

Aerojet Rocketdyne (AR) / CanmetENERGY Oxy-PFBC Technology Development

Task 1 – 1 MW_{th} Pilot Plant Revision B10

4.0 Integration

4.1 Block Flow Diagram

4.3 Process Flow Diagram

4.4 Process and Instrumentation Diagram

Research Program Leader – Robin Hughes
Project Leader – David McCalden
Lead Process Engineer – Robert Symonds
Process Engineers – Scott Champagne

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REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R.	Nov.	Cover Page				
1	Added WBS elements and program staff	APR 11, 2014	RS		Symonds	2014	DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
				APPROVED BY:			PFBC - P-002114.001 -	PFBC - P-002114.001	0-00	1	1
				ISSUED:			0-00 - 1				
				SCALE:	NONE						

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1. Equipment Numbering

The following designators are used for equipment, where the numbering system is of the form:

DD-YYY-###

1.1 Equipment Identification Conventions (DD)

- A – Analyzer
- AC – Air Cooler
- B – Blower
- BU – Bag Unloader
- C – Conveyor
- CO – Conditioner
- CY – Cyclone
- D – Dryer
- DI – Diffuser
- EV – Evaporator
- F – Filter / Strainer
- H – Heater
- HX – Heat Exchanger
- K – Compressor
- M – Mixer / Blender
- MO – Motor
- P – Pump
- Q – Quench
- R – Reactor
- S – Scrubber
- SE – Seal
- T – Tower
- TK – Tank
- V – Vessel

1.2 Block Flow Diagram Number (YYY)

- Block 1 – Bulk Supplies
- 1-01 – O₂ Supply
 - 1-02 – CO₂ Supply
 - 1-03 – NG Supply
 - 1-04 – Main Air Supply
 - 1-05 – Main Water Supply
 - 1-06 – Solid Fuel Supply
 - 1-07 – Solid Sorbent Supply
 - 1-08 – N₂ Supply
 - 1-09 – Bed Material Supply
 - 1-10 – H₂/CH₄ Supply
- Block 2 – Feed Preparation
- 2-01 – Gas Distribution System
 - 2-02 – Natural Gas Distribution System
 - 2-03 – Air Distribution System
 - 2-04 – Water Distribution System
 - 2-05 – Solids Distribution System
- Block 3 – Process
- 3-01 – PFBC
 - 3-02 – Process Gas Treatment
 - 3-03 – Recycle Gas Treatment
 - 3-04 – Solid Waste Handling
 - 3-05 – Process Water Treatment
- Block 4 – Utilities
- 4-01 – Cooling Tower System
 - 4-02 – PFBC Cooling System
- Block 5 – Sampling
- 5-01 – Gas Sampling System
 - 5-02 – Solid Sampling System
 - 5-03 – Analyzers

1.3 Sequential Number (###)

The sequential number designator (###) is used to differentiate between multiple instances of the same equipment class.

2. Instrumentation Numbering

The instrumentation symbols and identification is based on ISA-5.1-1984 (R1992). The following designators are used for instrumentation and valving, where the numbering system is of the form:

PST-####

Such numbering is found within a circle or diamond on the P&IDs.

2.1 Instrument Class (PST)

- CV – Check Valve
- HV – Hand Valve
- PSV – Pressure Safety Relief Valve
- FCV – Flow Control Valve
- PCV – Pressure Control Valve
- TCV – Temperature Control Valve
- LCV – Level Control Valve
- YV – Solenoid Valve
- PRV – Pressure Reduction Valve

- FT – Flow Transmitter
- PT – Pressure Transmitter
- DPT – Differential Pressure Transmitter
- TT – Temperature Transmitter
- LT – Level Transmitter
- AT – Analysis Transmitter
- WT – Weight Transmitter
- ST – Speed Transmitter
- IT – Current Transmitter

- FIC – Flow Indicator Controller
- PIC – Pressure Indicator Controller
- TIC – Temperature Indicator Controller
- LIC – Level Indicator Controller
- YIC – Solenoid Indicator Controller (On /Off)
- WIC – Weight Indicator Controller
- PC – Pressure Controller
- FC – Flow Controller
- TC – Temperature Controller
- SC – Speed Controller

- FI – Flow Indicator
- FQI – Flow Quantity Indicator
- PI – Pressure Indicator
- DPI – Differential Pressure Indicator
- TI – Temperature Indicator
- LI – Level Indicator
- AI – Analysis Indicator
- WI – Weight Indicator

- TE – Thermocouple
- WE – Weight Element (Load Cell)
- BE – Burner Element (Ignitor)
- PSE – Pressure Safety Element (Rupture Disc)
- VSD – Variable Speed Drive
- LSH/L – Level Switch High/Low
- FSH/L – Flow Switch High/Low
- ZSO/C – Position Switch Open/Closed
- PSH/L – Pressure Switch High/Low
- TSH/L – Temperature Switch High/Low

- XO – Power Run/Stop
- XC – Running Signal
- XF – Fault
- XA – Local/Auto

2.2 Sequential Number (###)

The sequential number designator (###) is used to differentiate between multiple instances of the same equipment class. The first “#” in the sequential number designator is reserved for the block designator in which the instrument is located.

3. Process Line Numbering

The following designators are used for process lines, where the numbering system is of the form:

DDD”-MM-RRR.SS-CCC

3.1 Process Line Diameter (DDD”)

The process line diameter designator (DDD”) is used to indicate the nominal pipe or tubing size. Examples:

1” or 2 1/2”

3.2 Medium Type (MM)

- O2 - Oxygen
- CD – Carbon Dioxide
- SC – Super Critical Carbon Dioxide
- NG – Natural Gas
- AR – Air
- N2 – Nitrogen
- H2 – Hydrogen
- ME – Methane
- CO – Condensate
- WA – Water
- SF – Solid Fuel
- SS – Solid Sorbent
- CF – Solid Fuel + Carbon Dioxide
- CS – Solid Sorbent + Carbon Dioxide
- RG – Recycle Flue Gas
- CG – Combustion Gas
- FS – Solid Fuel + Solid Sorbent
- FG – Flue Gas
- WS – Waste Solids
- BA – Bed Ash
- FA – Fly Ash
- GW – Glycol + Water
- BM – Bed Material
- HO – Hot Oil
- TC – Treated Condensate
- SC – Sodium Caustic
- TF – Thermal Fluid

3.3 Process Line and Sub-run Number (RRR.SS)

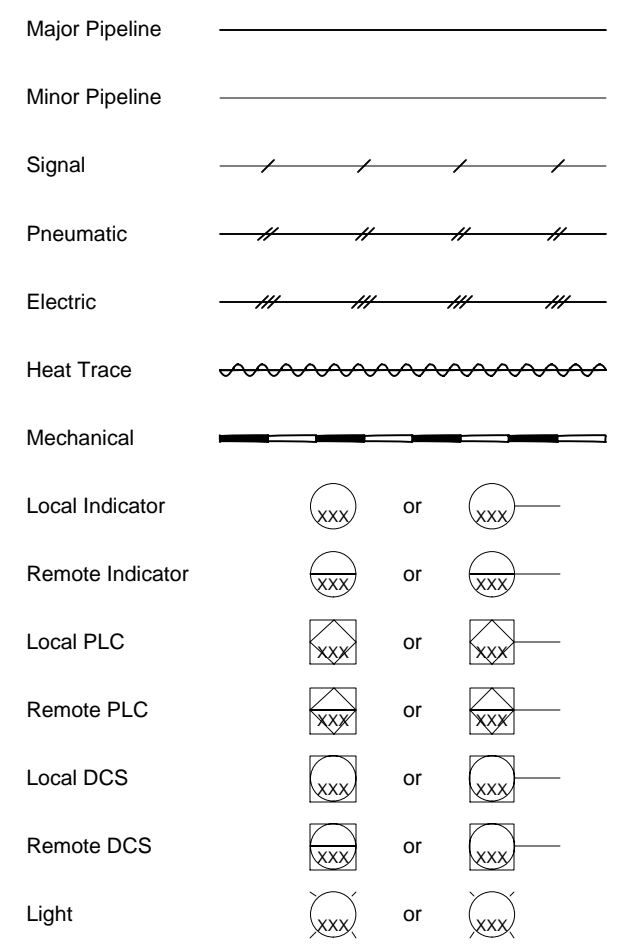
The process lines numbers (RRR) and sub-run (SS) designators are used to differentiate between multiple process lines. The process line designator (RRR) remains the same for a run from one piece of equipment to the next, whereas the line sub-run designator (SS) changes, in integer increments, for each pipe or tube segment within the particular line run, as described below:

- Main process lines runs should keep one sequence number.
- New process line run numbers should be assigned:
 - Upon entering and leaving an item of equipment;
 - To take-off or branch lines from main process line;
 - To structural material composition of line changes.
- Sub-run designators should be assigned:
 - For secondary branches from process lines;
 - For bypass lines around equipment, control valves, etc. Keep same sequence number as inlet or upstream line;
 - For identical multiple systems, piping corresponding identical service items, and lines.

3.4 Line Class (CCC)

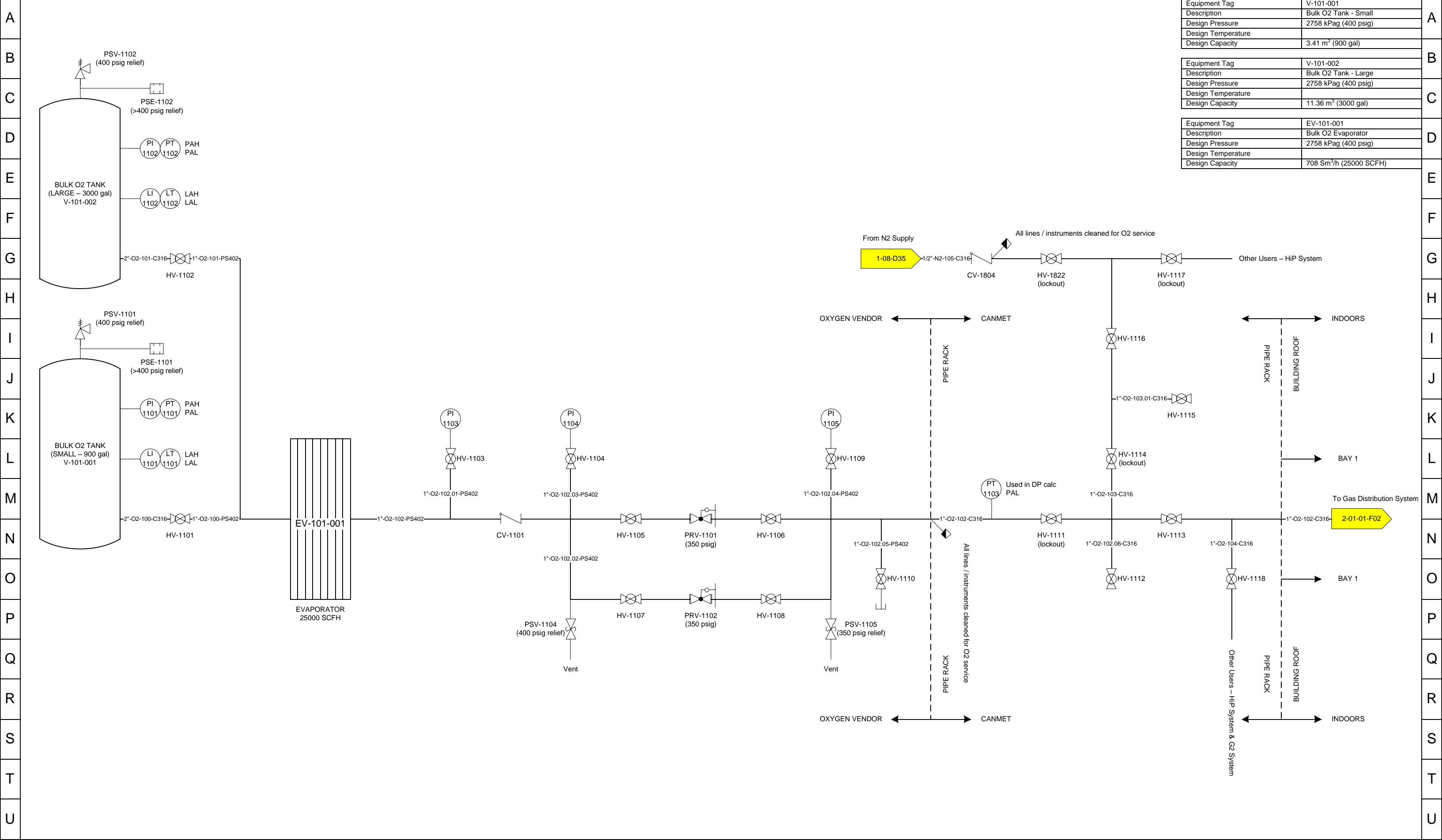
Designator (CCC)	Line Type	Material and Class
A106	Pipe	150#, 106 Carbon Steel, 0” Corrosion Allowance
B106		150#, 106 Carbon Steel, 0.125” Corrosion Allowance
B316		150#, 316/316L Stainless Steel, 0” Corrosion Allowance
C316		300#, 316/316L Stainless Steel, 0” Corrosion Allowance
D316		600#, 316/316L Stainless Steel, 0” Corrosion Allowance
R106	Tube	150#, Refractory Lines Pipe
PS101		150#, Carbon Steel
PS202		300#, 304L Stainless Steel
PS210		600#, 304L Stainless Steel
G316		316/316L Stainless Steel, 0.035” wall thickness
H316		316/316L Stainless Steel, 0.049” wall thickness
I316		316/316L Stainless Steel, 0.065” wall thickness
J316		316/316L Stainless Steel, thermal service
PS400		150# Copper Tubing, Category D
PS401		Copper Tubing
PS402	Copper Tubing, Type L	

4. Pipelines and Other Symbols



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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Engineering Standard – Plant Numbering System				
					APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					ISSUED:			PFBC – P-002114.001 – 0-05 – 1	PFBC – P-002114.001	0-05	1	0
					SCALE:	NONE						



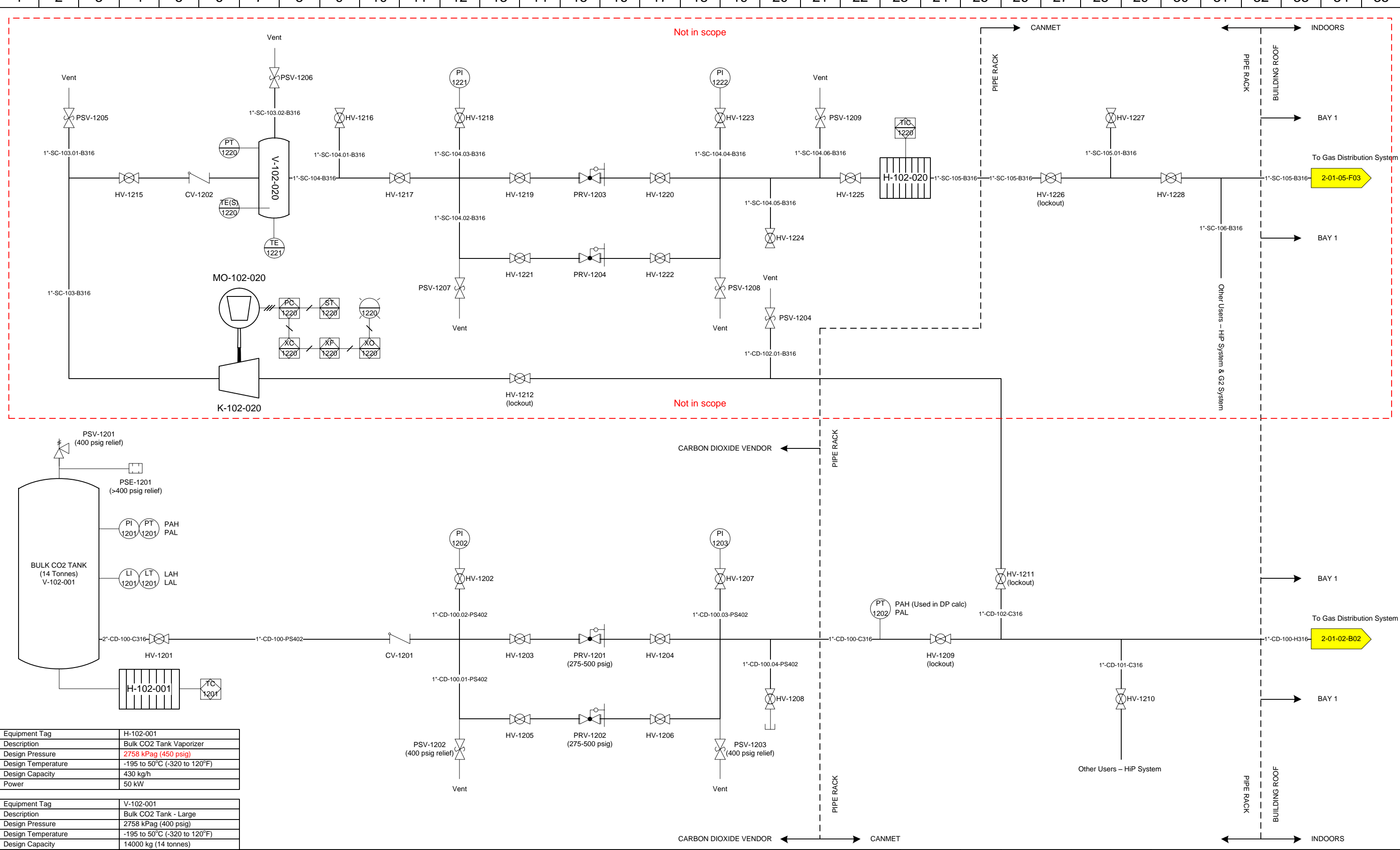
Equipment Tag	V-101-001
Description	Bulk O2 Tank - Small
Design Pressure	2758 kPag (400 psig)
Design Temperature	
Design Capacity	3.41 m ³ (900 gal)

Equipment Tag	V-101-002
Description	Bulk O2 Tank - Large
Design Pressure	2758 kPag (400 psig)
Design Temperature	
Design Capacity	11.36 m ³ (3000 gal)

Equipment Tag	EV-101-001
Description	Bulk O2 Evaporator
Design Pressure	2758 kPag (400 psig)
Design Temperature	
Design Capacity	708 Sm ³ /h (25000 SCFH)

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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	O ₂ Supply				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	NOV 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					SCALE:	NONE		PFBC - P-002114.001 - 1-01 - 1	PFBC - P-002114.001	1-01	1	2



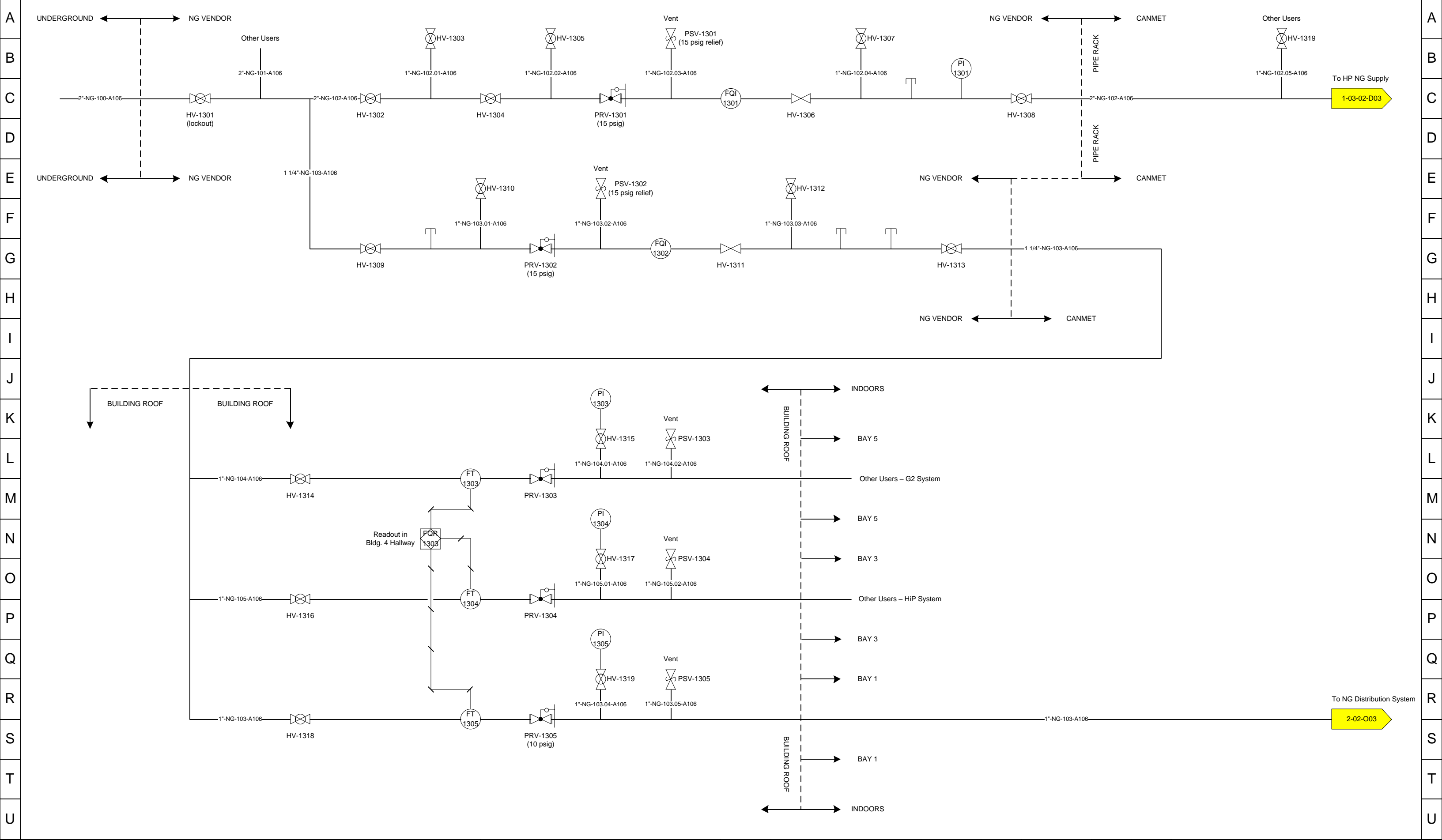
Equipment Tag	H-102-001
Description	Bulk CO2 Tank Vaporizer
Design Pressure	2758 kPag (450 psig)
Design Temperature	-195 to 50°C (-320 to 120°F)
Design Capacity	430 kg/h
Power	50 kW

Equipment Tag	V-102-001
Description	Bulk CO2 Tank - Large
Design Pressure	2758 kPag (400 psig)
Design Temperature	-195 to 50°C (-320 to 120°F)
Design Capacity	14000 kg (14 tonnes)

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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:		
	2	Update after initial P&ID review	NOV 2014	RS			
	3	Scope definition	JAN 15, 2015	RS	ISSUED:		
					SCALE:	NONE	

CO₂ Supply				
DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 1-02 - 1	PFBC - P-002114.001	1-02	1	3

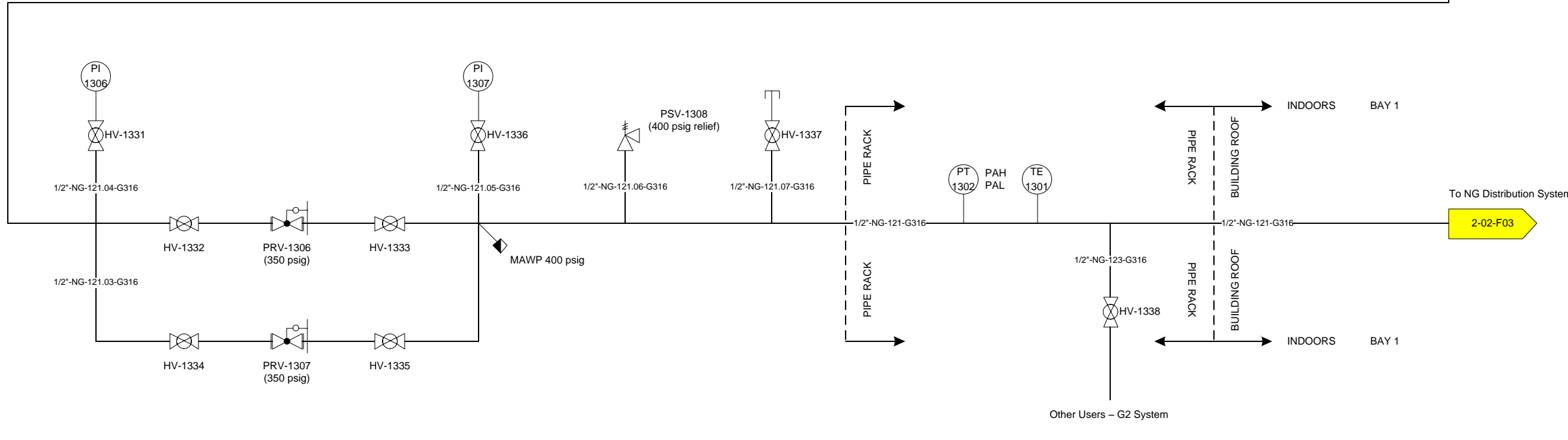
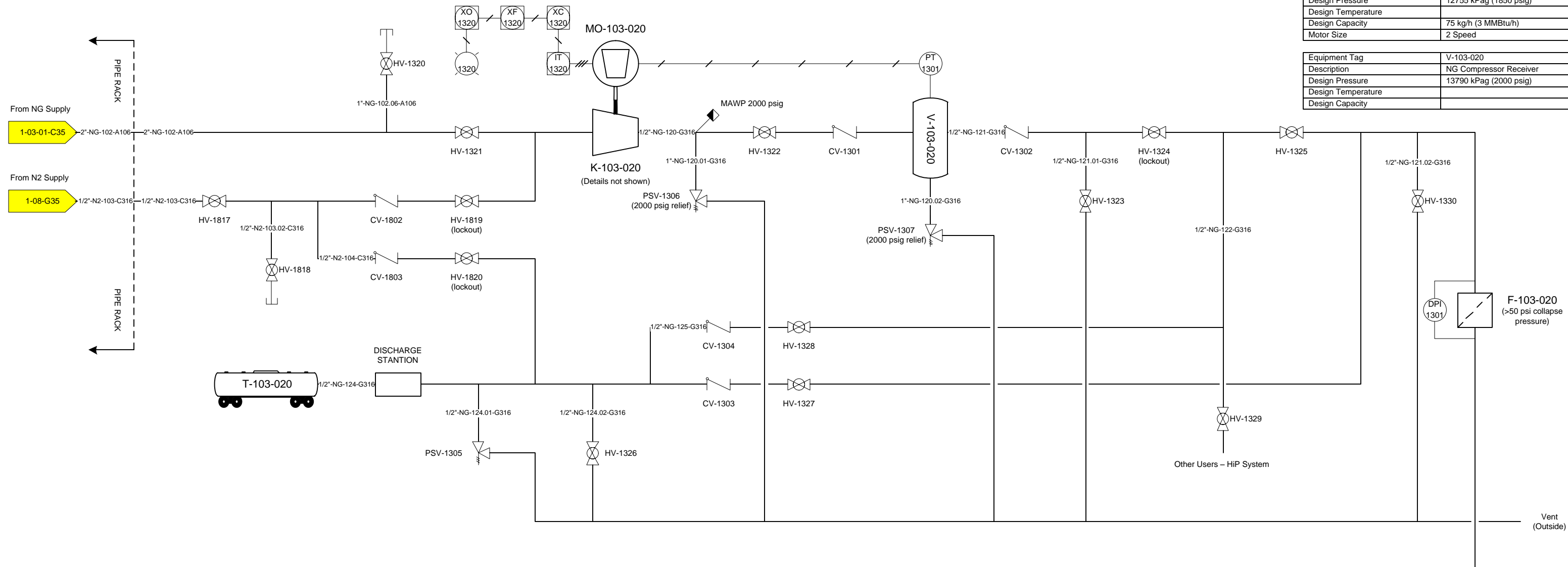


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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Natural Gas Supply – LP				
	1	Updated to reflect process changes	NOV 2014	RS								
	2	Update after initial P&ID review	NOV 2014	RS	APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					ISSUED:			PFBC – P-002114.001 – 1-03 – 1	PFBC – P-002114.001	1-03	1	2
					SCALE:	NONE						

Equipment Tag	K-103-020
Description	NG Compressor
Design Pressure	12755 kPag (1850 psig)
Design Temperature	
Design Capacity	75 kg/h (3 MMBtu/h)
Motor Size	2 Speed

Equipment Tag	V-103-020
Description	NG Compressor Receiver
Design Pressure	13790 kPag (2000 psig)
Design Temperature	
Design Capacity	

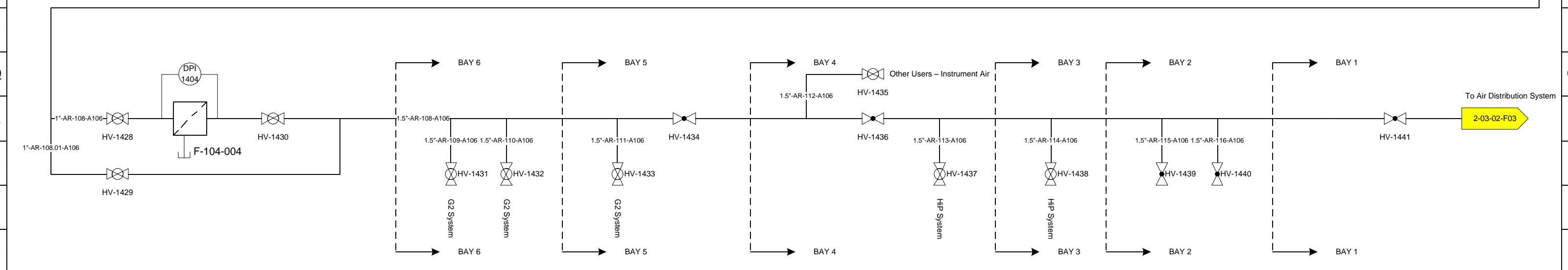
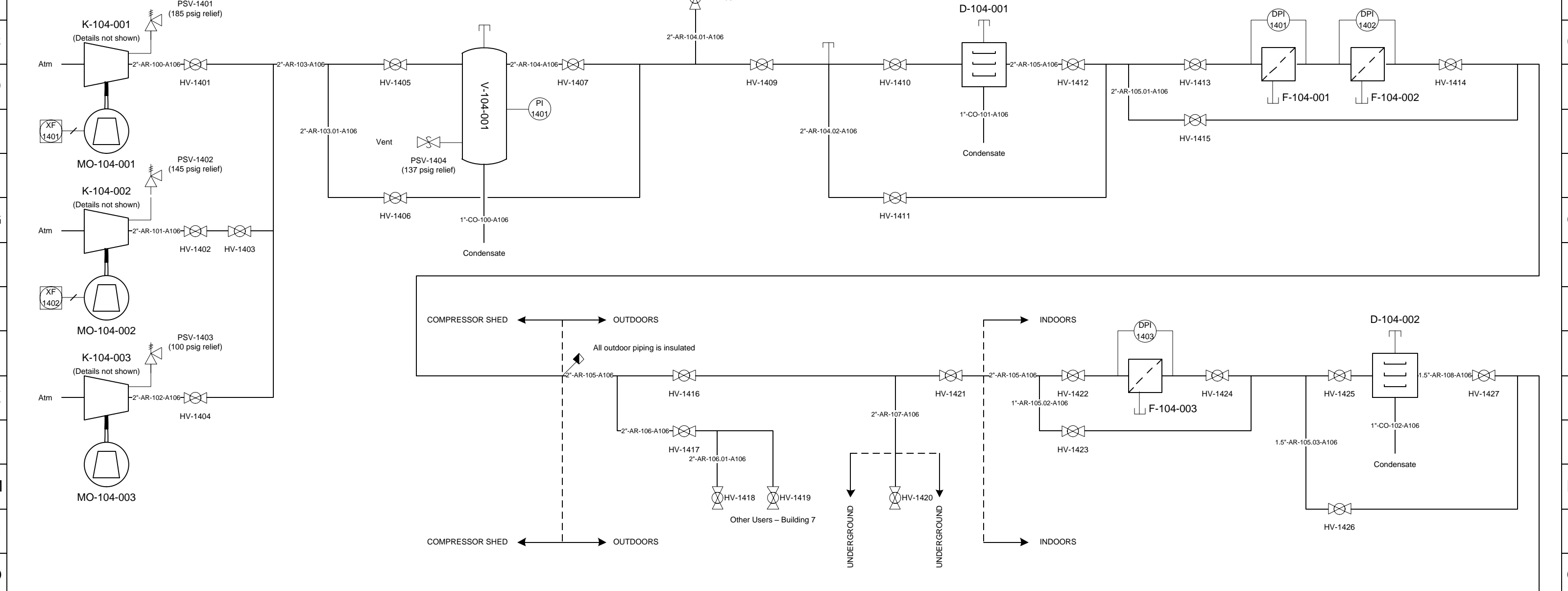


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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Natural Gas Supply – HP				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	NOV 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					SCALE:	NONE		PFBC – P-002114.001 – 1-03 – 2	PFBC – P-002114.001	1-03	2	2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35						
Equipment Tag			K-104-001 (Atlas Copco)			K-104-002 (Kaeser)			K-104-003 (Diesel)																				Equipment Tag			V-104-001			D-104-001			D-104-002		
Description			LP Air Compressor 1			LP Air Compressor 2			LP Air Compressor 3																				Description			LP Air Receiver			LP Air Dryer 1			LP Air Dryer 2		
Operating / Design Pressure			860 kPag (125 psig) / (185 psig)			860 kPag (125 psig) / (145 psig)			690 kPag (100 psig)																				Design Pressure			945 kPag (137 psig)			1000 kPag (145 psig)			1380 kPag (200 psig)		
Design Temperature																													Design Temperature			343°C (650°F)			66°C (150°F)					
Design Capacity			191 SCFM			141 SCFM			185 SCFM																				Design Capacity									100 SCFM		
Motor Size			40 HP, variable speed, electric			30 HP, variable speed, electric			?? HP, fixed speed, diesel																				Power											

Equipment Tag			V-104-001			D-104-001			D-104-002		
Description			LP Air Receiver			LP Air Dryer 1			LP Air Dryer 2		
Design Pressure			945 kPag (137 psig)			1000 kPag (145 psig)			1380 kPag (200 psig)		
Design Temperature			343°C (650°F)			66°C (150°F)					
Design Capacity									100 SCFM		
Power											

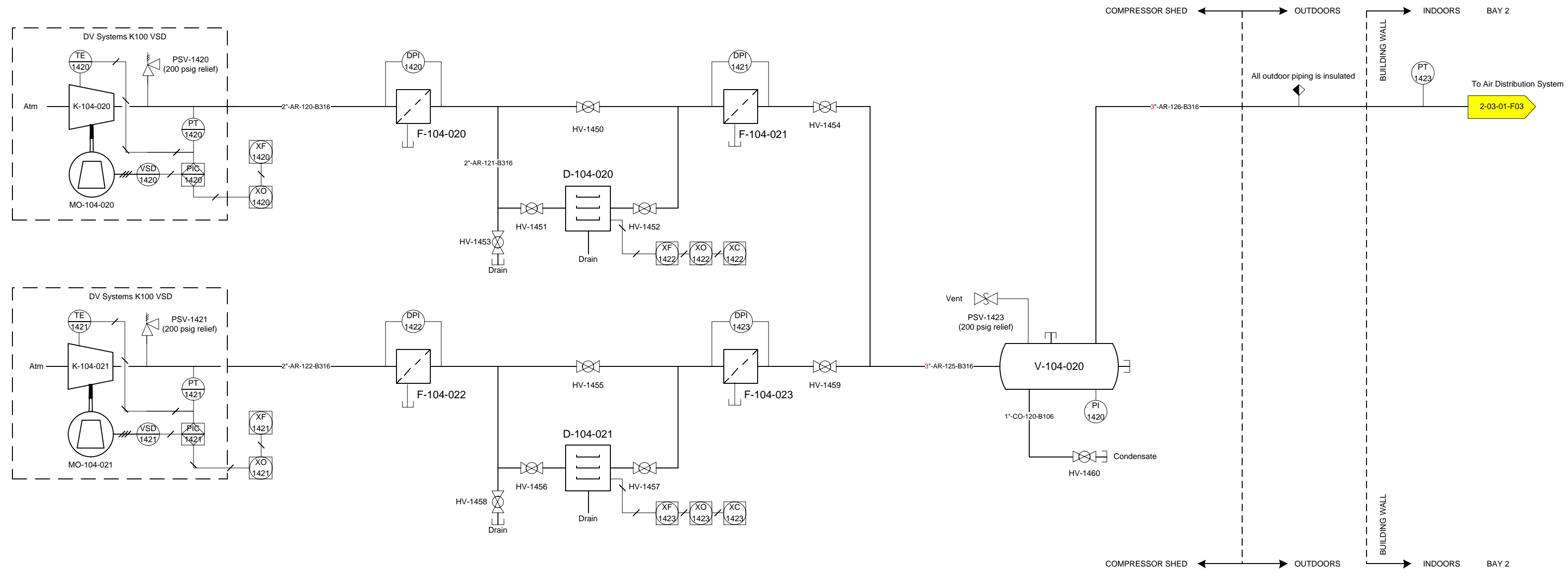


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Notes:		REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Main Air Supply – LP				
		1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
		2	Update after initial P&ID review	NOV 2014	RS								
		3	Update to pre-filters and line sizing	JAN 15, 2015	RS								
						ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
						SCALE:		NONE	PFBC – P-002114.001 – 1-04 – 1	PFBC – P-002114.001	1-04	1	3

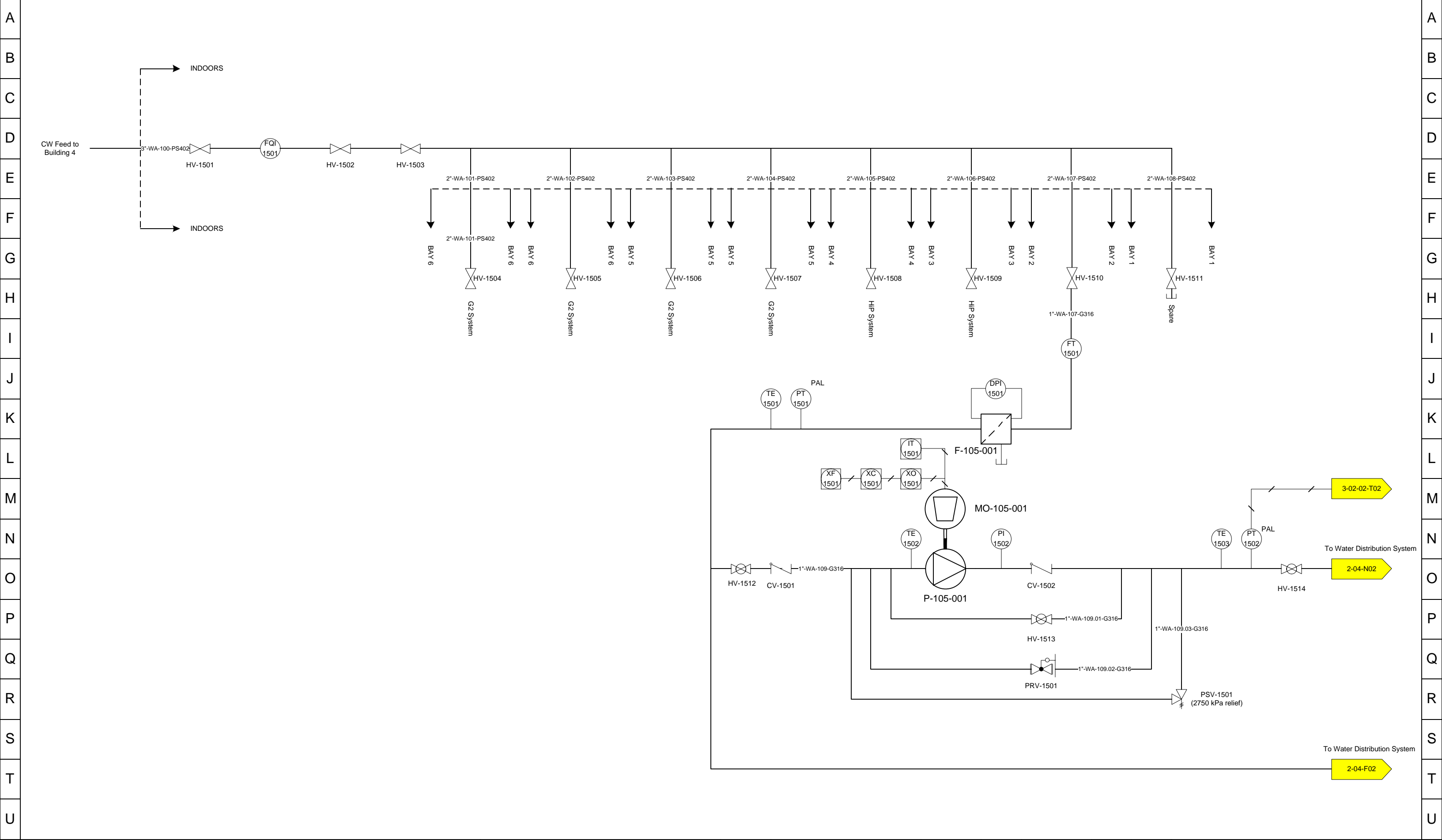
1	2	3	4	5	6	7	8	9
Equipment Tag			K-104-020			K-104-021		
Description			HP Air Compressor 1			HP Air Compressor 2		
Design Pressure			1210 kPag (175 psig)			1210 kPag (175 psig)		
Design Temperature			60°C (140°F)			60°C (140°F)		
Design Capacity			792 kg/h (388 SCFM)			792 kg/h (388 SCFM)		
Motor Size			100 HP, variable speed, electric			100 HP, variable speed, electric		

24	25	26	27	28	29	30	31	32	33	34	35
Equipment Tag			V-104-020			D-104-020			D-104-021		
Description			HP Air Receiver			HP Air Dryer 1			HP Air Dryer 2		
Design Pressure			1379 kPag (200 psig)			1210 kPag (175 psig)			1210 kPag (175 psig)		
Design Temperature			204°C (400°F)			60°C (140°F)			60°C (140°F)		
Design Capacity			4 m³ (1060 USG)			810 kg/h (400 SCFM)			810 kg/h (400 SCFM)		
Power			N/A								



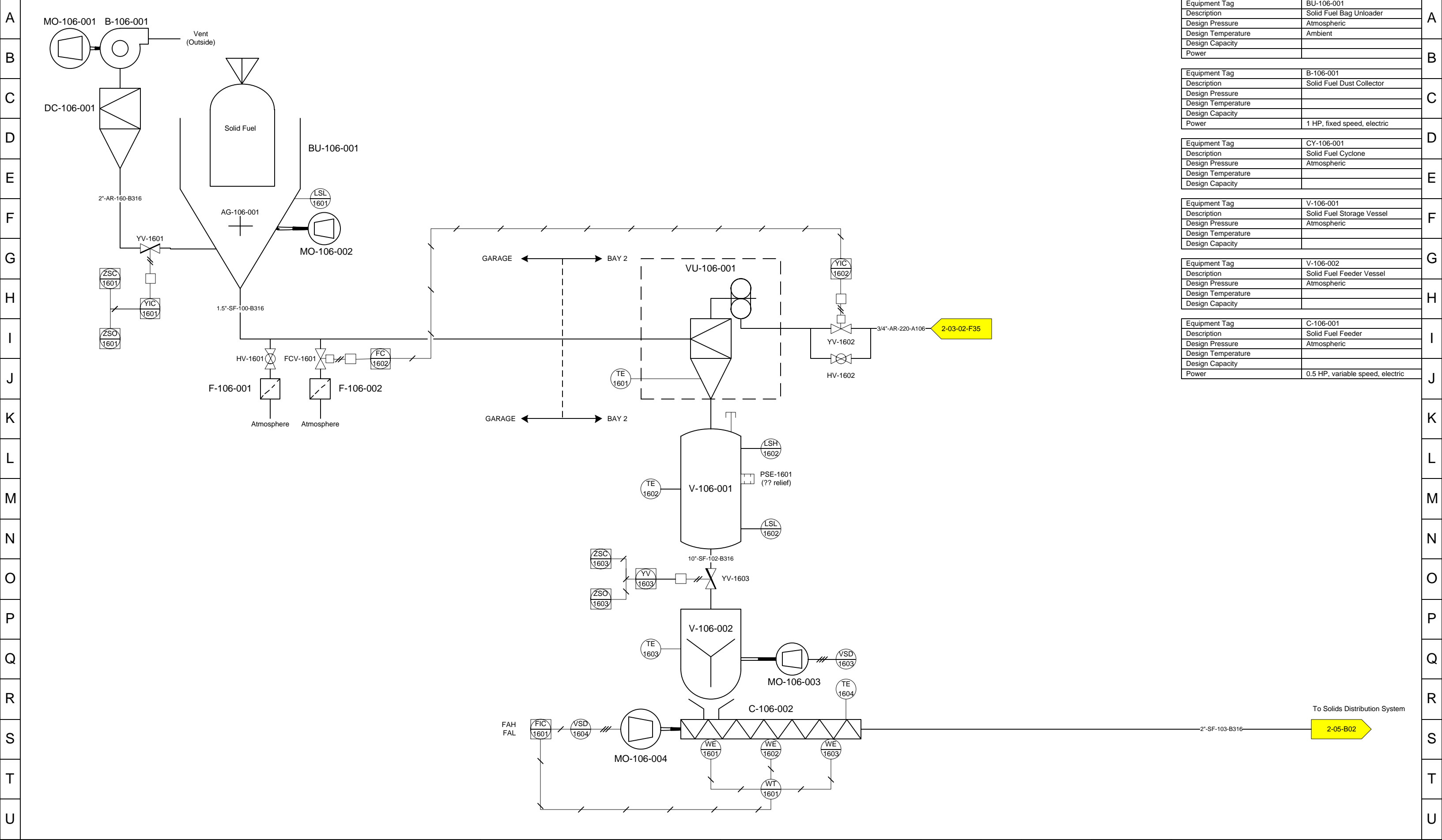
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Notes:		REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Main Air Supply – HP					
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		2	Update after initial P&ID review	NOV 2014	RS				ISSUED:	DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
		3	Update after compressor contract award	OCT 2015	SC				SCALE:	PFBC – P-002114.001 – 1-04 – 2	PFBC – P-002114.001	1-04	2	3



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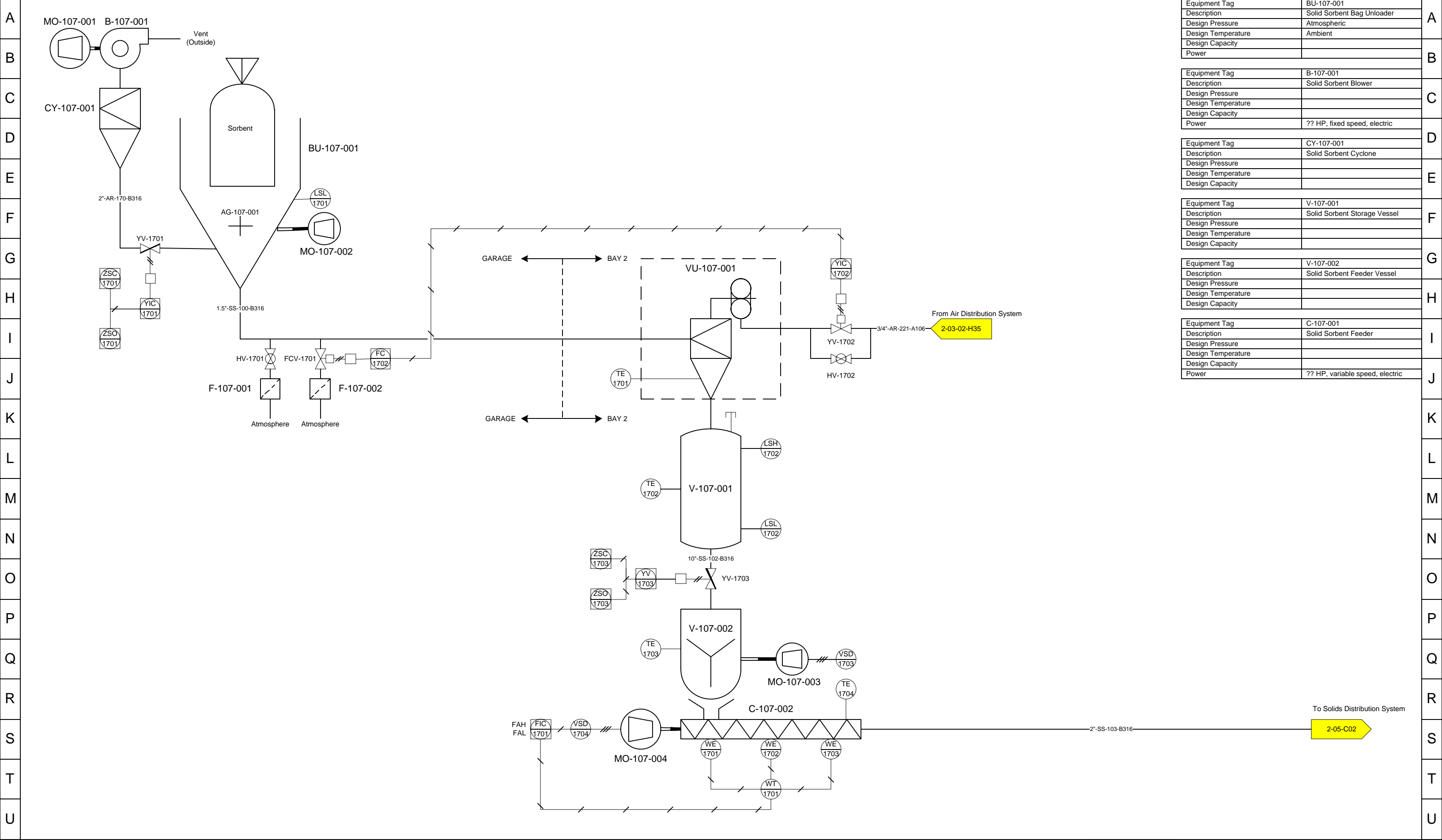
REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Main Water Supply				
1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
2	Update after initial P&ID review	NOV 2014	RS	ISSUED:			PFBC - P-002114.001 - 1-05 - 1	PFBC - P-002114.001	1-05	1	3
3	Added water pump	AUG 2015	SC	SCALE:			NONE				



Equipment Tag	BU-106-001
Description	Solid Fuel Bag Unloader
Design Pressure	Atmospheric
Design Temperature	Ambient
Design Capacity	
Power	
Equipment Tag	B-106-001
Description	Solid Fuel Dust Collector
Design Pressure	
Design Temperature	
Design Capacity	
Power	1 HP, fixed speed, electric
Equipment Tag	CY-106-001
Description	Solid Fuel Cyclone
Design Pressure	Atmospheric
Design Temperature	
Design Capacity	
Equipment Tag	V-106-001
Description	Solid Fuel Storage Vessel
Design Pressure	Atmospheric
Design Temperature	
Design Capacity	
Equipment Tag	V-106-002
Description	Solid Fuel Feeder Vessel
Design Pressure	Atmospheric
Design Temperature	
Design Capacity	
Equipment Tag	C-106-001
Description	Solid Fuel Feeder
Design Pressure	Atmospheric
Design Temperature	
Design Capacity	
Power	0.5 HP, variable speed, electric

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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Solid Fuel Supply				
	1	Updated to reflect process changes	NOV 2014	RS								
	2	Update after initial P&ID review	NOV 2014	RS	APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Removed blower, pos. pressure to be used	AUG 2015	SC				PFBC - P-002114.001 - 1-06 - 1	PFBC - P-002114.001	1-06	1	4
4	Updated with PROMAT drawing DAP-7600	NOV 2015	SC	ISSUED:			SCALE:	NONE				

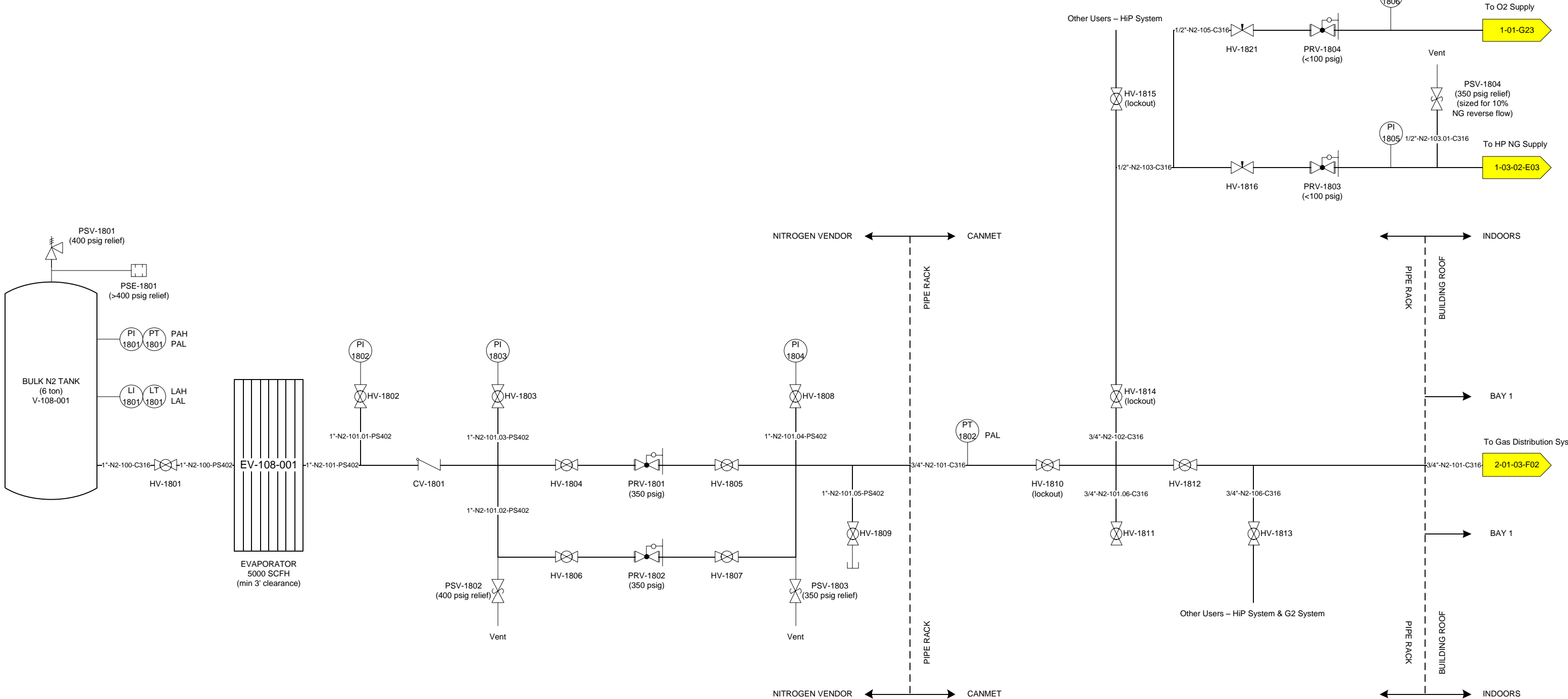


Equipment Tag	BU-107-001
Description	Solid Sorbent Bag Unloader
Design Pressure	Atmospheric
Design Temperature	Ambient
Design Capacity	
Power	
Equipment Tag	B-107-001
Description	Solid Sorbent Blower
Design Pressure	
Design Temperature	
Design Capacity	
Power	?? HP, fixed speed, electric
Equipment Tag	CY-107-001
Description	Solid Sorbent Cyclone
Design Pressure	
Design Temperature	
Design Capacity	
Equipment Tag	V-107-001
Description	Solid Sorbent Storage Vessel
Design Pressure	
Design Temperature	
Design Capacity	
Equipment Tag	V-107-002
Description	Solid Sorbent Feeder Vessel
Design Pressure	
Design Temperature	
Design Capacity	
Equipment Tag	C-107-001
Description	Solid Sorbent Feeder
Design Pressure	
Design Temperature	
Design Capacity	
Power	?? HP, variable speed, electric

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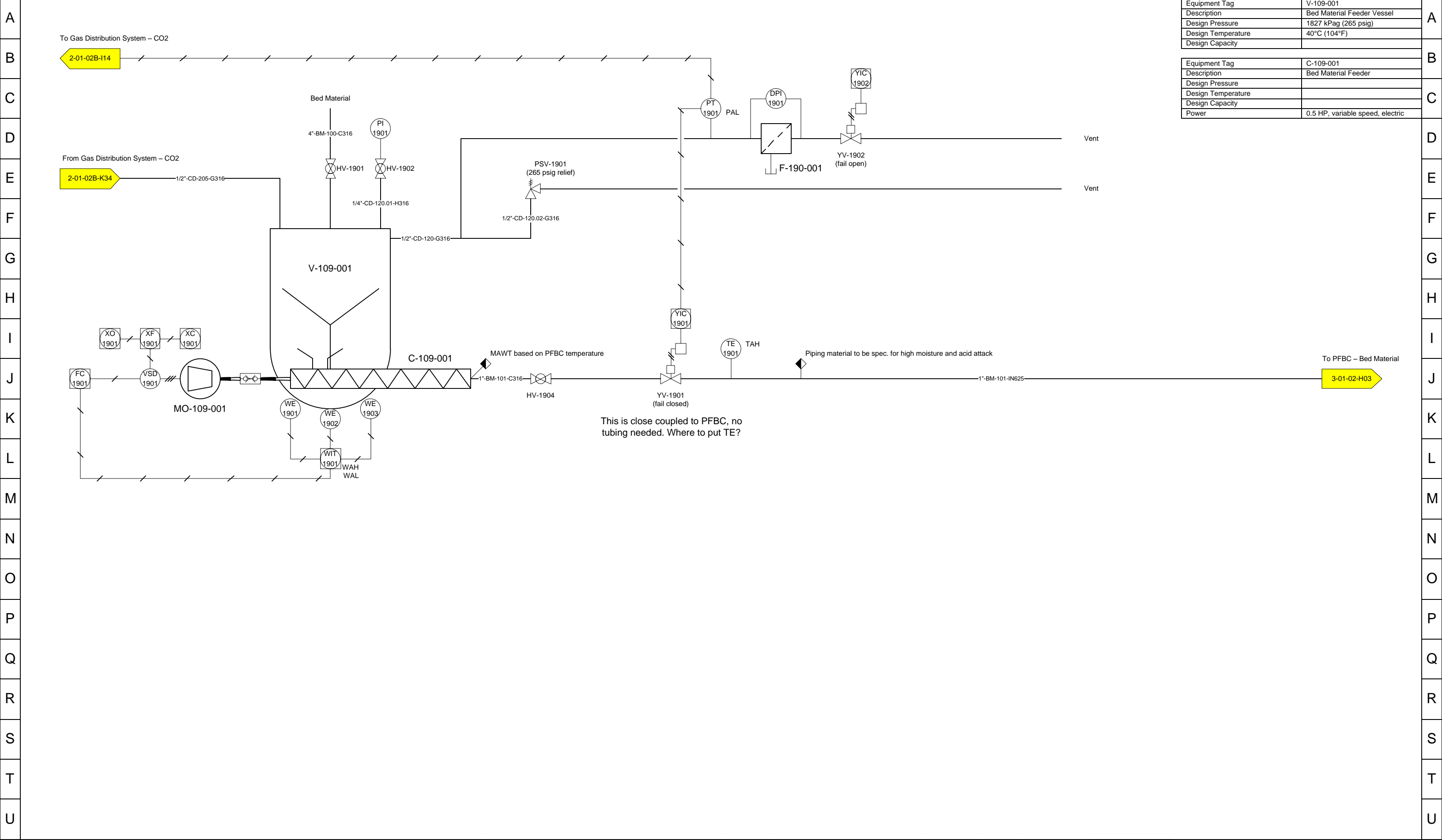
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	2	Update after initial P&ID review	NOV 2014	RS	APPROVED BY:		DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Removed blower, pos. pressure to be used	AUG 2015	SC							
4	Updated with PROMAT drawing DAP-7600	NOV 2015	SC	ISSUED:		PFBC - P-002114.001 - 1-07 - 1	PFBC - P-002114.001	1-07	1	4	
					SCALE:	NONE					

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A	Equipment Tag			V-108-001																																		
	Description			Bulk N2 Tank																																		
	Design Pressure			2758 kPag (400 psig)																																		
	Design Temperature																																					
	Design Capacity			6000 kg (6 tonnes)																																		
B	Equipment Tag			EV-108-001																																		
	Description			Bulk N2 Evaporator																																		
	Design Pressure			2758 kPag (400 psig)																																		
	Design Temperature																																					
	Design Capacity			142 Sm ³ /h (5000 SCFH)																																		



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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	N ₂ Supply				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	NOV 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
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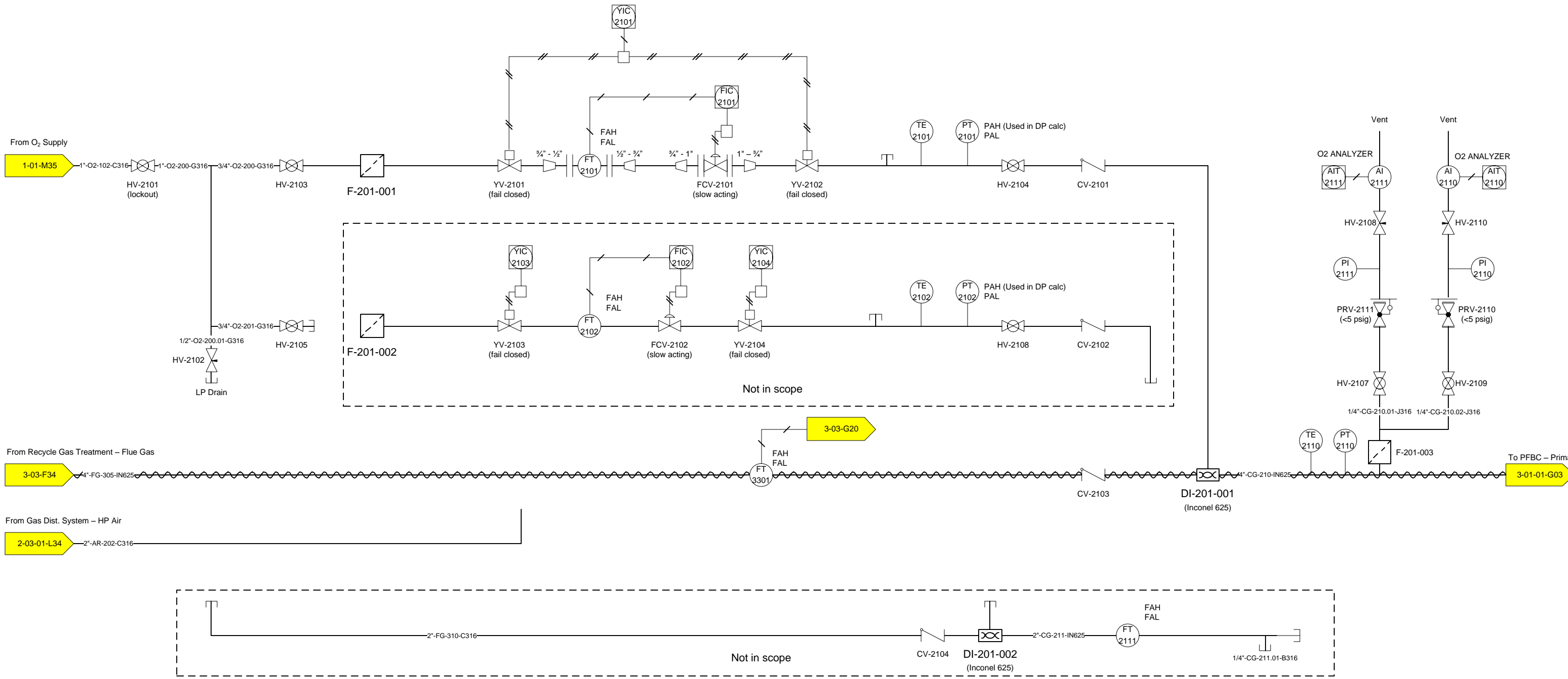


Equipment Tag	V-109-001
Description	Bed Material Feeder Vessel
Design Pressure	1827 kPag (265 psig)
Design Temperature	40°C (104°F)
Design Capacity	

Equipment Tag	C-109-001
Description	Bed Material Feeder
Design Pressure	
Design Temperature	
Design Capacity	
Power	0.5 HP, variable speed, electric

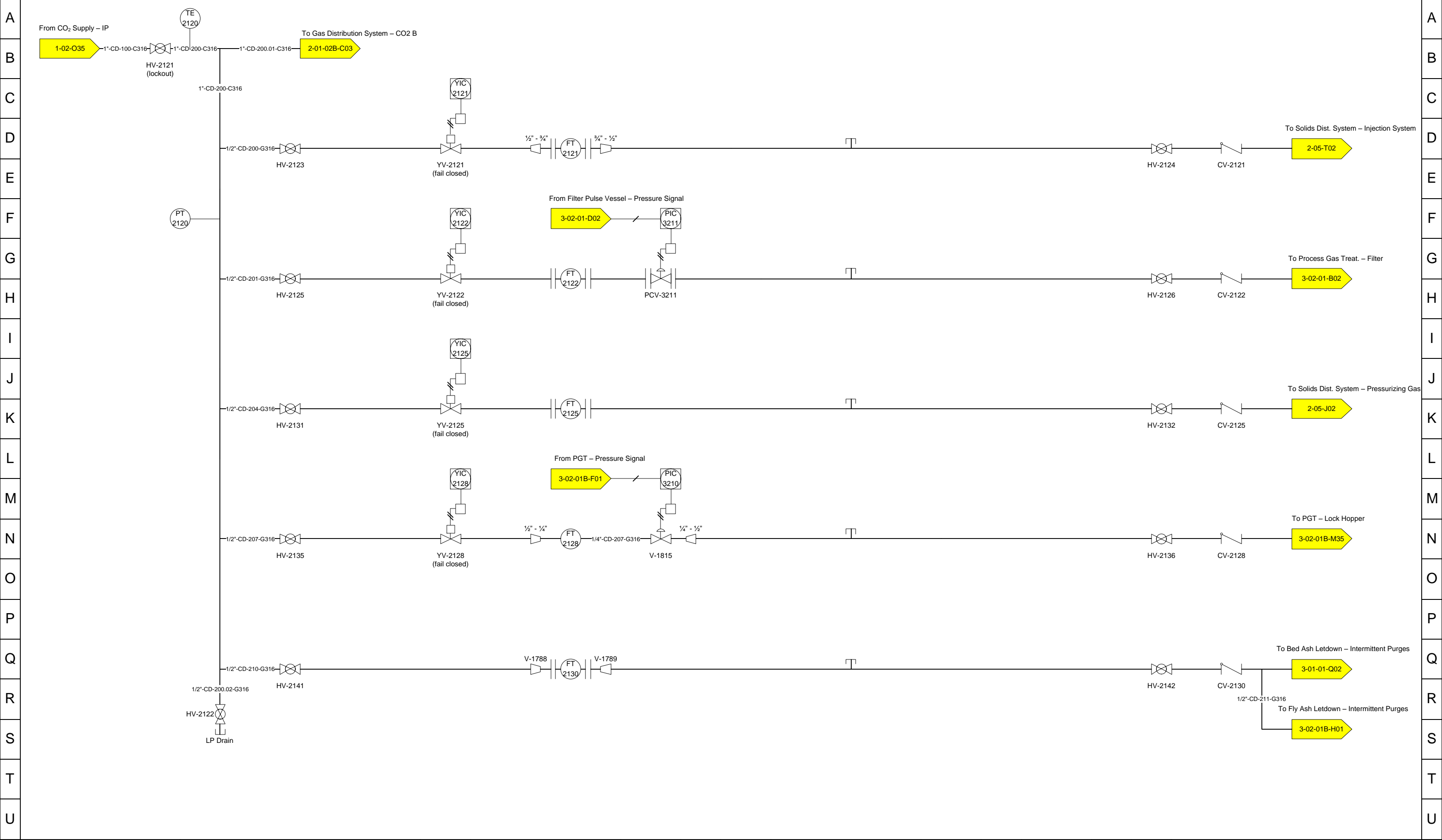
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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Bed Material Supply				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	NOV 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
3	Removed water-type mech. Seal	AUG 2015	SC	SCALE:	NONE		PFBC - P-002114.001 - 1-09 - 1	PFBC - P-002114.001	1-09	1	3	



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REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R.	Dec.	Gas Distribution System – O ₂				
1	Updated to reflect process changes	NOV 2014	RS	Symonds	2014	DRAWING NO: PFBC - P-002114.001 - 2-01 - 1 JOB NO: PFBC - P-002114.001 BLOCK NO: 2-01 SHEET NO: 1 REV NO: 5					
2	Update after initial P&ID review	DEC 2014	RS								
3	Update to O ₂ sampling train	JAN 16, 2015	RS								
4	Mech. Install Tender Review	OCT 2015	SC								
5	Detailed FT/Valve connection sizes	MAY 2016	SC								
Notes:				APPROVED BY:	ISSUED:	SCALE:	NONE				

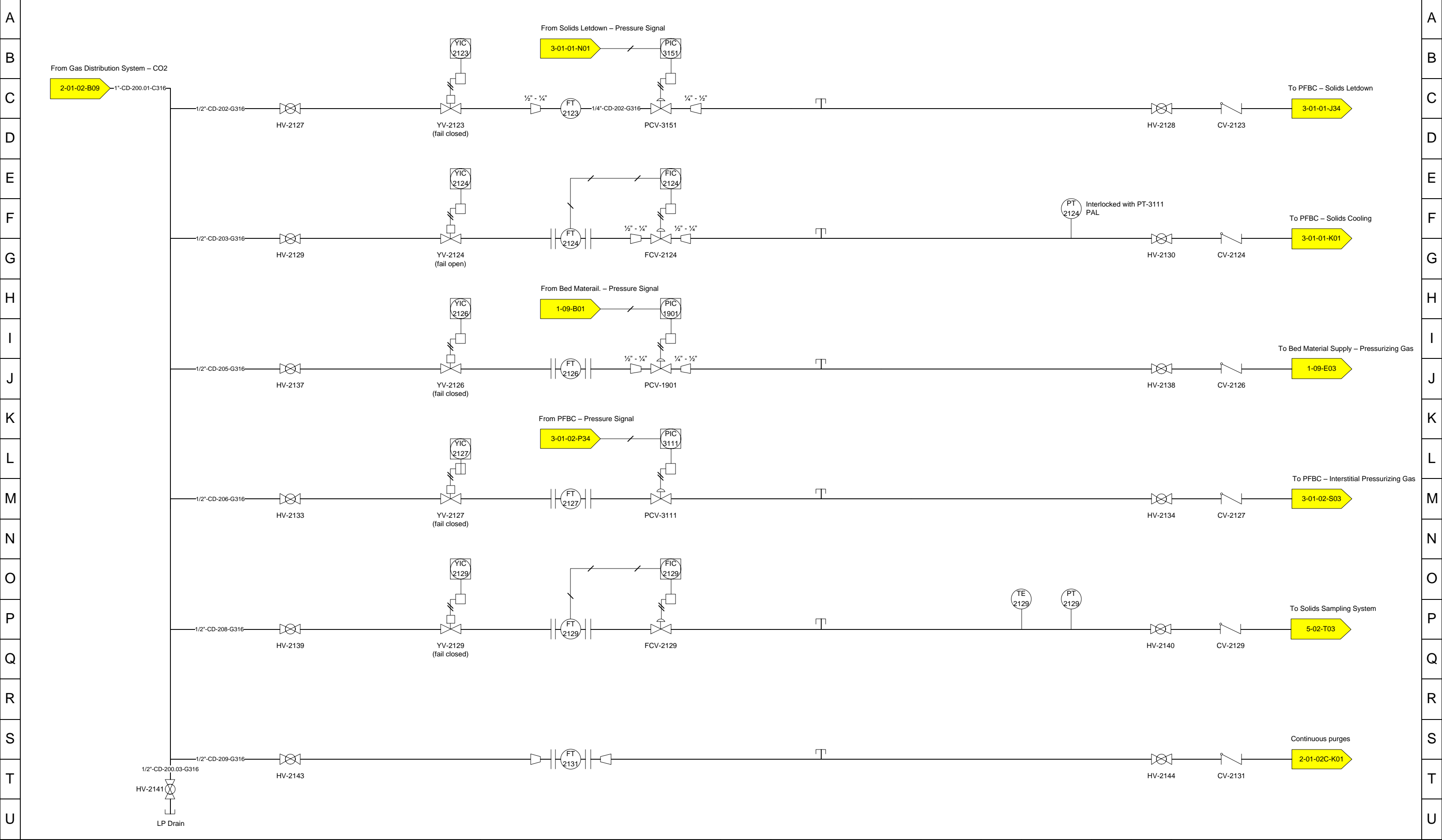


Notes:

REV.	DESCRIPTION	DATE	BY	REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS	7	Detailed FT/Valve connection sizes	MAY 2016	SC
2	Update after initial P&ID review	NOV 2014	RS				
3	Update to flow trains	JAN 16, 2015	RS				
4	Reduction of non-critical IO	AUG 2015	SC				
5	Separation of controls by plant location	OCT 2015	SC				
6	Addition of intermittent purge line	FEB 2016	SC				

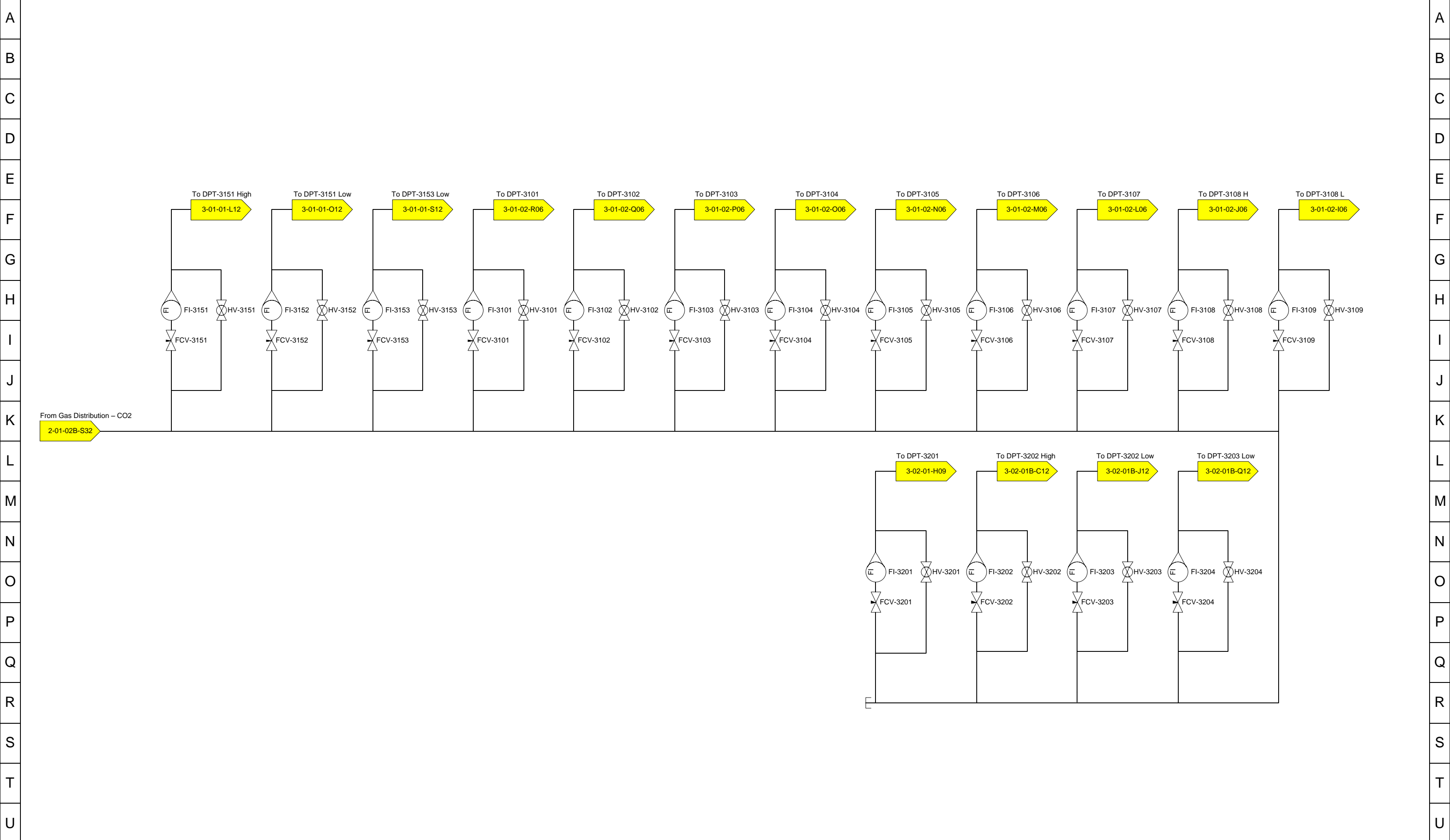
DRAWN BY:	R. Symonds	Nov. 2014	Gas Distribution System - CO₂				
APPROVED BY:							
ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
SCALE:	NONE		PFBC - P-002114.001 - 2-01 - 2	PFBC - P-002114.001	2-01	2	7

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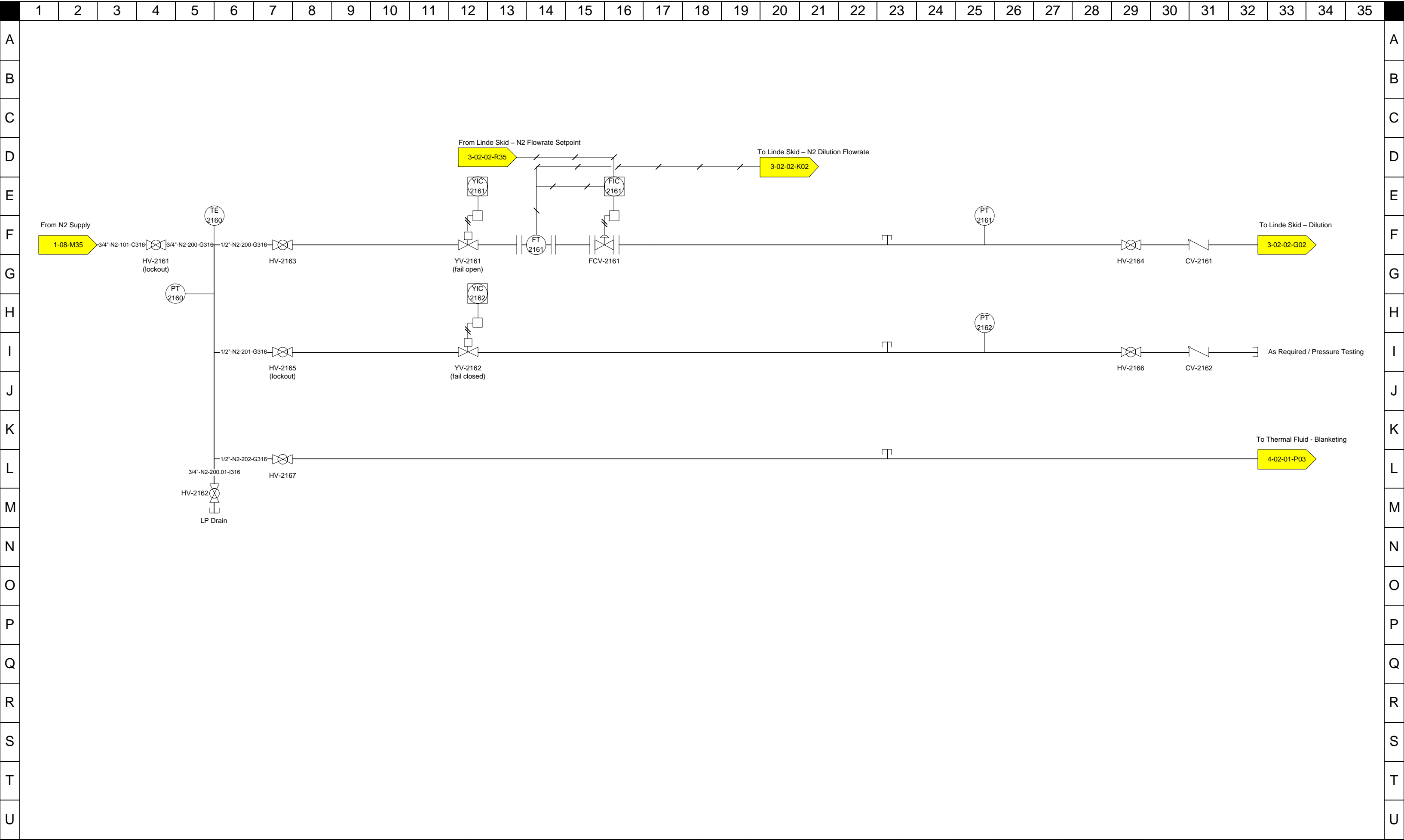
CONFIDENTIAL

Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Nov. 2014	Gas Distribution System – CO ₂				
	1	Reduction of non-critical IO	AUG 2015	SC	APPROVED BY:							
	2	Separation of controls by plant location	OCT 2015	SC	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Added supply for continuous purges	FEB 2016	SC	SCALE:		NONE	PFBC - P-002114.001 - 2-01 - 2B	PFBC - P-002114.001	2-01	2B	4
4	Detailed FT/Valve connection sizes	MAY 2016	SC									



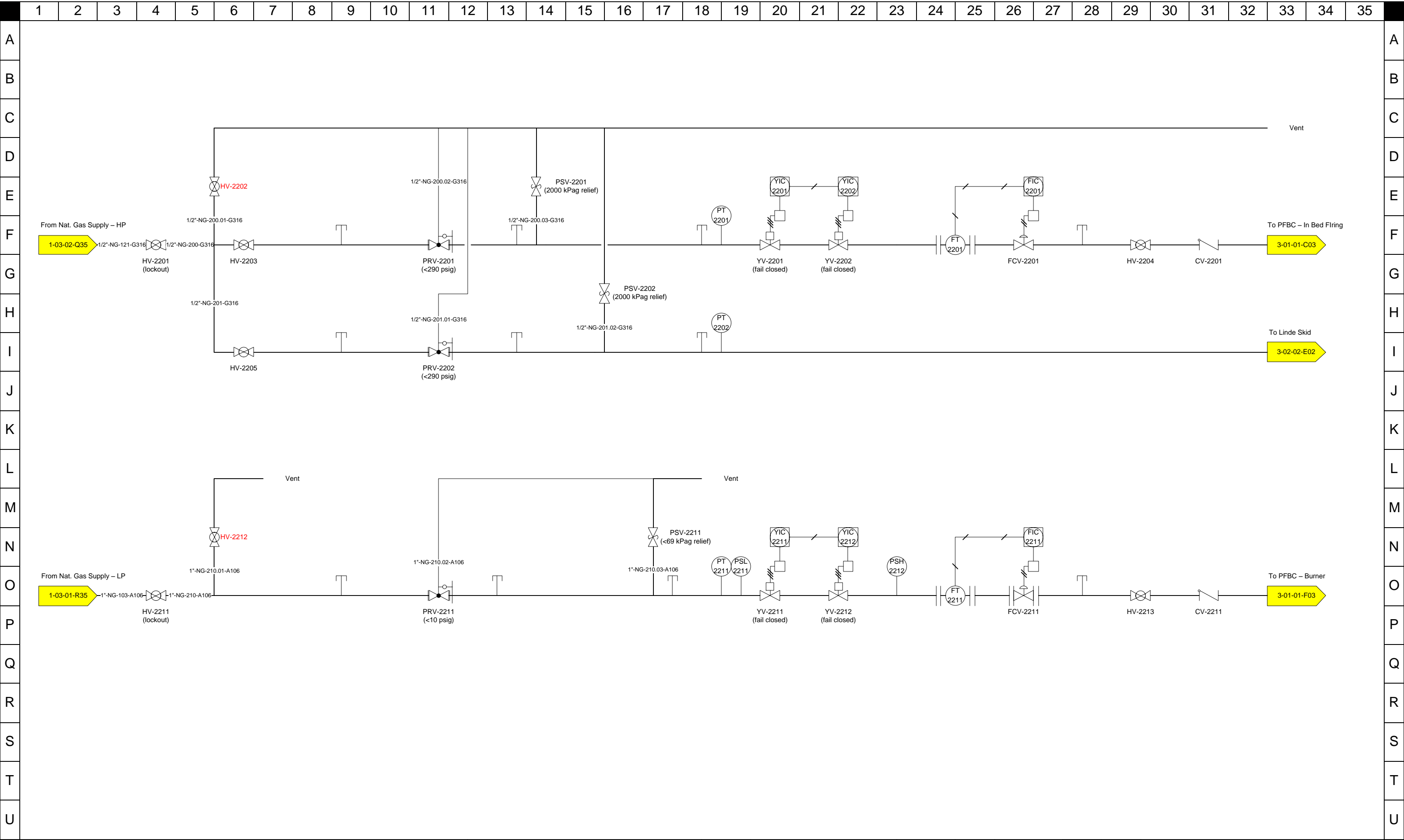
CONFIDENTIAL

Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	S.	Feb.	Gas Distribution – CO ₂ Purges					
	1	Purges based on design from GTI	FEB 2016	SC		Champagne	2016						
					APPROVED BY:								
					ISSUED:				DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					SCALE:	NONE			PFBC - P-002114.001 - 2-01-02C	PFBC - P-002114.001	2-01	2C	1



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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Gas Distribution System – N ₂				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	DEC 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Removed unnecessary instrumentation	AUG 2015	SC	SCALE:		NONE	PFBC – P-002114.001 – 2-01 – 3	PFBC – P-002114.001	2-01	3	4
4	Added line for TF tank blanketing	FEB 2016	SC									

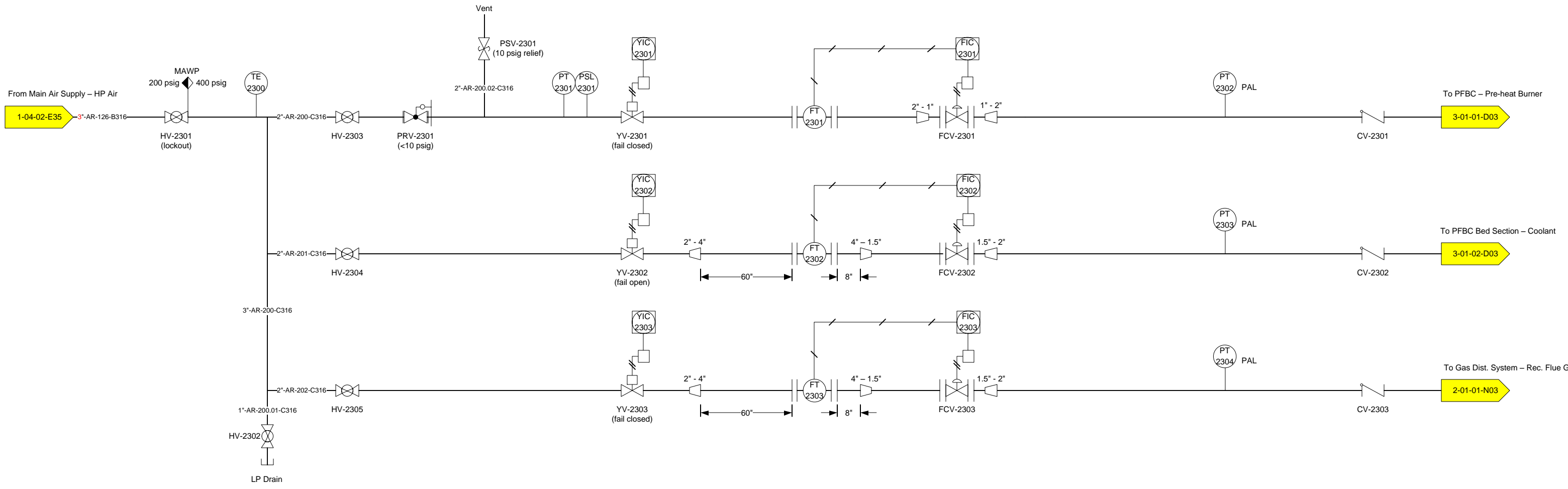


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REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS
2	Update after initial P&ID review	DEC 2014	RS
3	Removed carbon bed	JAN 16, 2015	RS
4	See note 1.	MAY 2016	SC
5	Added line reduction/expansion	MAY 2016	SC

Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014
1. Removed filters on NG line, PSL-2201, PSH-2202	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:		
	2	Update after initial P&ID review	DEC 2014	RS	ISSUED:		
	3	Removed carbon bed	JAN 16, 2015	RS	SCALE:	NONE	
	4	See note 1.	MAY 2016	SC			
	5	Added line reduction/expansion	MAY 2016	SC			

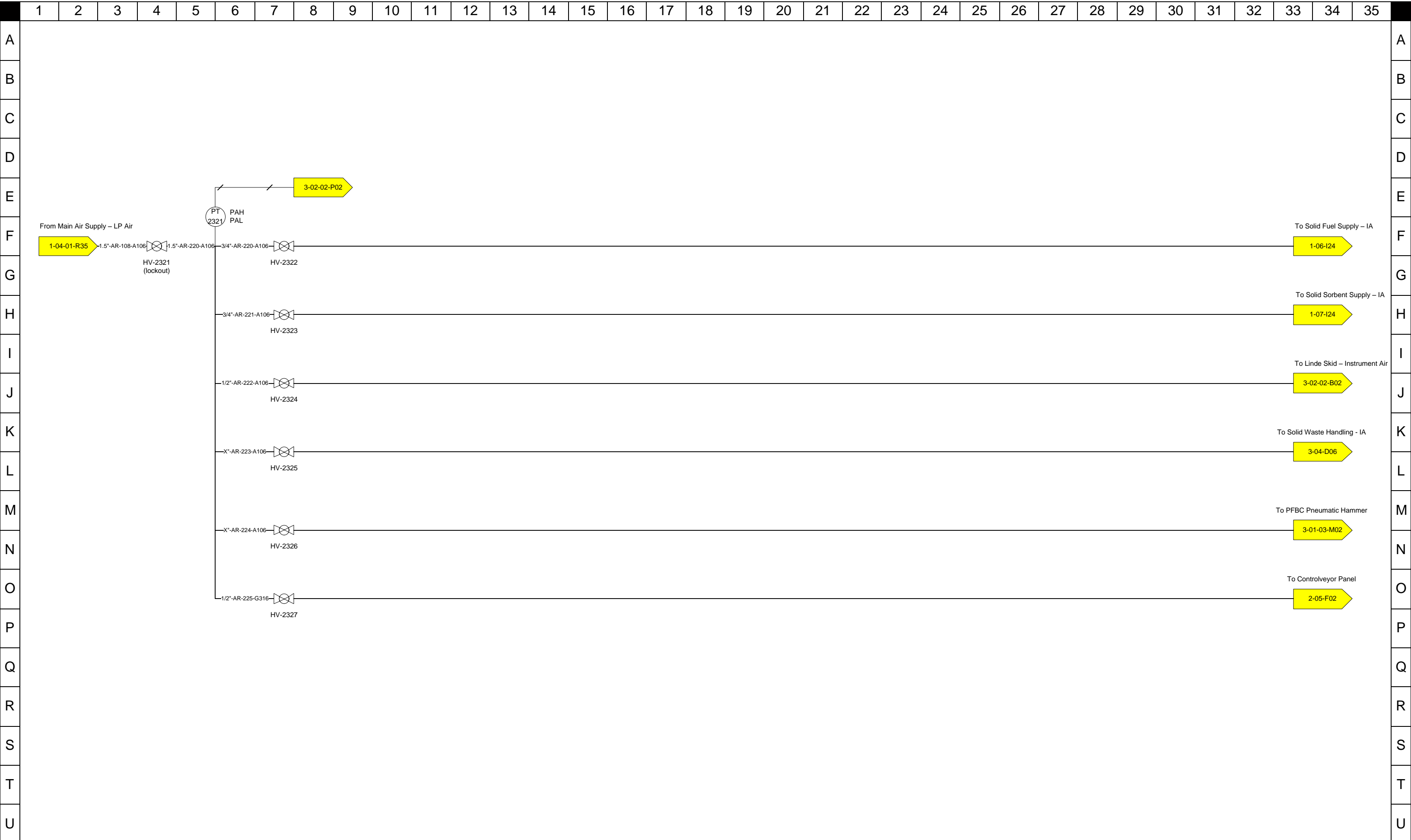
Natural Gas Distribution System				
DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 2-02 - 1	PFBC - P-002114.001	2-02	1	5



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REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Air Distribution – HP				
1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
2	Update after initial P&ID review	DEC 2014	RS				PFBC - P-002114.001 - 2-03 - 1	PFBC - P-002114.001	2-03	1	6
3	Added HP air pre-heater	FEB 2015	RS				ISSUED:	SCALE:	NONE		
4	Removed redundant instrumentation	AUG 2015	SC								
5	Removed redundant hand valves	FEB 2016	SC								
6	Added line reduction/expansion	MAY 2016	SC								

Notes:



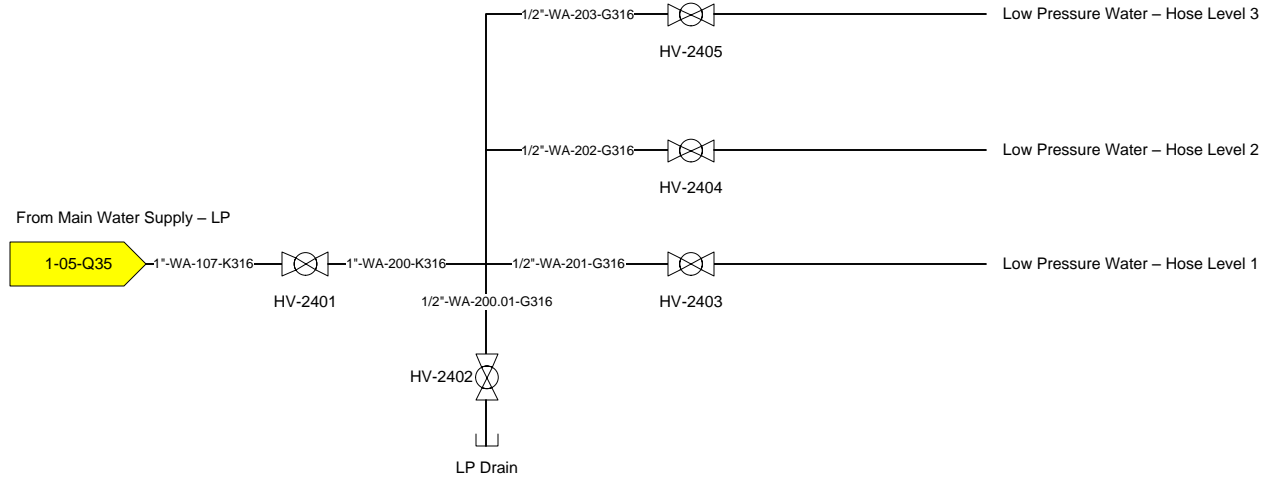
CONFIDENTIAL

Notes:

REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS
2	Update after initial P&ID review	DEC 2014	RS
3	Added feed for pneumatic hammers	AUG 2015	SC
4	Added feed for Controlveyor panel	FEB 2016	SC

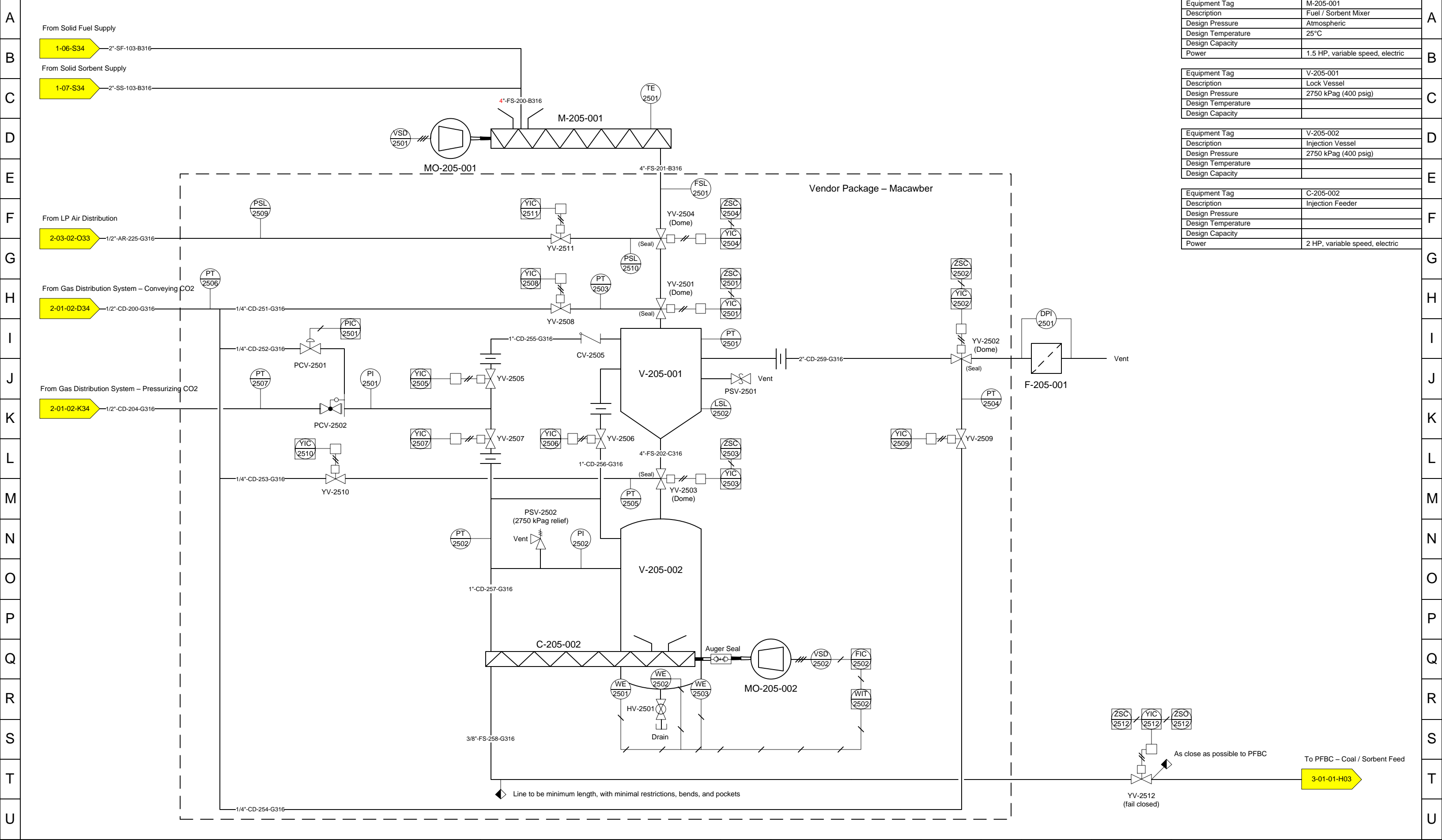
DRAWN BY:	R. Symonds	Dec. 2014
APPROVED BY:		
ISSUED:		
SCALE:	NONE	

Air Distribution – LP and Instrument				
DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 2-03 - 2	PFBC - P-002114.001	2-03	2	4



CONFIDENTIAL

Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Water Distribution System				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	DEC 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Added Linde process and cooling	JAN 19, 2015	RS	SCALE:		NONE	PFBC - P-002114.001 - 2-04 - 1	PFBC - P-002114.001	2-04	1	4
4	Update to add HP water	AUG 2015	SC									



Equipment Tag	M-205-001
Description	Fuel / Sorbent Mixer
Design Pressure	Atmospheric
Design Temperature	25°C
Design Capacity	
Power	1.5 HP, variable speed, electric

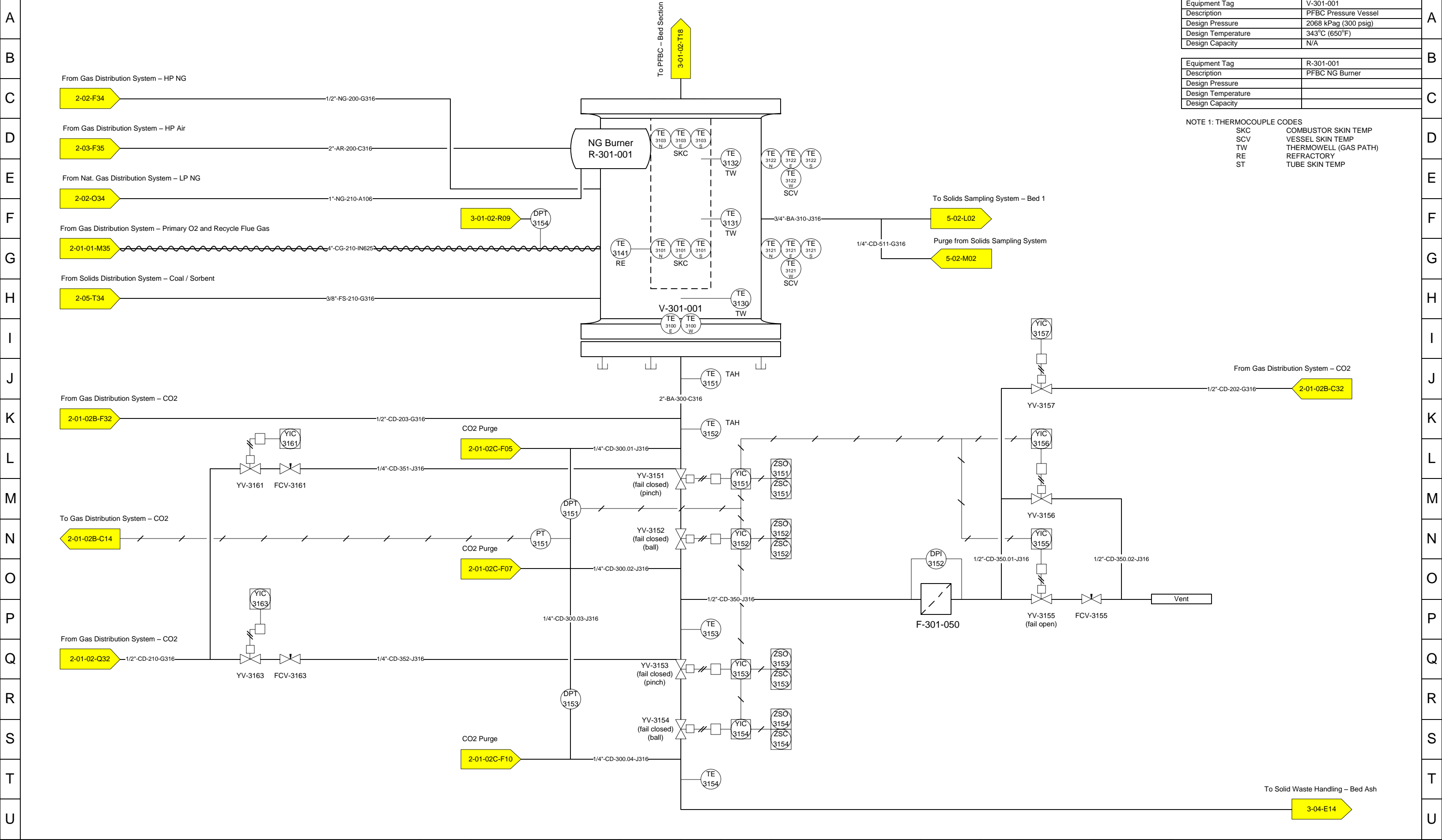
Equipment Tag	V-205-001
Description	Lock Vessel
Design Pressure	2750 kPag (400 psig)
Design Temperature	
Design Capacity	

Equipment Tag	V-205-002
Description	Injection Vessel
Design Pressure	2750 kPag (400 psig)
Design Temperature	
Design Capacity	

Equipment Tag	C-205-002
Description	Injection Feeder
Design Pressure	
Design Temperature	
Design Capacity	
Power	2 HP, variable speed, electric

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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Solids Distribution System			
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:						
	2	Update after initial P&ID review	DEC 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO
3	Update with fab. Drawings from Macawber	FEB 2016	SC	SCALE:		NONE	PFBC - P-002114.001 - 2-05 - 1	PFBC - P-002114.001	2-05	1	3



Equipment Tag	V-301-001
Description	PFBC Pressure Vessel
Design Pressure	2068 kPag (300 psig)
Design Temperature	343°C (650°F)
Design Capacity	N/A

Equipment Tag	R-301-001
Description	PFBC NG Burner
Design Pressure	
Design Temperature	
Design Capacity	

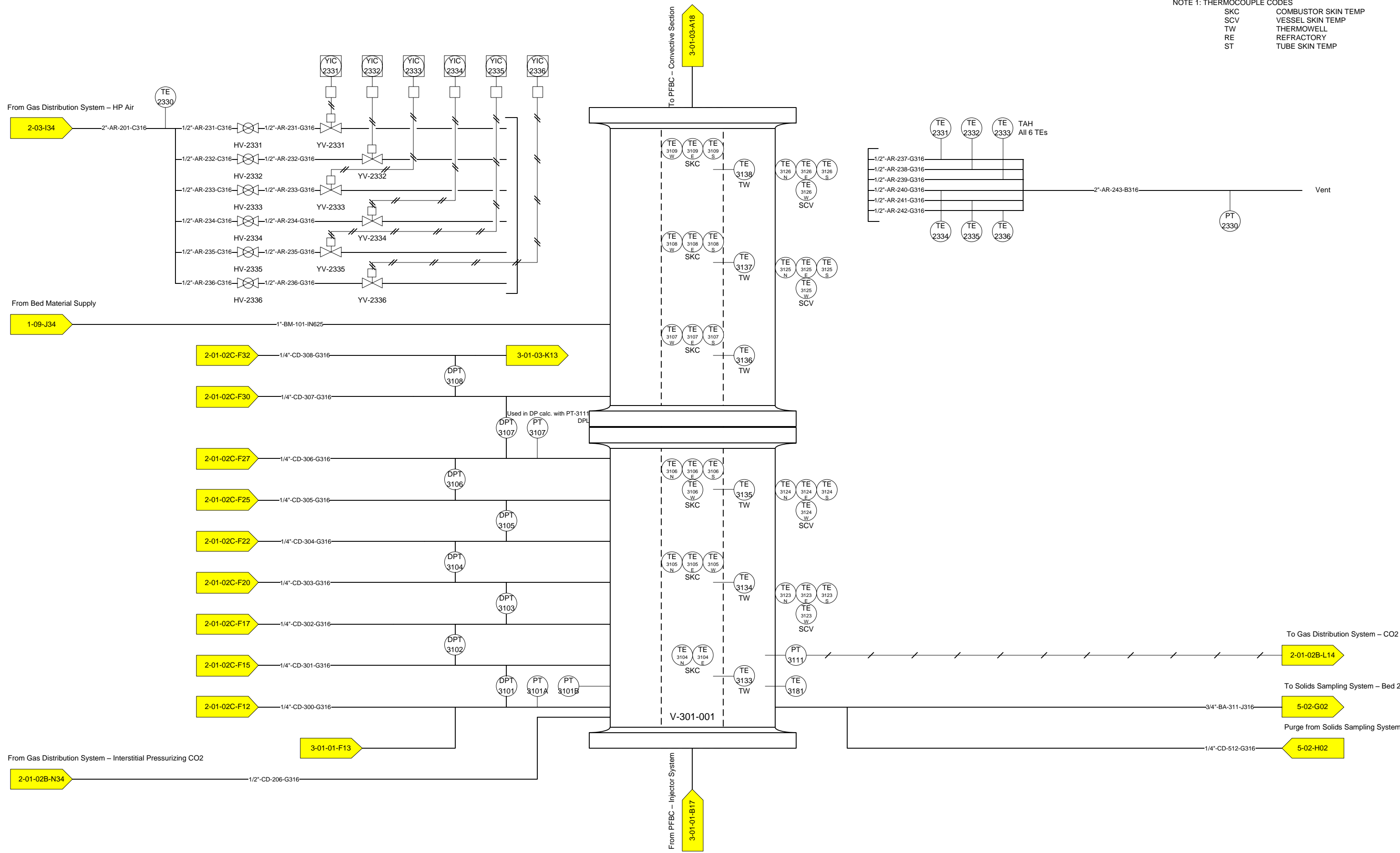
NOTE 1: THERMOCOUPLE CODES
 SKC COMBUSTOR SKIN TEMP
 SCV VESSEL SKIN TEMP
 TW THERMOWELL (GAS PATH)
 RE REFRACTORY
 ST TUBE SKIN TEMP

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REV.	DESCRIPTION	DATE	BY	REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS	7	Changes to ash letdown from GTI Eng.	FEB 2016	SC
2	Update after initial P&ID review	DEC 2014	RS				
3	Update for AR	JAN 16, 2015	RS				
4	Update to NG vessel	FEB, 2015	RS				
5	July Update from AR	JULY 2015	SC				
6	Changes from AR	AUG 2015	SC				

DRAWN BY:	R. Symonds	Dec. 2014	PFBC - Injector / Letdown System				
APPROVED BY:							
ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
SCALE:	NONE		PFBC - P-002114.001 - 3-01 - 1	PFBC - P-002114.001	3-01	1	7

NOTE 1: THERMOCOUPLE CODES
 SKC COMBUSTOR SKIN TEMP
 SCV VESSEL SKIN TEMP
 TW THERMOWELL
 RE REFRACTORY
 ST TUBE SKIN TEMP



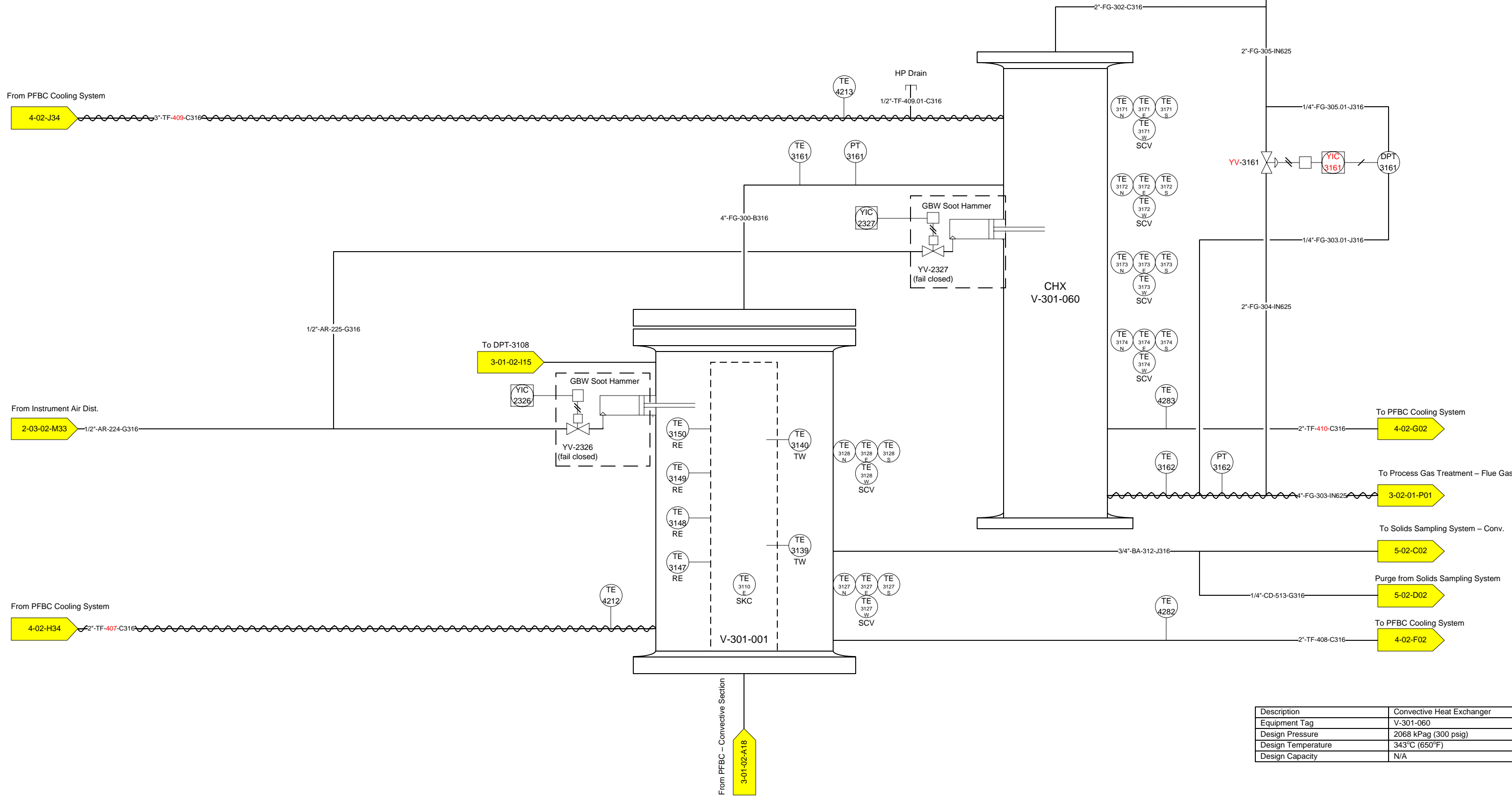
CONFIDENTIAL

REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014
1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:		
2	Update after initial P&ID review	DEC 2014	RS			
3	Update for AR	JAN 16, 2015	RS			
4	Changes from AR	AUG 2015	SC	ISSUED:		DRAWING NO PFBC - P-002114.001 - 3-01 - 2
5	Moved Thermol line to 4-02-02	NOV 2015	SC			
6	Added purges to pressure taps	FEB 2016	SC			
Notes:				SCALE:	NONE	JOB NO PFBC - P-002114.001

PFBC - Bed Section

DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 3-01 - 2	PFBC - P-002114.001	3-01	2	6

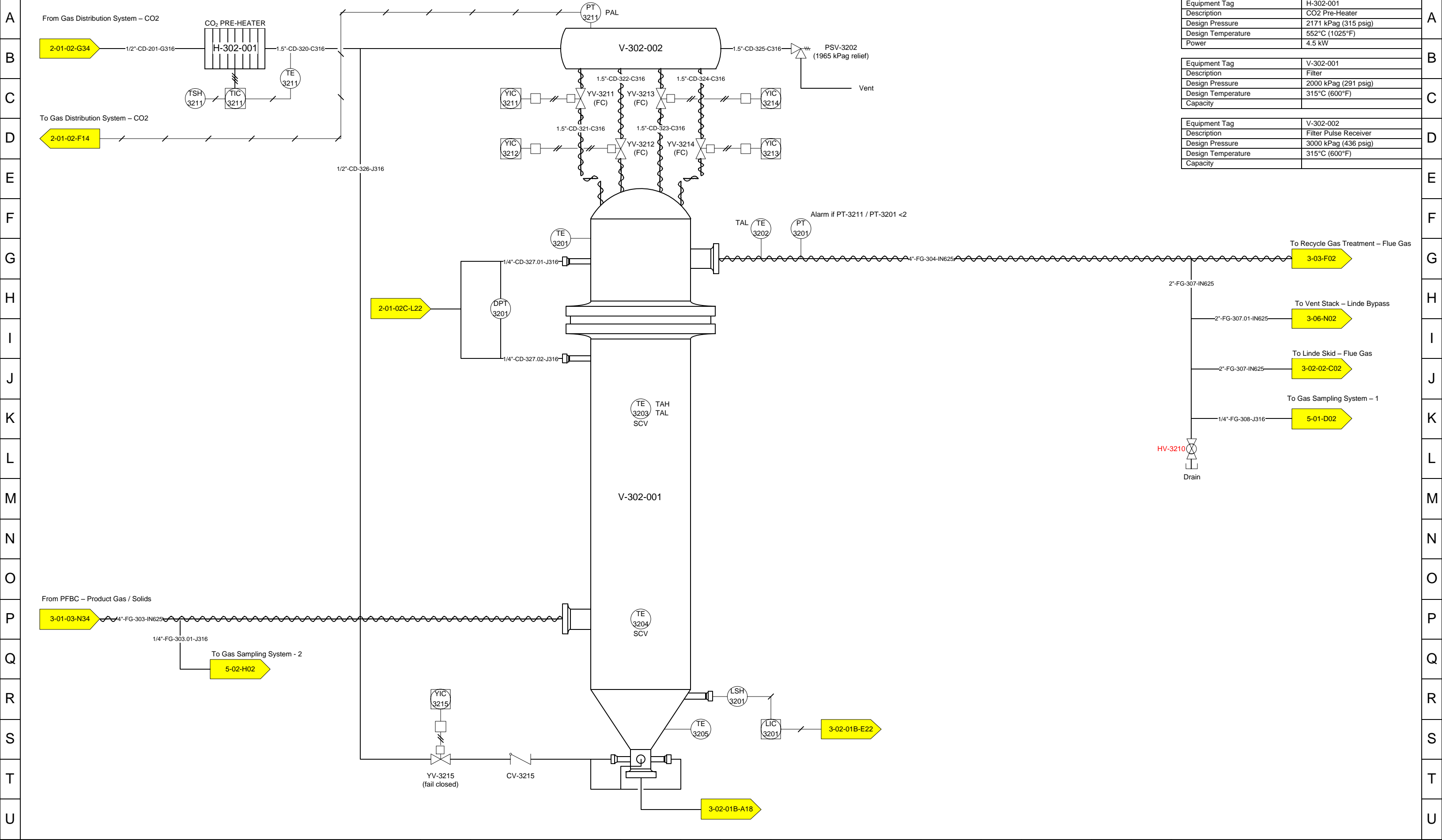
NOTE 1: THERMOCOUPLE CODES
 SKC COMBUSTOR SKIN TEMP
 SCV VESSEL SKIN TEMP
 TW THERMOWELL (GAS PATH)
 RE REFRACTORY
 ST TUBE SKIN TEMP



Description	Convective Heat Exchanger
Equipment Tag	V-301-060
Design Pressure	2068 kPag (300 psig)
Design Temperature	343°C (650°F)
Design Capacity	N/A

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Notes: Aerojet Rocketdyne Scope	REV.	DESCRIPTION	DATE	BY	DRAWN BY: R. Symonds	Dec. 2014	PFBC – Convective Section				
	1	Updated to reflect process changes	NOV 2014	RS							
	2	Update after initial P&ID review	DEC 2014	RS	APPROVED BY:	ISSUED:	DRAWING NO PFBC – P-002114.001 – 3-01 – 3	JOB NO PFBC – P-002114.001	BLOCK NO 3-01	SHEET NO 3	REV NO 4
	3	Update for AR	JAN 16, 2015	RS							
4	Changes from AR	AUG 2015	SC	SCALE:	NONE						



Equipment Tag	H-302-001
Description	CO ₂ Pre-Heater
Design Pressure	2171 kPag (315 psig)
Design Temperature	552°C (1025°F)
Power	4.5 kW

Equipment Tag	V-302-001
Description	Filter
Design Pressure	2000 kPag (291 psig)
Design Temperature	315°C (600°F)
Capacity	

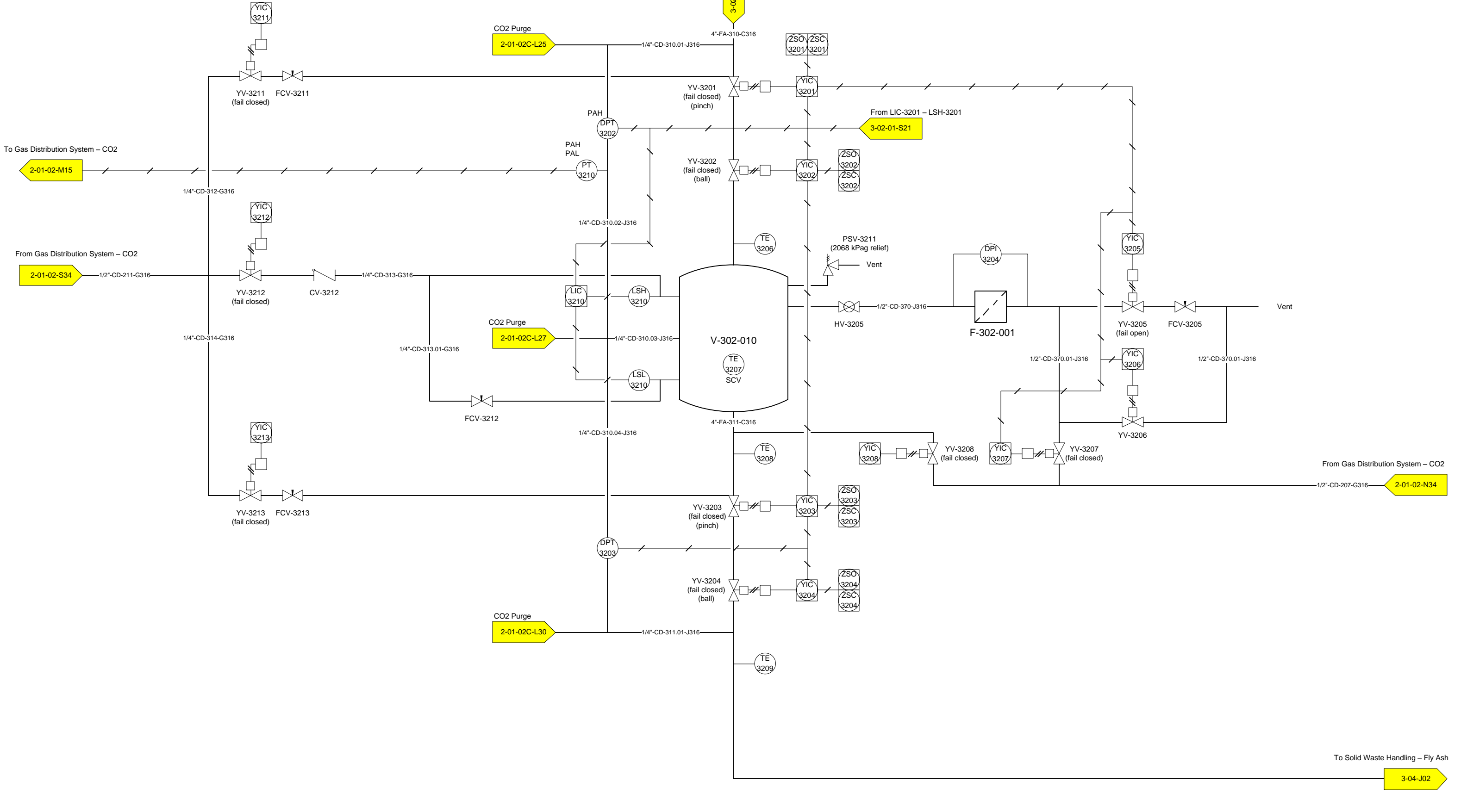
Equipment Tag	V-302-002
Description	Filter Pulse Receiver
Design Pressure	3000 kPag (436 psig)
Design Temperature	315°C (600°F)
Capacity	

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REV.	DESCRIPTION	DATE	BY	REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS	7	Ash valves to 3-02-01B, new vessel dwg	FEB 2016	SC
2	Update after initial P&ID review	DEC 2014	RS				
3	Added CO ₂ pre-heater	JAN 19, 2014	RS				
4	Added solids letdown	FEB 2014	RS				
5	Changes from AR	AUG 2015	SC				
6	Removed PSV on 3-02-001, Cleaned up	NOV 2015	SC				

DRAWN BY:	R. Symonds	Dec. 2014	Process Gas Treatment				
APPROVED BY:							
ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
SCALE:	NONE		PFBC - P-002114.001 - 3-02 - 1	PFBC - P-002114.001	3-02	1	7

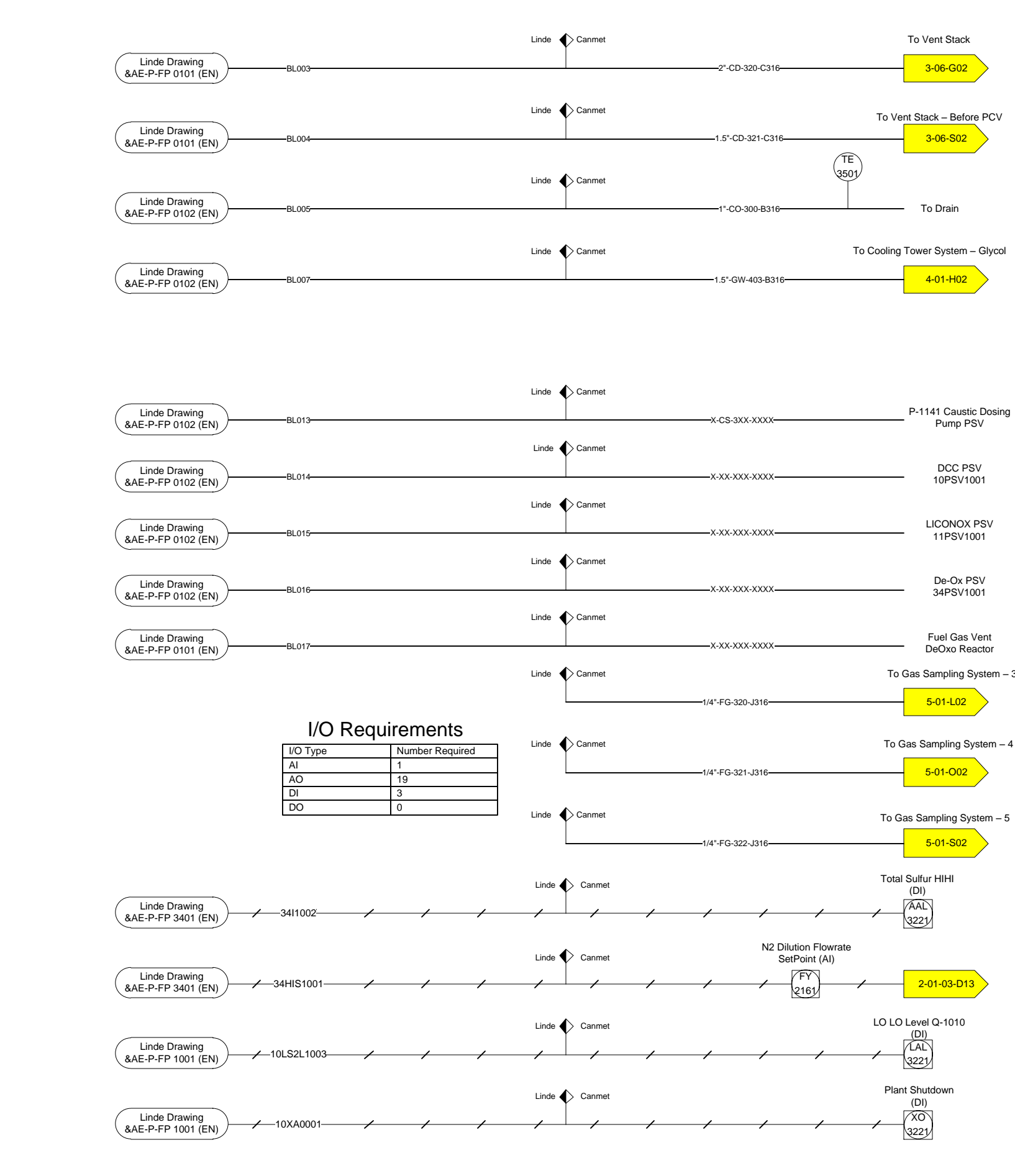
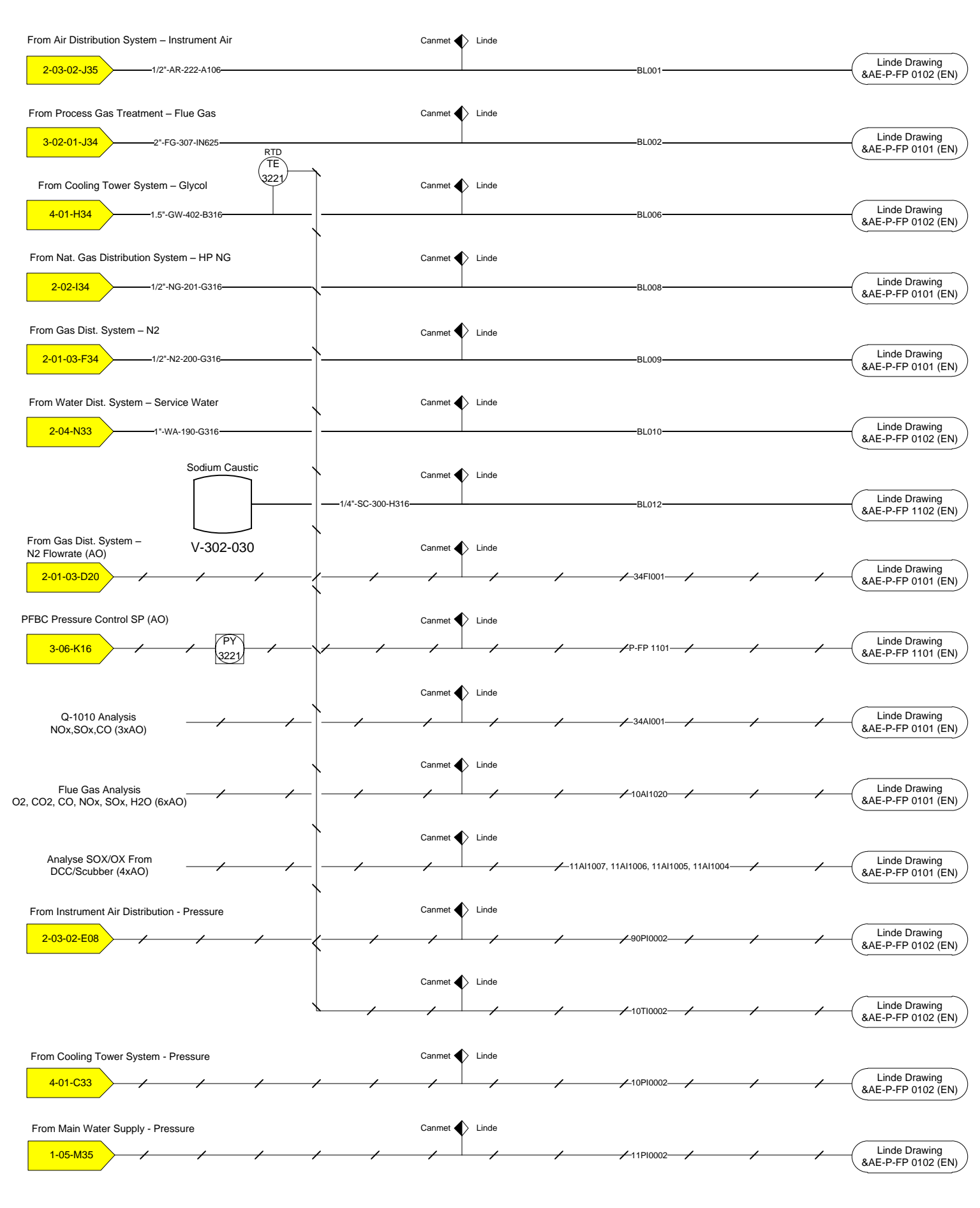
Equipment Tag	V-302-010
Description	Fly Ash Lockhopper
Design Pressure	2068 kPag (300 psig)
Design Temperature	343°C (650°F)
Capacity	



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Notes:	REV. 1	DESCRIPTION	DATE	BY	DRAWN BY:	S. Champagne	Feb. 2016	Process Gas Treatment				
		Moved from 3-02-01 and added purges	FEB 2016	SC								
					APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
					ISSUED:			PFBC - P-002114.001 - 3-03 - 1B	PFBC - P-002114.001	3-02	1B	1
					SCALE:	NONE						

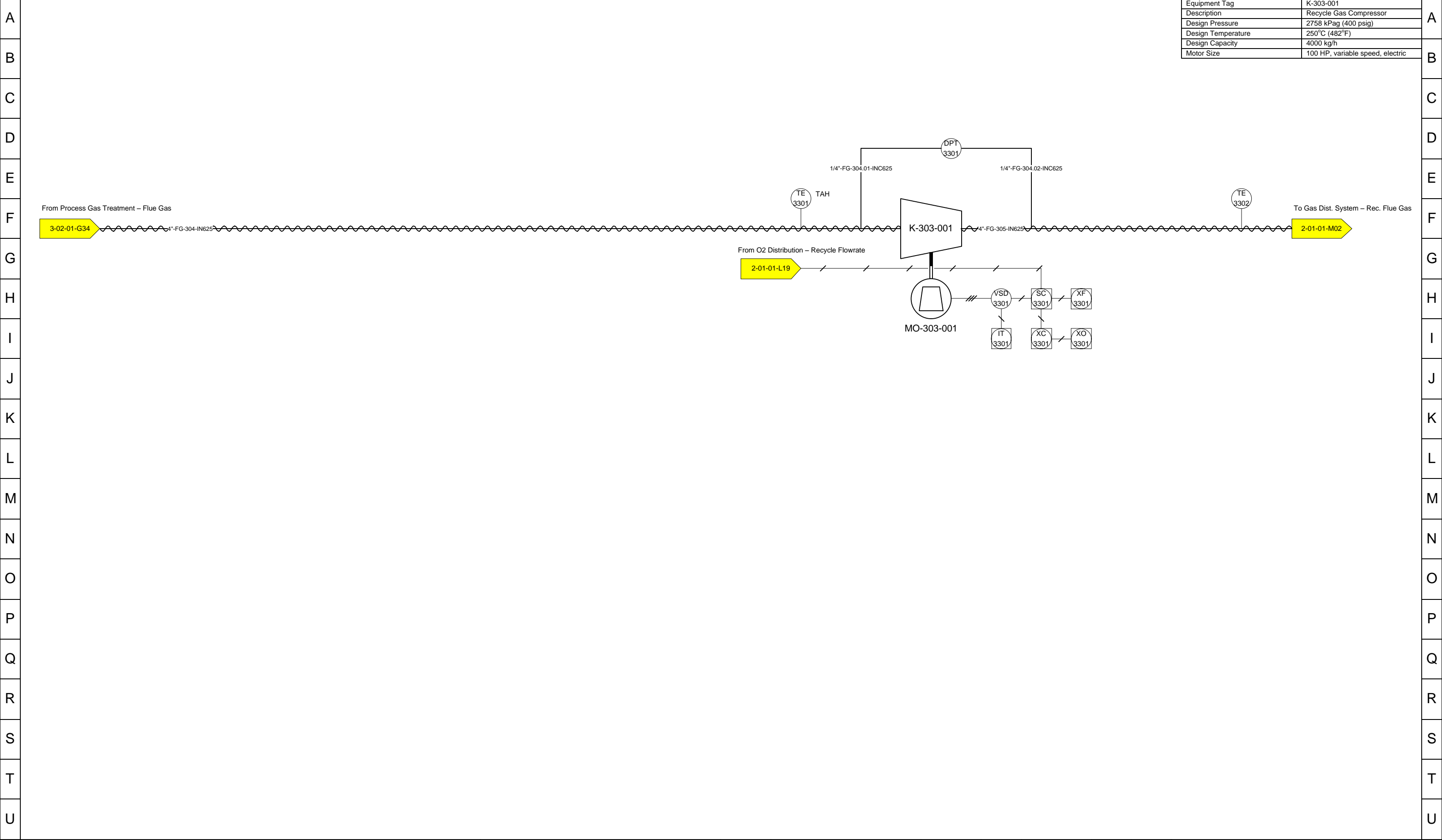
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Notes: Linde Scope – excluding the sodium caustic storage vessel.	REV.	DESCRIPTION	DATE	BY	DRAWN BY: R. Symonds	Dec. 2014	Linde Skid				
	1	Updated to reflect process changes	NOV 2014	RS							
	2	Update after initial P&ID review	DEC 2014	RS	APPROVED BY:	ISSUED:	DRAWING NO PFBC – P-002114.001 – 3-02 – 2	JOB NO PFBC – P-002114.001	BLOCK NO 3-02	SHEET NO 2	REV NO 5
	3	Added sodium caustic stream	JAN 19, 2015	RS							
	4	Added sodium caustic storage vessel	FEB 2015	RS							
5	Update with Linde Battery Limits	AUG 2015	SC	SCALE:	NONE						

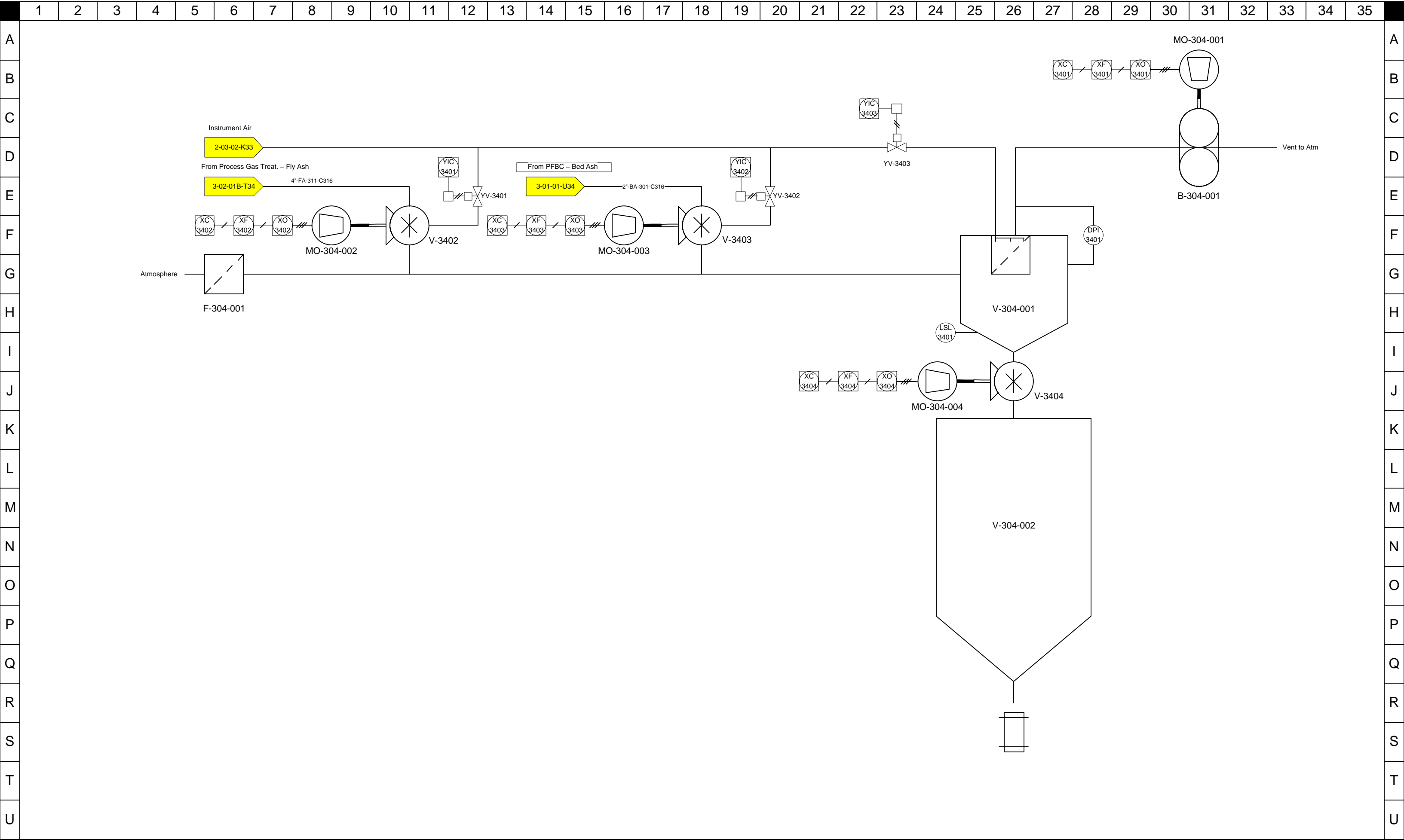
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35



Equipment Tag	K-303-001
Description	Recycle Gas Compressor
Design Pressure	2758 kPag (400 psig)
Design Temperature	250°C (482°F)
Design Capacity	4000 kg/h
Motor Size	100 HP, variable speed, electric

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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Recycle Gas Treatment				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	DEC 2014	RS	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
	3	Update to reflect optional equipment	JAN 19, 2015	RS	SCALE:		NONE	PFBC - P-002114.001 - 3-03 - 1	PFBC - P-002114.001	3-03	1	5
	4	Update after P&ID review	AUG 2015	SC								
	5	Updated valving and added DTP	NOV 2015	SC								



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REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R.	Dec.	Solid Waste Handling				
1	Updated to reflect process changes	NOV 2014	RS		Symonds	2014	DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
2	Update after initial P&ID review	DEC 2014	RS	APPROVED BY:			PFBC - P-002114.001 -	PFBC - P-002114.001	3-04	1	4
3	Update from vendor drawing	JULY 2015	SC	ISSUED:			3-04 - 1				
4	New design using BLDG2 Pneuveyor Sys	JAN 2016	SC	SCALE:	NONE						

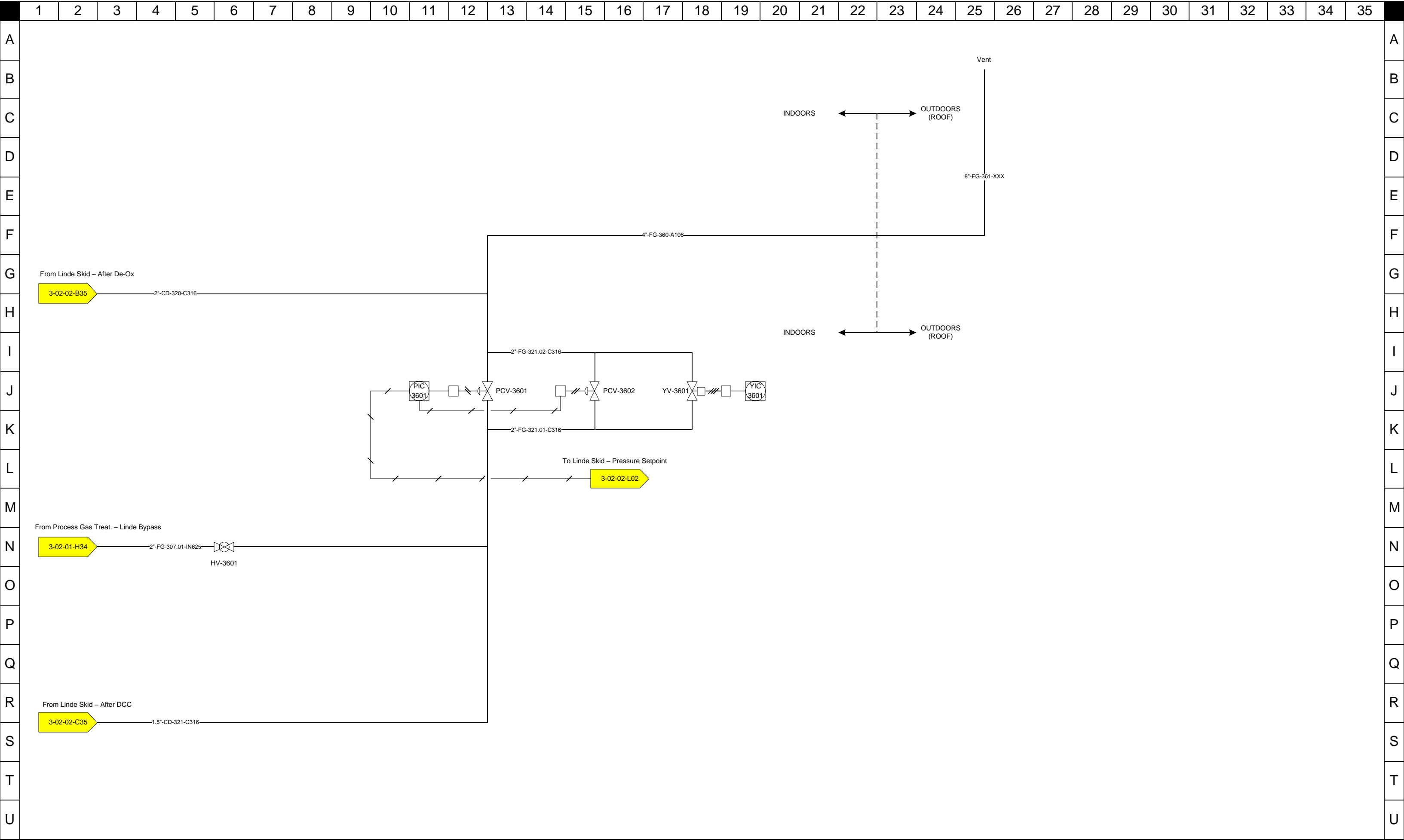
Notes:

NO SCOPE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
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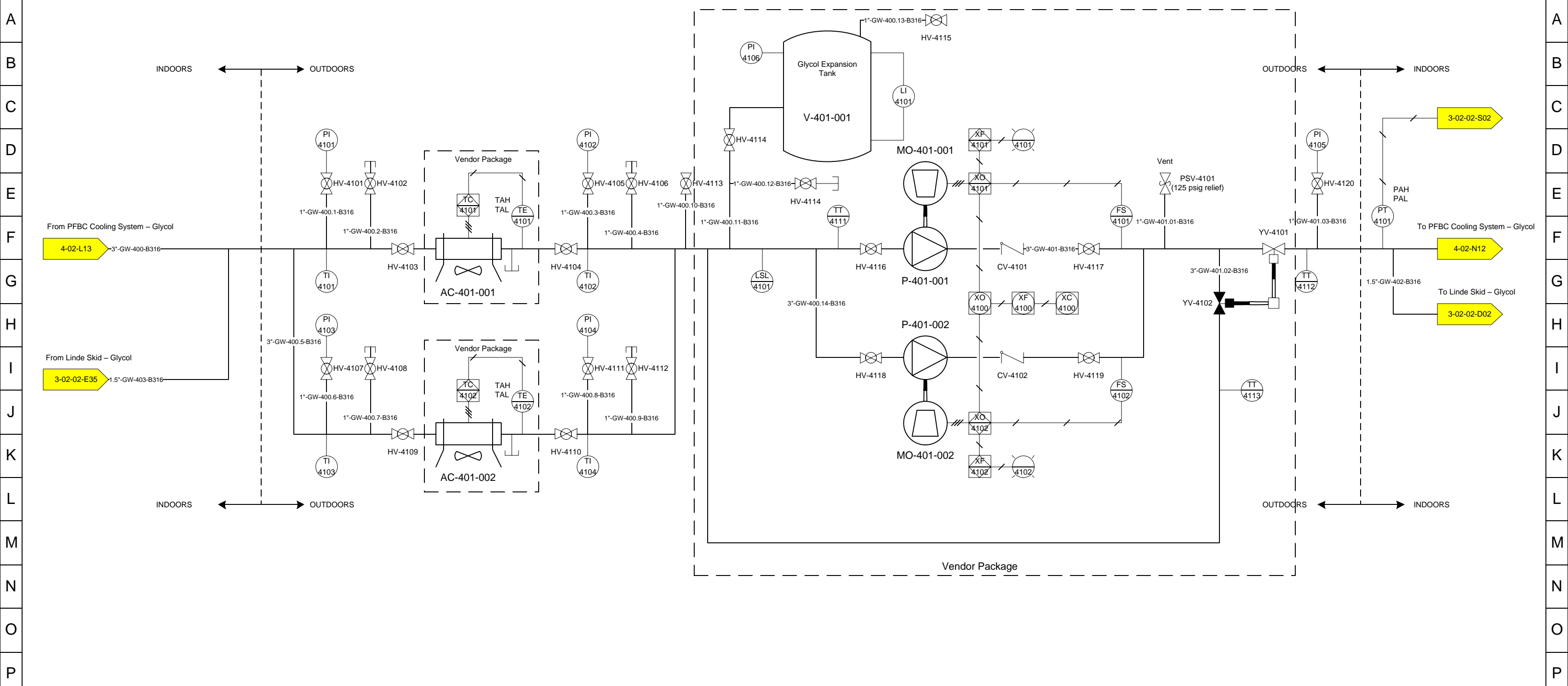
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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014	Process Water Treatment				
	1	Updated to reflect process changes	NOV 2014	RS	APPROVED BY:							
	2	Update after initial P&ID review	DEC 2014	RS								
	3	Totes for storage	AUG 2015	SC								
	4	Removed totes	OCT 2015	SC								
					ISSUED:		DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO	
					SCALE:	NONE	PFBC - P-002114.001 - 3-05 - 1	PFBC - P-002114.001	3-05	1	4	



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Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	S. Champagne	Aug 2015	Vent Stack				
	1	First Draft	AUG 2015	SC	APPROVED BY:							
	2	Added bypass around PCV for startup	OCT 2015	SC	ISSUED:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
3	Added second PCV for low P	FEB 2016	SC	SCALE:		NONE	PFBC - P-002114.001 - 3-06 - 1	PFBC - P-002114.001	3-06	1	3	



Equipment Tag	P-401-001	Equipment Tag	AC-401-001
Description	Glycol Pump 1	Description	Glycol Air Cooler 1
Design Pressure		Design Pressure	862 kPag (125 psig)
Design Temperature		Design Temperature	121°C (250°F)
Design Capacity		Design Capacity	570 kW
Power	10 HP, fixed speed, electric	Power	10 HP, fixed speed, electric
Equipment Tag	P-401-002	Equipment Tag	AC-401-002
Description	Glycol Pump 2	Description	Glycol Air Cooler 2
Design Pressure		Design Pressure	862 kPag (125 psig)
Design Temperature		Design Temperature	121°C (250°F)
Design Capacity		Design Capacity	570 kW
Power	10 HP, fixed speed, electric	Power	10 HP, fixed speed, electric
Equipment Tag	V-401-001	Equipment Tag	AC-401-001
Description	Glycol Expansion Tank	Description	Glycol Air Cooler 1
Design Pressure		Design Pressure	862 kPag (125 psig)
Design Temperature		Design Temperature	121°C (250°F)
Design Capacity		Design Capacity	570 kW
Power		Power	10 HP, fixed speed, electric

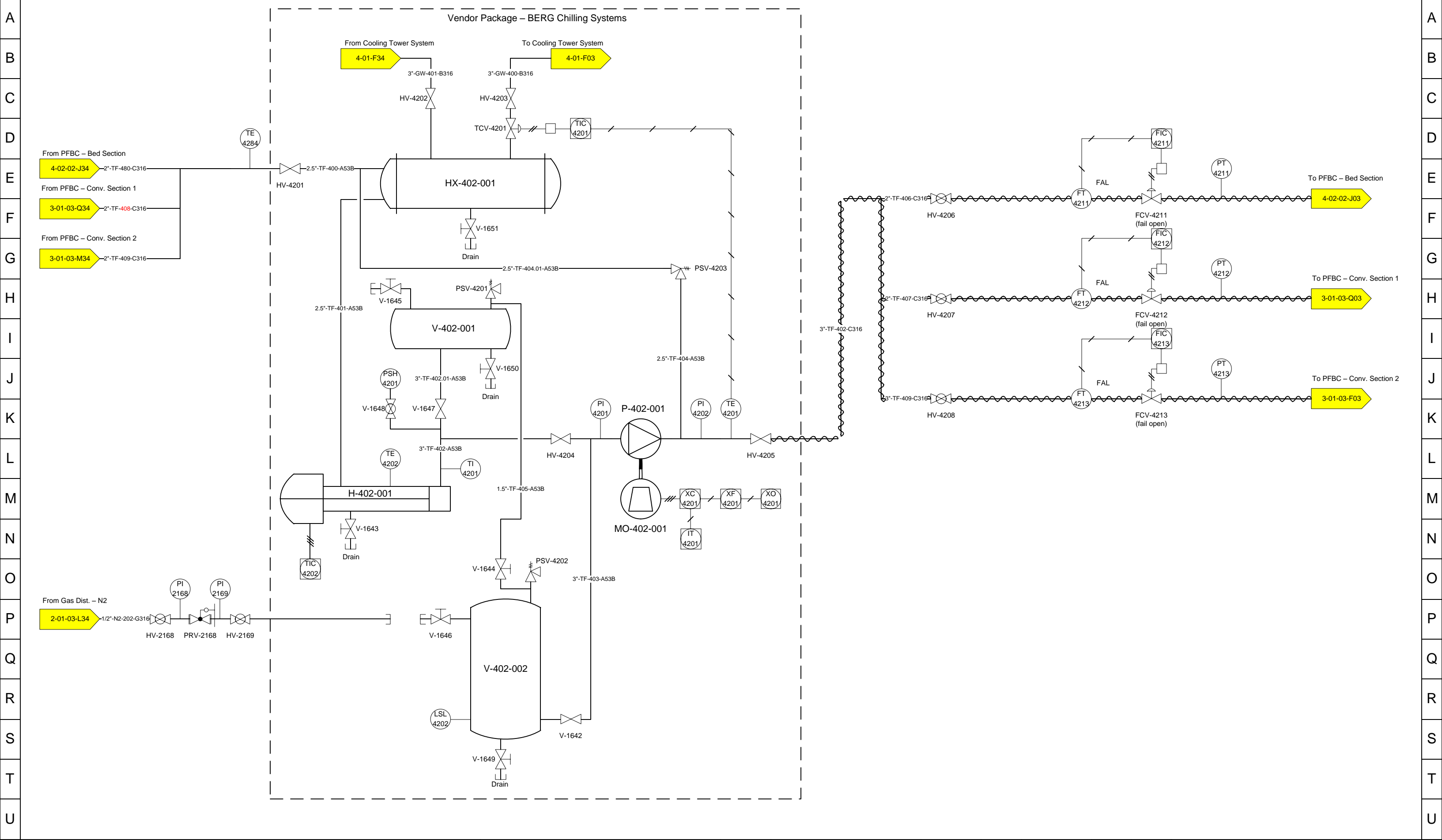
CONFIDENTIAL

Notes:

REV.	DESCRIPTION	DATE	BY	DRAWN BY:	R. Symonds	Dec. 2014
1	Updated to reflect process changes	NOV 2014	RS			
2	Update after initial P&ID review	DEC 2014	RS			
3	Updated to reflect control changes	FEB 2016	SC			
				APPROVED BY:		
				ISSUED:		
				SCALE:	NONE	

Cooling Tower System

DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 4-01 - 1	PFBC - P-002114.001	4-01	1	3



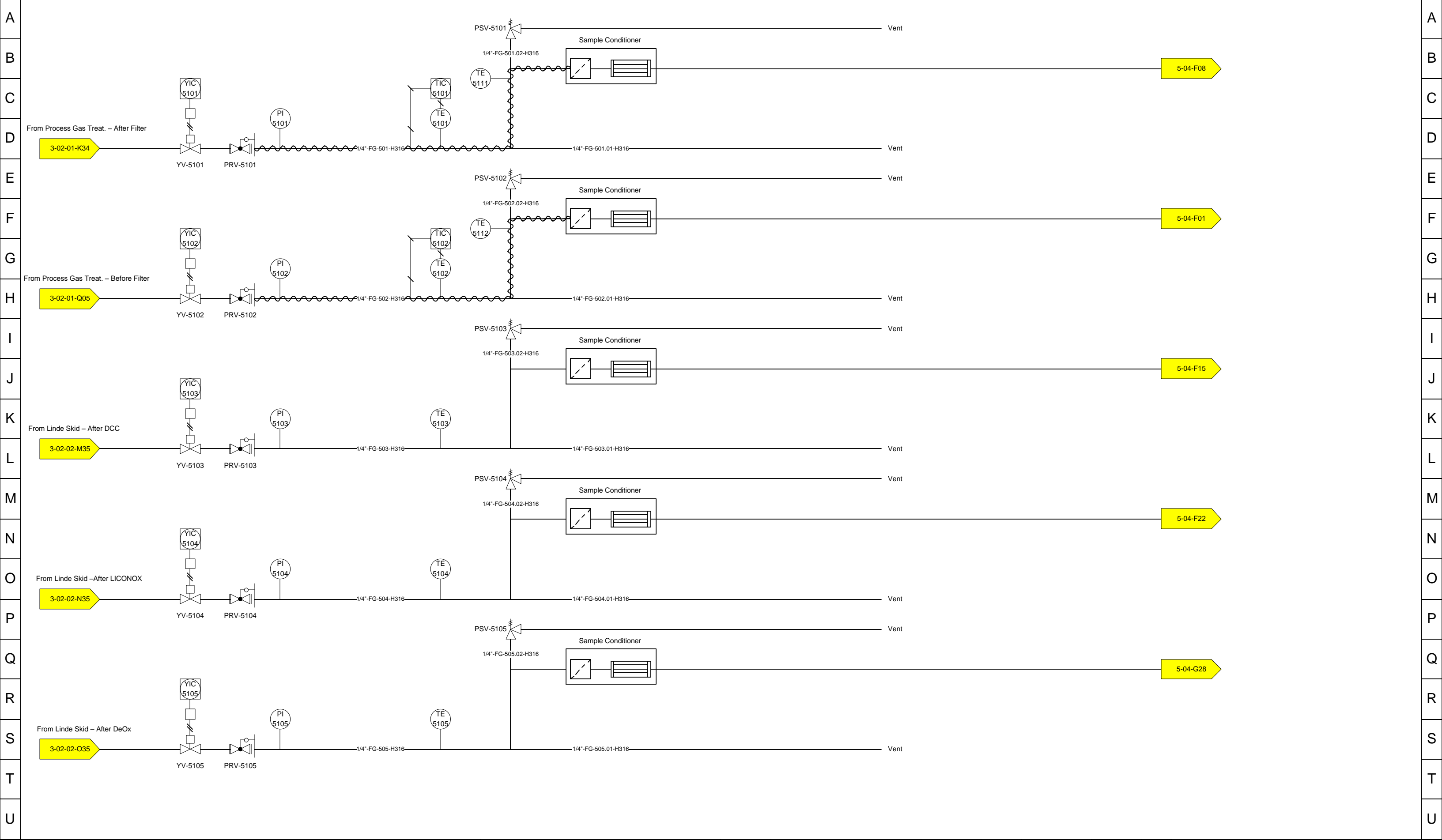
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Notes:

REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS
2	Update after initial P&ID review	DEC 2014	RS
3	Update to flow trains and reservoir	JAN 20, 2014	RS
4	Update to tags and IO	AUG 2015	SC
5	Updated with drawings from BERG	FEB 2016	SC

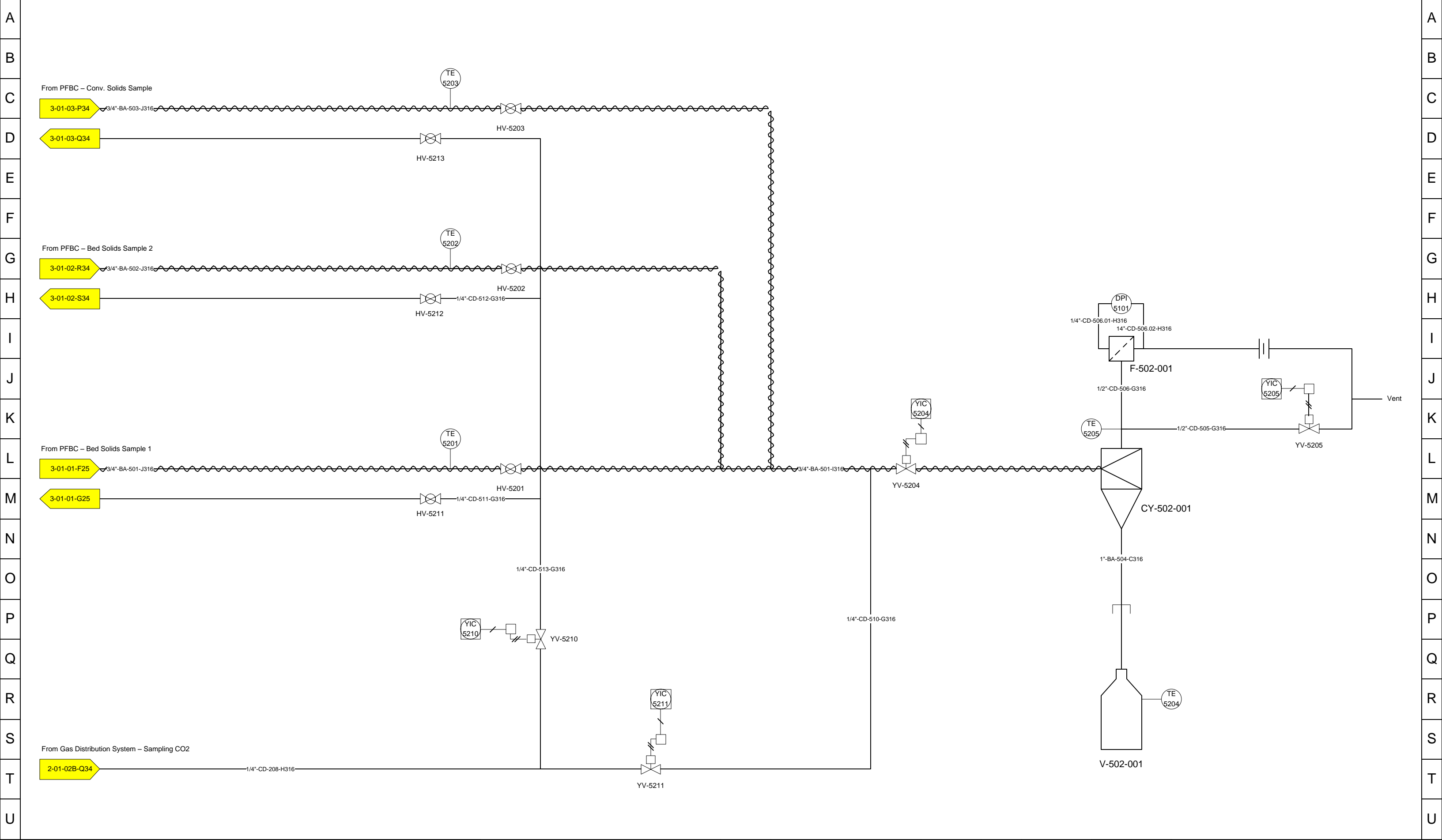
DRAWN BY:	R. Symonds	Dec. 2014
APPROVED BY:		
ISSUED:		
SCALE:	NONE	

PFBC Cooling System				
DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 4-02 - 1	PFBC - P-002114.001	4-02	1	5



CONFIDENTIAL

Notes:	REV.	DESCRIPTION	DATE	BY	DRAWN BY:	S.	Aug.	Gas Sampling System			
	1	First Draft	AUG 2015	SC	Champagne	2015					
	2	Removed high limit on heat trace	OCT 2015	SC	APPROVED BY:			DRAWING NO	JOB NO	BLOCK NO	SHEET NO
3	Moved analysers to new sheet	FEB 2016	SC				PFBC - P-002114.001 - 5-01 - 1	PFBC - P-002114.001	5-01	1	3
					ISSUED:						
					SCALE:	NONE					



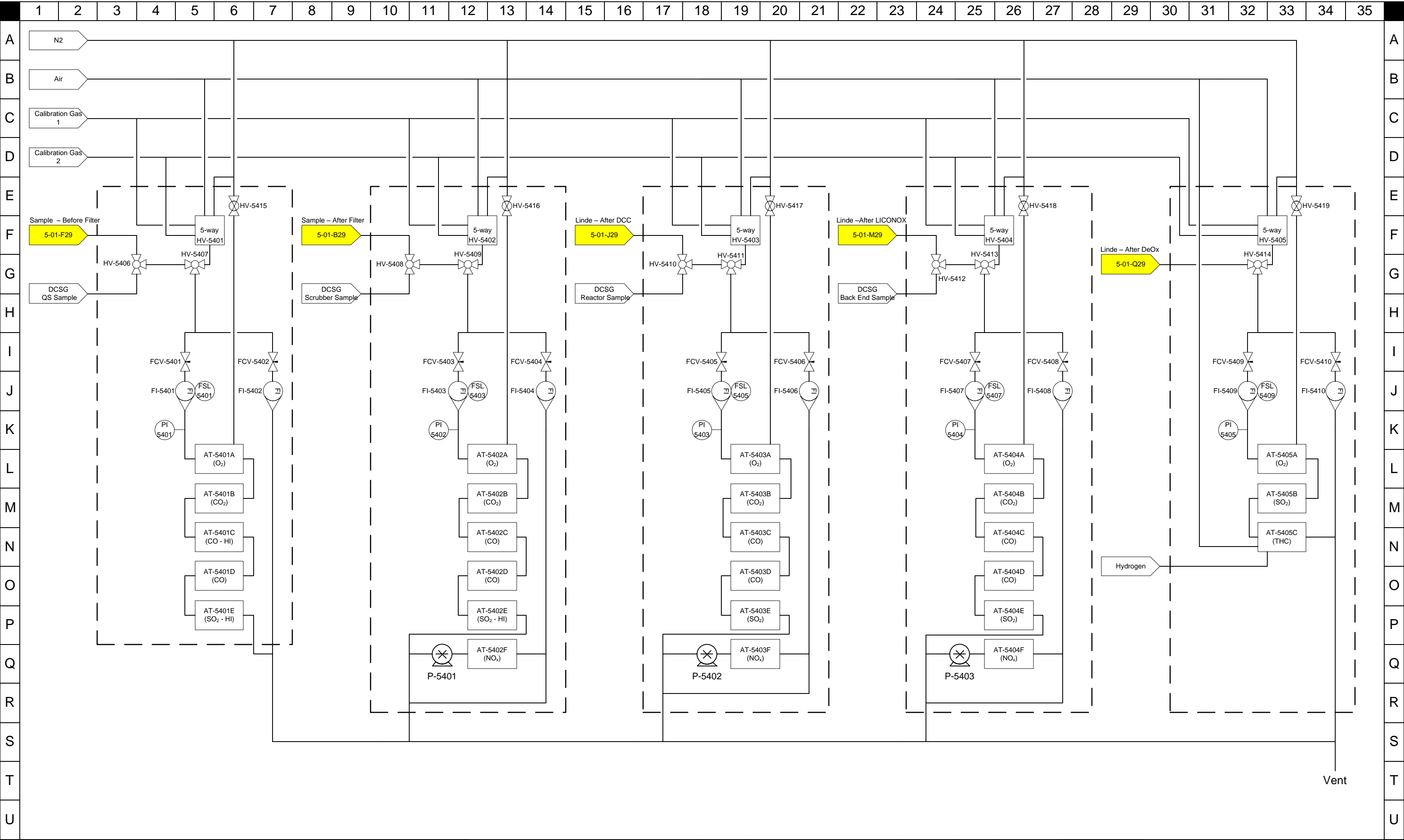
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Notes:
Aerojet Rocketdyne Scope

REV.	DESCRIPTION	DATE	BY
1	Updated to reflect process changes	NOV 2014	RS
2	Update after initial P&ID review	DEC 2014	RS
3	Update for AR	JAN 16, 2015	RS
4	Update from AR	AUG 2015	SC
5	Update to off page references	NOV 2015	SC

DRAWN BY:	R. Symonds	Dec. 2014
APPROVED BY:		
ISSUED:		
SCALE:	NONE	

Solids Sampling System				
DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
PFBC - P-002114.001 - 5-02 - 2	PFBC - P-002114.001	5-02	1	5



CONFIDENTIAL

REV.	DESCRIPTION	DATE	BY	DRAWN BY:	S.	Dec.	Analyzer Rack				
1	First draft, based on DCSG draft	DEC 2016	SC	Champagne	Dec.	2015	DRAWING NO	JOB NO	BLOCK NO	SHEET NO	REV NO
				APPROVED BY:			PFBC - P-002114.001 - 5-04 - 1	PFBC - P-002114.001	5-04	1	1
				ISSUED:							
				SCALE:	NONE						