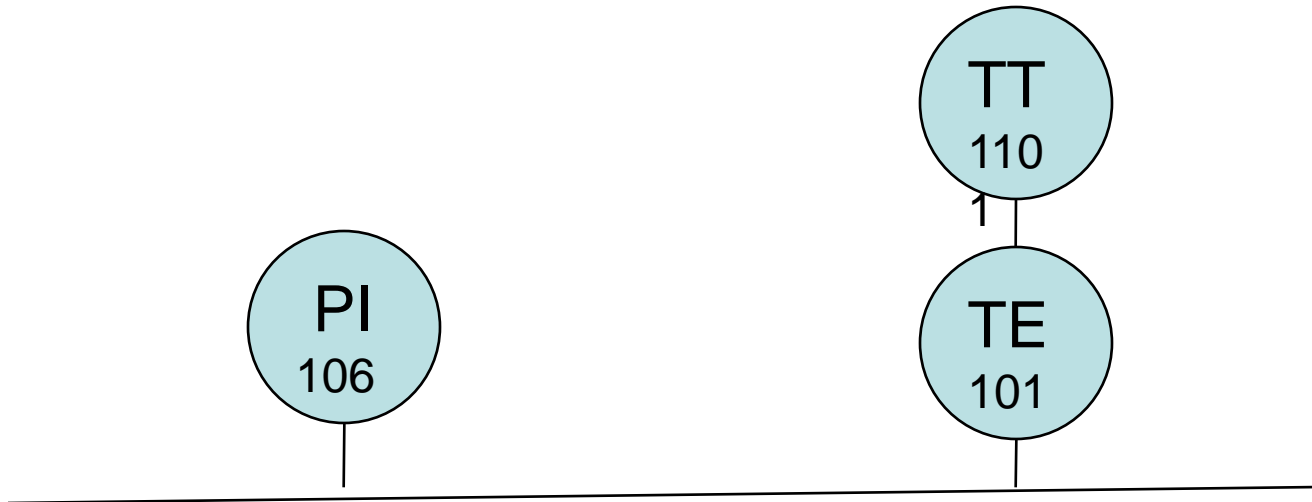
E = element

T = transmitter

G = gage

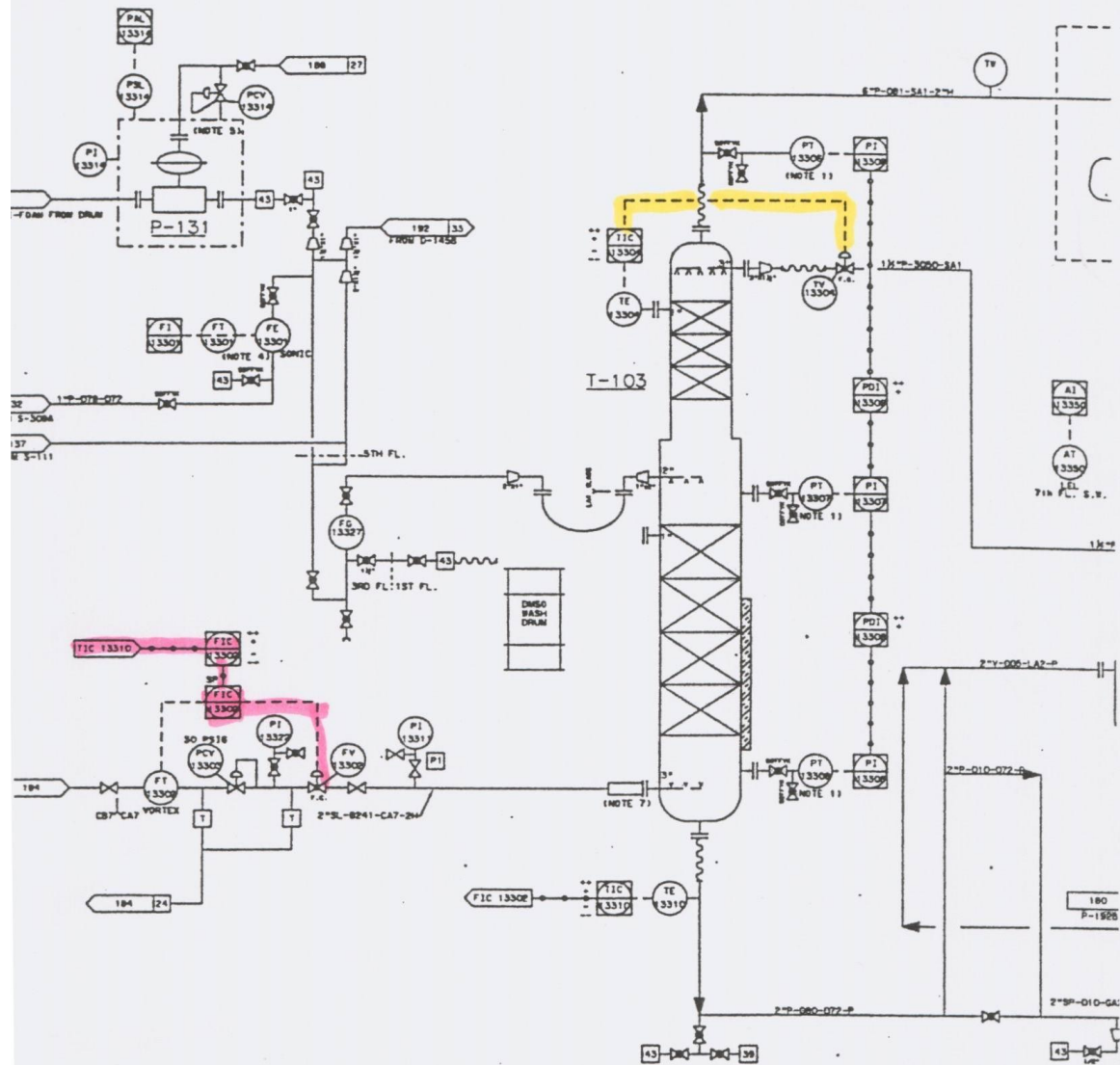
- ISA designations usually used

Instrument Configuration



Control Paths

- Hardwired
- “Computer program”



OLING WATER SUPPLY	STEAM	AIR-PLANT	SEWER-SANITARY	QUICK DISCONNECT	NOTES 1. SPECIALTY CERAMIC 2. FUSES INTO LINE FF 3. PROVIDE LIQUID BEG 4. P-131 IS LOCATED 3 5. ALARMS WHEN OIL IS 7. STEAM SPARGER IS 3
OLING WATER RETURN	STEAM	AIR-INSTRUMENT	SEWER-PROCESS	HOT OIL SUPPLY	
TER-DEMINERALIZED	STEAM	NATURAL GAS	SEWER-NONCONTACT	HOT OIL RETURN	
TER-CONGLUATED	CHILLED WATER SUPPLY	NITROGEN	DRAIN	DEIONIZED H ₂ O	
TER-CITY	CHILLED WATER RETURN	BLEED	SAMPLE	TEMPERED H ₂ O SUPPLY	
TER-FIRE PROTECTION	CONDENSATE (HIGH PRESS)	TO ATMOSPHERE	SAMPLE WITH COOLER	TEMPERED H ₂ O RETURN	
TER-RIVER	CONDENSATE (LOW PRESS)	NITROGEN PADDING	PUMP/OUT	VACUUM	
Y DISCONNECT	ROOM AIR	EMERGENCY VENT	HOSE CONNECTION	PRESSURE TAP PLUGGED	

ITEM NO.	E-102	E-103	E-102M/S	ITEM NO.
ART1-FOAM PUMP	METHANOL SUBCOOLER	METHANOL STRIPPER CONDENSER	COOLER	SERVICE
	75/113	100/212		SIZE DIA

Piping Designations

- Line Codes
- Spec breaks

Line Codes

- Size
- Service
- Mat'l of Constr or Piping Spec
- Insulation amount and Spec

Pipe size

“Nominal diameter”

1”, 2 1/2”, 4” etc.

Pipe Service

Coded to a designation shown on P&IDs

Examples: Methanol- Me

Reactor Product Stream- RxP

Material of Construction

- Generic

Examples- *PVC*

316L S/S

- Company or Project Specification

Examples- *PP1*

(a specification covering the materials and joining methods for PVC plastic pipe)

Insulation Code

- Thickness of insulation (inches)
- Type or Insulation Specification

Example- F (fiberglass)

- IN 9 (Project Specification for
Calcium Silicate System)

- Tracing Code

Examples- S (steam)

E (electric)

Total Line Code

Example-

2" dia., Type 304 s/s pipe in acetic acid reactor discharge service, insulated with 1" of fiberglass insulation

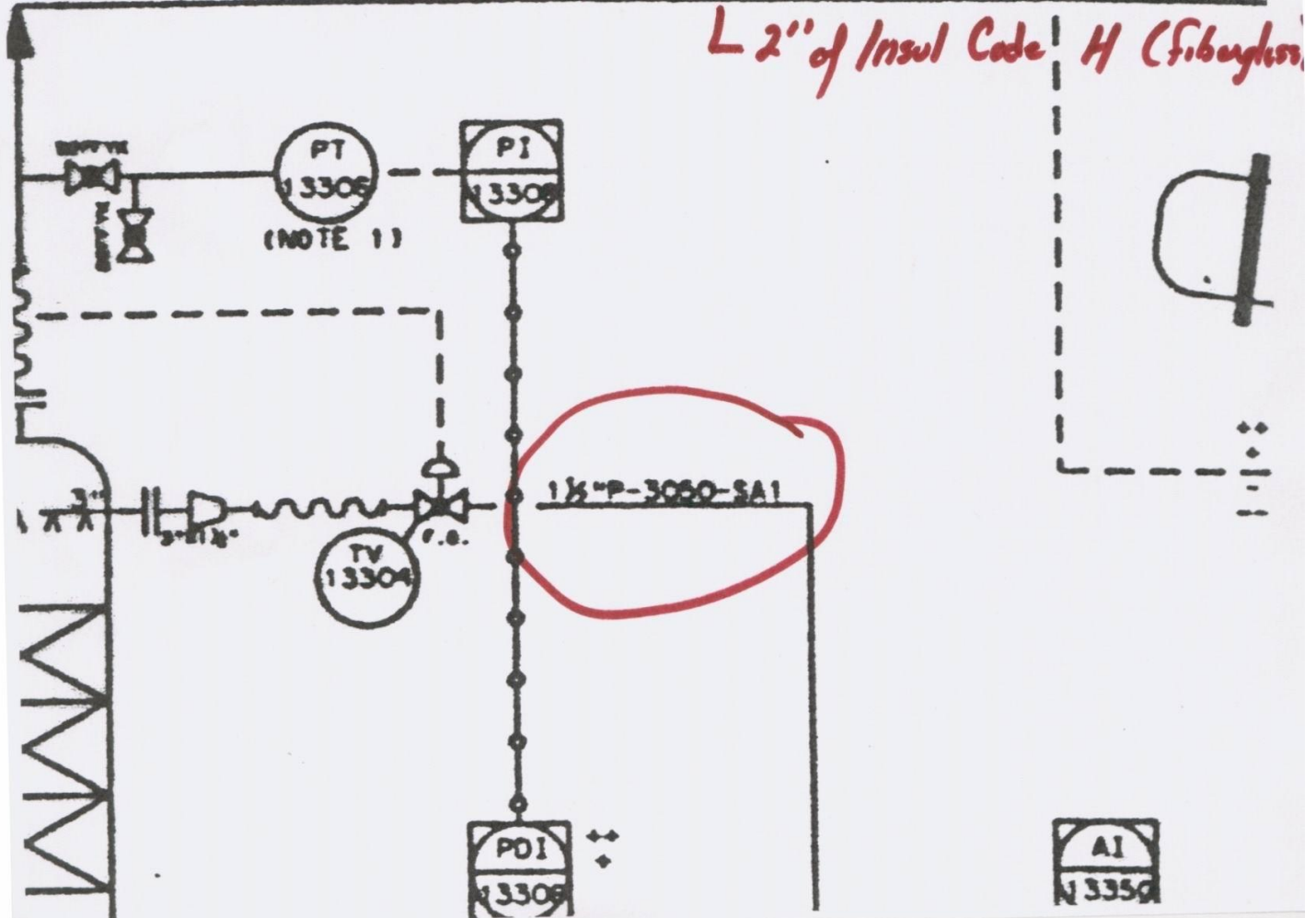
2"AARX-304S/S-1"F

6" pipe
Process Code - OBI
Project Code SA1 (Carbon Steel)

6"-P-OBI-SA1-2"-H



2" of Insul Code H (Fiberglass)



Spec Breaks

- A Line /Code changes every time *ANY ELEMENT* in the code changes

IE 3"AARX-304L S/S-1"F --> 3"AARX-304L S/S

at the point where the fluid has cooled enough to eliminate the insulation.

Spec Breaks are shown as 

Notes on P&IDs

- Normally read LEFT to RIGHT
TOP to BOTTOM
- The Stream No.s, Ts, Ps and Flows from the PFD do NOT appear on a P& ID
- Equipment numbers are the same as on the corresponding PFD

THANK YOU

$Q_s ?$