



7664 – 10 Street N.E. Calgary, Alberta T2E 8W1
Tel (24hr): 403 295-5855 Fax: 403 571-6187 Toll-free: 1 800 555-9439

www.startec.ca

TO WHOM IT MAY CONCERN:

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GASFRAC ENERGY SERVICES

P.O. 014932

**5 mmscfd Trailer Mounted Dewpoint Plant
250 HP Marathon / Howden XRV 204/193**

SERIAL NO. DPC-1002





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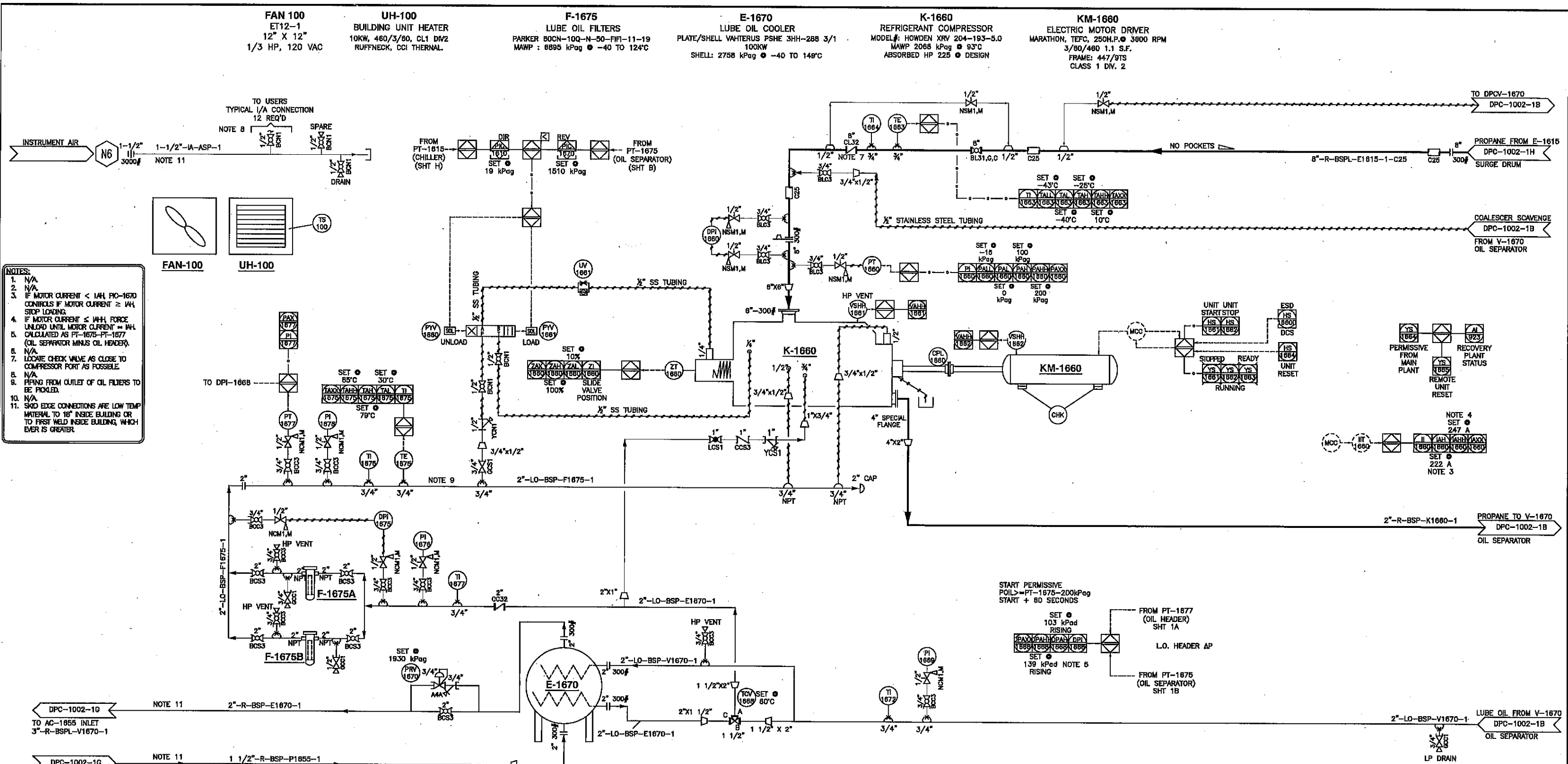
GASFRAC ENERGY SERVICES
P.O. 014932

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250 HP Marathon / Howden 204/193

SERIAL NO. DPC-1002

OPERATING MANUAL

Drawings P&ID.....	Volume 1
Drawings GA – Compressor & Vessel Skids	Volume 1
Process Description.....	Volume 1
Shut-Down Key	Volume 1
Control Panel Drawings	Volume 1
PSV Certificates.....	Volume 1
Alignment	Volume 1
Compressor	Volume 1
Motor	Volume 1
Transfer Pump	Volume 1
Spare Parts.....	Volume 1
Vendor Brochures.....	Volume 2
Vessel Data Reports/Drawings.....	Volume 2



- NOTES:**
- N/A
 - N/A
 - IF MOTOR CURRENT < 144, PIC-1670 CONTROLS IF MOTOR CURRENT ≥ 144, STOP LOADING.
 - IF MOTOR CURRENT ≤ 144, FORCE UNLOAD UNTIL MOTOR CURRENT = 144, CALCULATED AS PT-1675-PT-1677 (OIL SEPARATOR MINUS OIL HEADER).
 - N/A
 - LOCATE CHECK VALVE AS CLOSE TO COMPRESSOR PORT AS POSSIBLE.
 - N/A
 - PIPING FROM OUTLET OF OIL FILTERS TO BE PICKLED.
 - N/A
 - SKID EDGE CONNECTIONS ARE LOW TEMP MATERIAL TO 18" INSIDE BUILDING OR TO FIRST WELD INSIDE BUILDING, WHICH EVER IS GREATER.

CERTIFIED
AS BUILT DWG

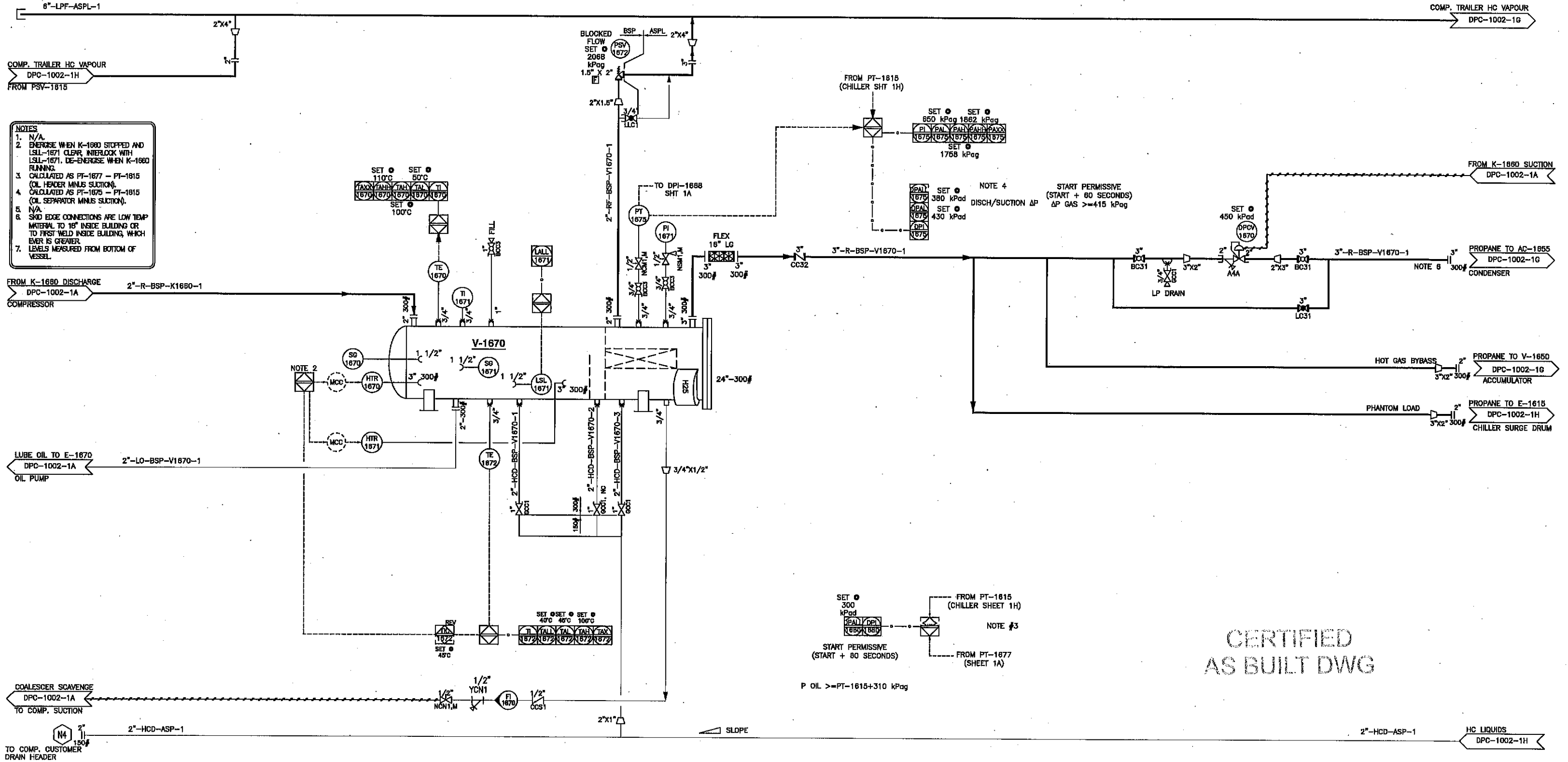
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				5	11-02-07	DD	LB	UPDATED AS SHOWN.	
				6	11-03-23	DD	LB	UPDATED AS SHOWN.	
				7	11-05-02	DD		AS BUILT	

DRAWN	DINA DING	DATE	11-05-02	CUSTOMER GASFRAC ENERGY SERVICES INC.			
CHECKED		DATE					
ENG. APPL	AB	DATE	11-05-02				
PROD. APPL		DATE		TITLE COMPRESSOR TRAILER AND VESSEL TRAILER P&ID			
JOB NO.	DPC-1002	SCALE	NTS	DRAWING NO.	DPC-1002-1A	PAGE 1 OF 10	REV. 7



HTR-1670/1671
IMMERSION HEATER
CALORITECH MODEL:
CXFT3023F322X-00X,
2 KW (EACH), 3/60/480VAC
CLASS 1 DIV. 2

V-1670
OIL SEPARATOR
24" O.D 120" S/S
MAWP: 2413 kPag @ -29 TO 149°C
CA Xa



- NOTES
1. N/A.
 2. ENERGISE WHEN K-1880 STOPPED AND LSL-1671 CLEAR. INTERLOCK WITH LSL-1671. DE-ENERGISE WHEN K-1880 RUNNING.
 3. CALCULATED AS PT-1677 - PT-1615 (OIL HEADER MINUS SUCTION).
 4. CALCULATED AS PT-1675 - PT-1615 (OIL SEPARATOR MINUS SUCTION).
 5. N/A.
 6. SKID EDGE CONNECTIONS ARE LOW TEMP MATERIAL TO 18" INSIDE BUILDING OR TO FIRST WELD INSIDE BUILDING, WHICH EVER IS GREATER.
 7. LEVELS MEASURED FROM BOTTOM OF VESSEL.

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REVISIONS

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5	11-02-07	DD	LB	UPDATED AS SHOWN.					

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REFRIGERATION • COMPRESSION
• PROCESS SOLUTIONS

CUSTOMER
GASFRAC ENERGY SERVICES INC.

TITLE
COMPRESSOR TRAILER AND VESSEL TRAILER P&ID

SCALE: NTS
DRAWING NO.: DPC-1002-1B
PAGE 2 OF 10
REV. 7

SHIPPING WEIGHT
SANDBLAST
PRIMER
PAINT

DRAWN: DINA DING
CHECKED: [Signature]
DATE: 11-05-02

ENG. APPL: [Signature]
DATE: 11-05-02

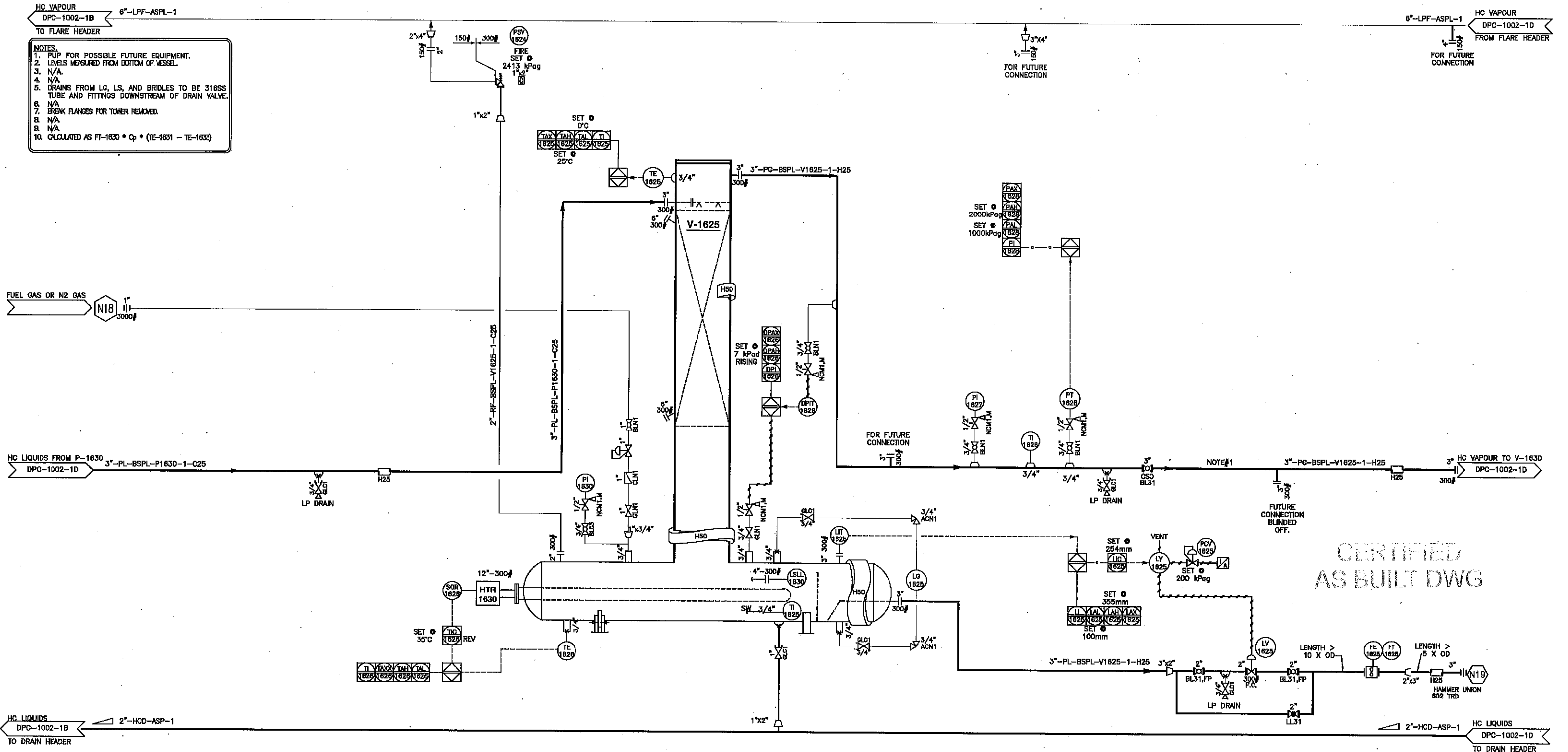
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DATE: [Signature]

JOB NO.: DPC-1002

HTR-1630
 DEETHANIZER REBOILER HEATER
 IMMERSION HEATER
 CALORITECH MODEL: CX1601723F1283X-DOX,
 173 KW, 3/80/480VAC
 CLASS 1 DIV. 2

V-1625
 DEETHANIZER BOTTOM TOWER
 20" O.D. x 96" (HORIZONTAL S/S)
 20" O.D. x 80" (VERTICAL TOWER S/S)
 MAWP: 2413 kPag @ -40 TO 121°C
 O.A.: 7/8"
 BED: 0.75 m3 IMPT #25 RANDOM PACKING C.S.

- HC VAPOUR
 DPC-1002-1B
 6"-LPF-ASPL-1
 TO FLARE HEADER
- NOTES:**
- PUP FOR POSSIBLE FUTURE EQUIPMENT.
 - LEVELS MEASURED FROM BOTTOM OF VESSEL.
 - N/A
 - N/A
 - DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND FITTINGS DOWNSTREAM OF DRAIN VALVE.
 - N/A
 - BREAK FLANGES FOR TOWER REMOVED.
 - N/A
 - N/A
 - N/A
 10. CALCULATED AS FF-1630 * Cp * (TE-1631 - TE-1633)



**CERTIFIED
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CHECKED		DATE		TITLE	COMPRESSOR TRAILER AND VESSEL TRAILER P&ID
ENG. APPL	<i>LB</i>	DATE	11-05-02	JOB NO.	DPC-1002
PROD. APPL		DATE		SCALE	NTS
				DRAWING NO.	DPC-1002-1C
				PAGE	3 OF 10
				REV.	7



CUSTOMER
GASFRAC ENERGY SERVICES INC.

TITLE
COMPRESSOR TRAILER AND VESSEL TRAILER P&ID

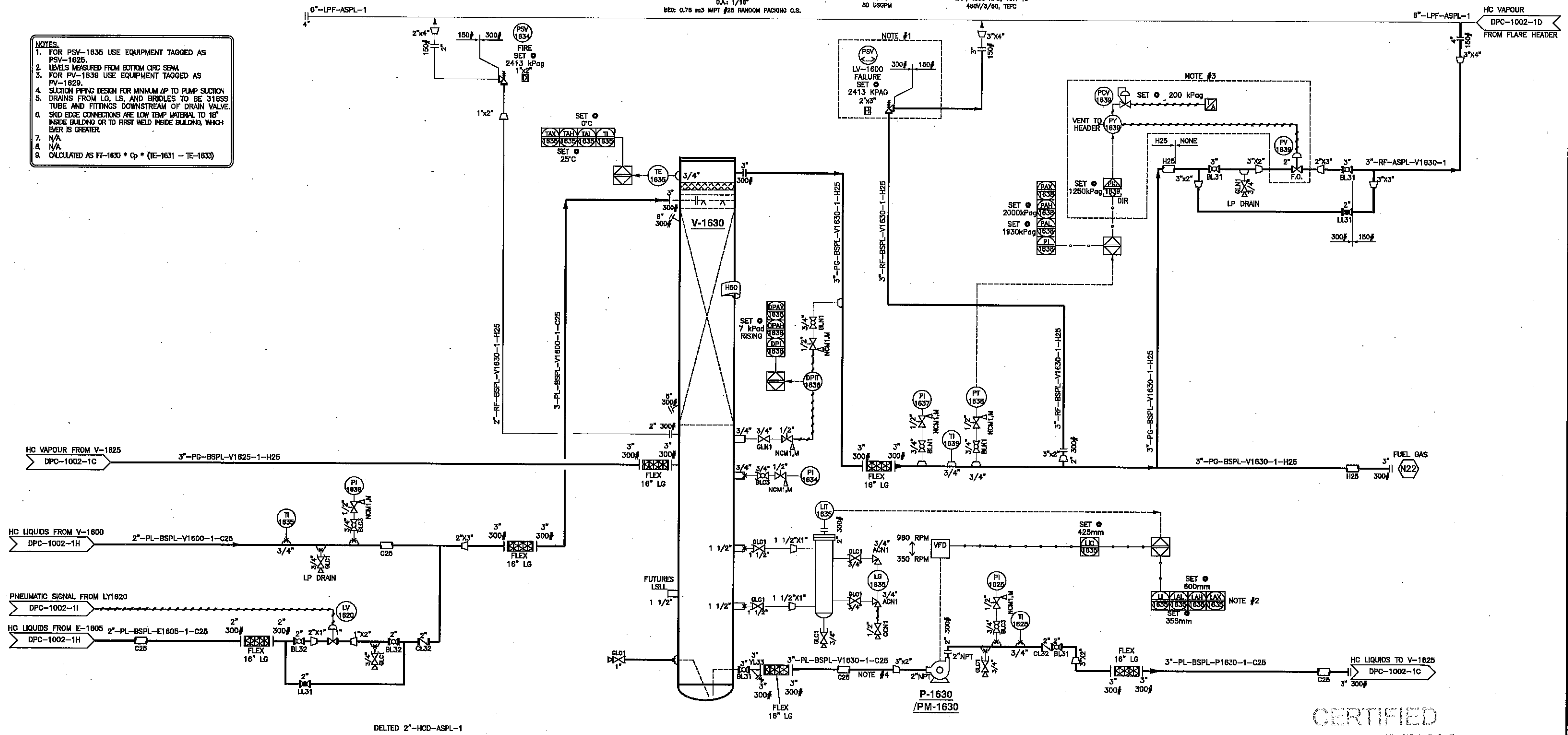
JOB NO. DPC-1002 SCALE NTS DRAWING NO. DPC-1002-1C PAGE 3 OF 10 REV. 7

V-1630
DEETHANIZER TOPS TOWER
20" O.D. x 120' 5/8"
MAMP: 2413 kPag @ -40 TO 121°C
C.A.: 1/18"
BED: 0.78 m3 MPF #25 RANDOM PACKING C.S.

P-1630
BLACKMER VANE PUMP
LGD2E
80 USGPM

PM-1630
TECO-WESTINGHOUSE
5HP, 1800 RPM, 10:1 TD
480V/3/60, TEFC

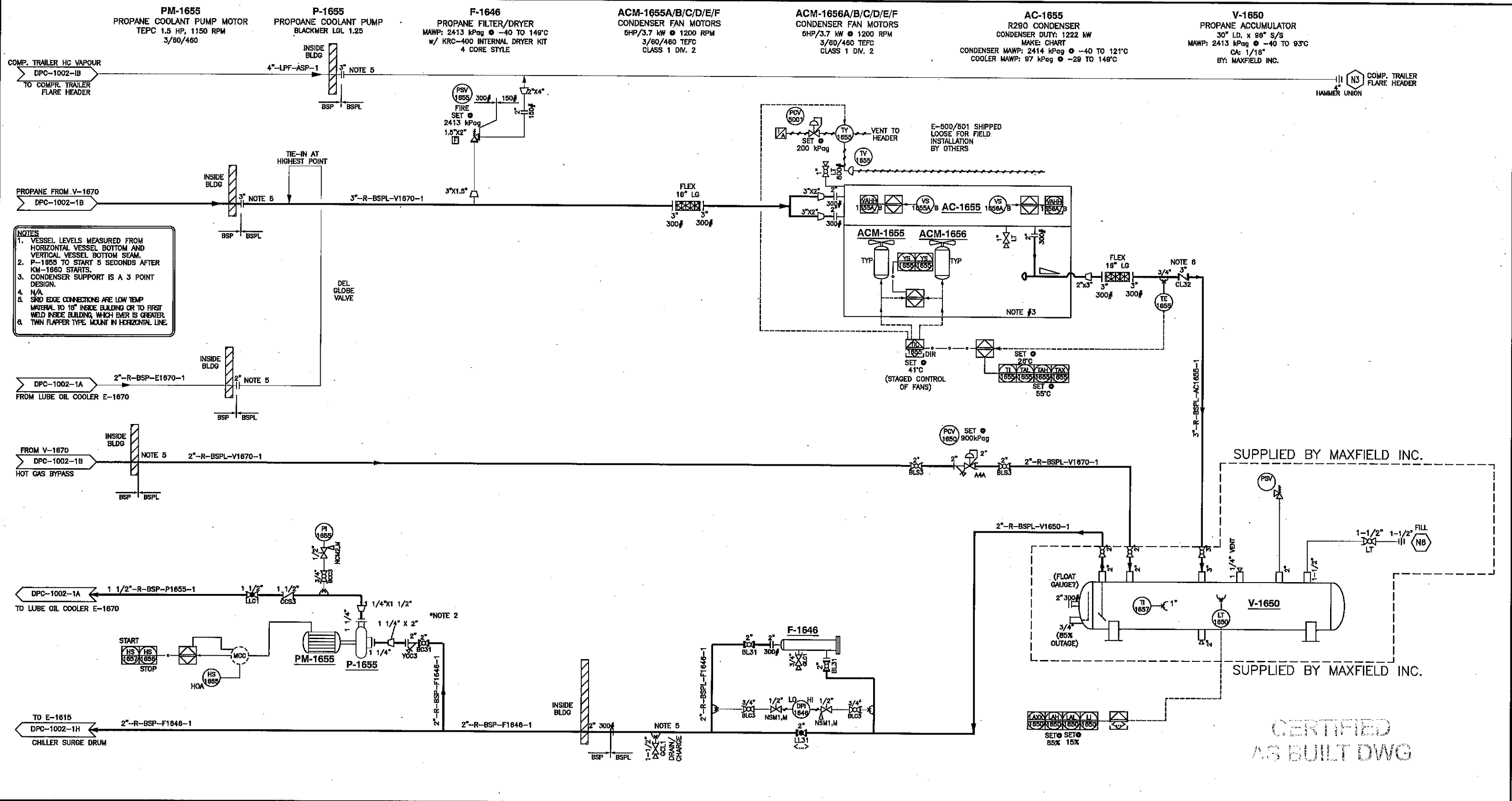
- NOTES:
- FOR PSV-1835 USE EQUIPMENT TAGGED AS PSV-1825.
 - LEVELS MEASURED FROM BOTTOM CIRC SEAM.
 - FOR PV-1839 USE EQUIPMENT TAGGED AS PV-1829.
 - SUCTION PIPING DESIGN FOR MINIMUM AP TO PUMP SUCTION.
 - DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND FITTINGS DOWNSTREAM OF DRAIN VALVE.
 - SKID EDGE CONNECTIONS ARE LOW TEMP MATERIAL TO 18" INSIDE BUILDING OR TO FIRST WELD INSIDE BUILDING, WHICH EVER IS GREATER.
 - N/A
 - N/A
 - CALCULATED AS FT-1830 * Cp * (TE-1631 - TE-1833)



CERTIFIED
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				3	10-12-29	DD	LB	UPDATED AS SHOWN.	
				4	11-01-19	DD	LB	UPDATED AS SHOWN.	PAIN
				5	11-02-07	DD	LB	UPDATED AS SHOWN	
				6	11-03-23	DD	LB	UPDATED AS SHOWN.	
				7	11-05-02	DD		AS BUILT	

DRAWN	DINA DING	DATE	11-05-02	CUSTOMER	GASFRAC ENERGY SERVICES INC.
CHECKED		DATE			
ENG. APPL	<i>d.b.</i>	DATE	11-05-02	TITLE	COMPRESSOR TRAILER AND VESSEL TRAILER P&ID
PROD. APPL		DATE			
JOB NO.	DPC-1002	SCALE	NTS	DRAWING NO.	DPC-1002-1D
		PAGE	4	REV.	7



- NOTES**
1. VESSEL LEVELS MEASURED FROM HORIZONTAL VESSEL BOTTOM AND VERTICAL VESSEL BOTTOM SEAM.
 2. P-1655 TO START 5 SECONDS AFTER KM-1660 STARTS.
 3. CONDENSER SUPPORT IS A 3 POINT DESIGN.
 4. N/A
 5. SKID EDGE CONNECTIONS ARE LOW TEMP MATERIAL TO 18" INSIDE BUILDING OR TO FIRST WELD INSIDE BUILDING, WHICH EVER IS GREATER.
 6. TWIN FLAPPER TYPE MOUNT IN HORIZONTAL LINE.

SUPPLIED BY MAXFIELD INC.

SUPPLIED BY MAXFIELD INC.

CERTIFIED AS BUILT DWG

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ENG. APPL.	<i>[Signature]</i>	DATE	11-05-02	JOB NO.	DPC-1002
PROD. APPL.		DATE		SCALE	NTS
				DRAWING NO.	DPC-1002-1G
				PAGE	5 OF 10
				REV.	7



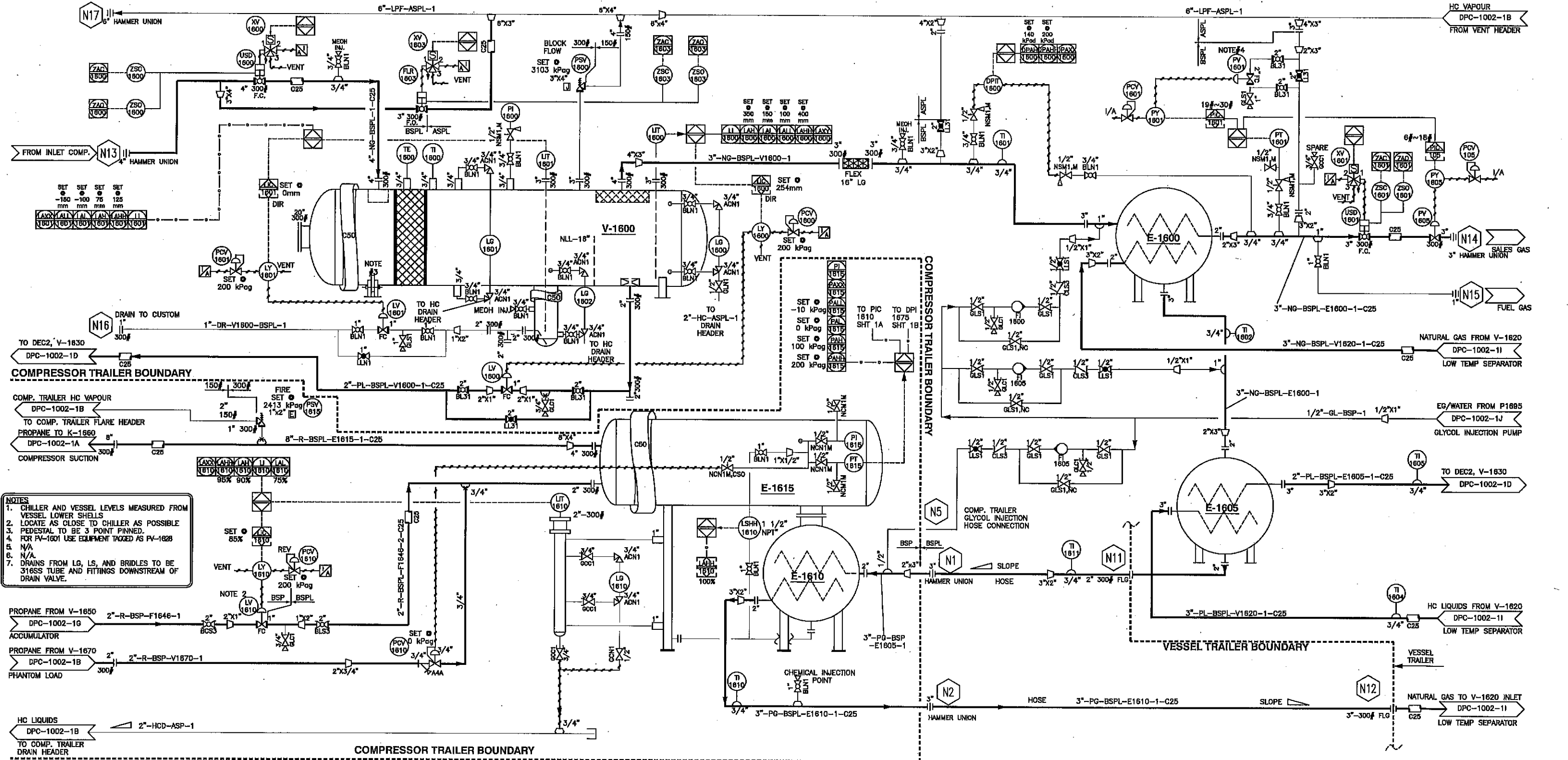
V-1600
 INLET SEPARATOR
 48" OD X 144" S/S
 MAWP: 2413 kPag @ -40 TO 93°C
 CA 1/8"
 C/W BOOT 12.75" OD X 18" LG

E-1600
 GAS/GAS EXCHANGER
 VAHTERUS 17.7 SQ MT
 DUTY: 97 kW
 SHELL MAWP: 2758 kPag @ -40 TO 93°C
 PLATE MAWP: 2758 kPag @ -40 TO 93°C

E-1605
 GAS/LIQUIDS EXCHANGER
 VAHTERUS 10.5 SQ MT
 DUTY: 70 kW
 SHELL MAWP: 2758 kPag @ -40 TO 93°C
 PLATE MAWP: 2758 kPag @ -40 TO 93°C

E-1610
 GAS CHILLER
 VAHTERUS 18.8 SQ MT
 DUTY: 189 kW
 SHELL MAWP: 2758 kPag @ -40 TO 93°C
 PLATE MAWP: 2758 kPag @ -40 TO 93°C

E-1615
 CHILLER SURGE DRUM
 C/W 870mm O.D. x 120mm S/S SURGE
 MAWP: 2413 kPag @ -40 TO 93°C



- NOTES**
1. CHILLER AND VESSEL LEVELS MEASURED FROM VESSEL LOWER SHELLS
 2. LOCATE AS CLOSE TO CHILLER AS POSSIBLE
 3. PEDESTAL TO BE 3 POINT PINNED
 4. FOR PV-1601 USE EQUIPMENT TAGGED AS PV-1628
 5. N/A
 6. N/A
 7. DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND FITTINGS DOWNSTREAM OF DRAIN VALVE.

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION
DPC-1002-1D	TO DEC2, V-1630		
DPC-1002-1B	COMP. TRAILER HC VAPOUR		
DPC-1002-1A	TO COMP. TRAILER FLARE HEADER		
DPC-1002-1A	PROPANE TO K-1860		
DPC-1002-1A	COMPRESSOR SUCTION		
DPC-1002-1G	PROPANE FROM V-1650 ACCUMULATOR		
DPC-1002-1B	PROPANE FROM V-1670 PHANTOM LOAD		
DPC-1002-1B	HC LIQUIDS		

REVISIONS

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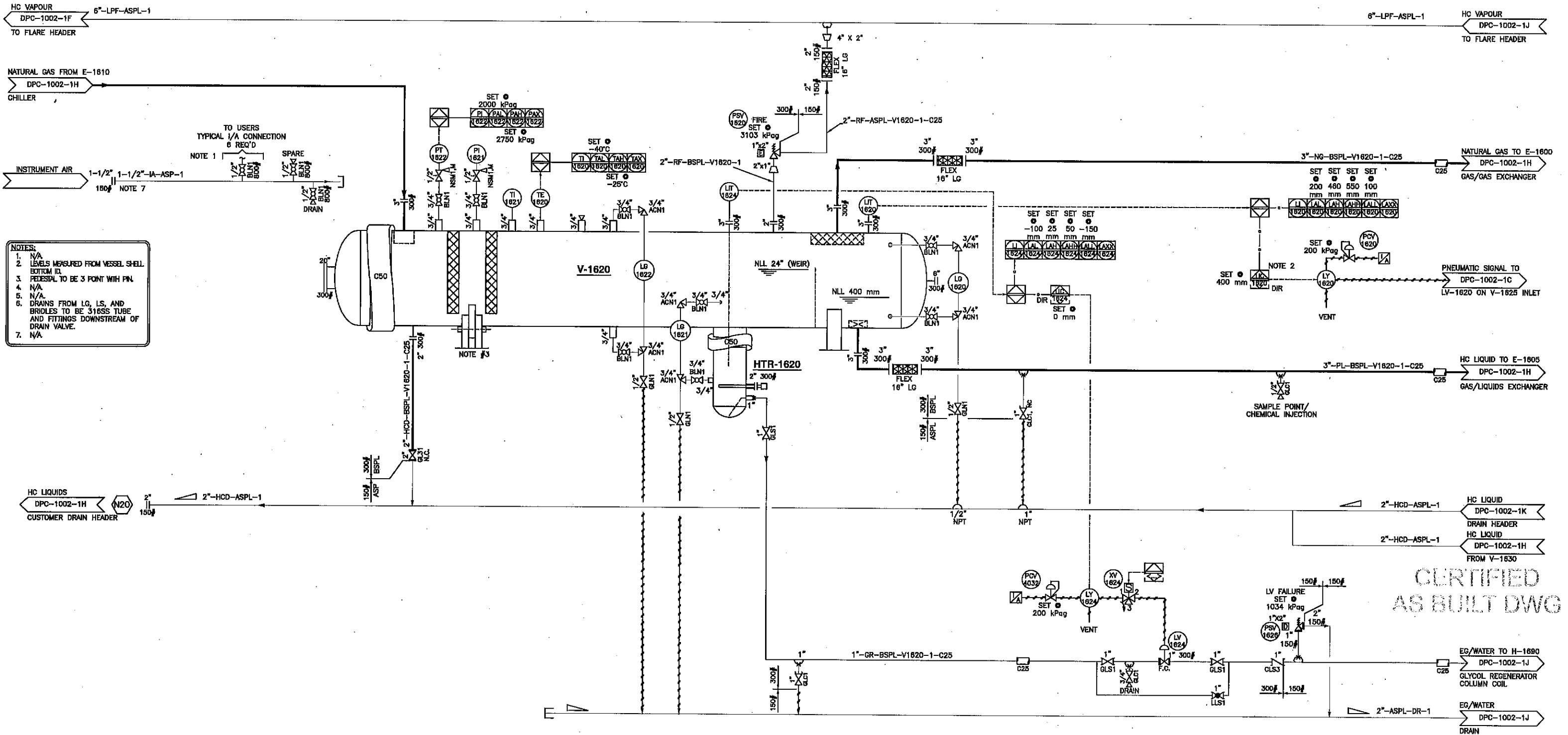
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CHECKED		DATE			
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PROD. APPL.		DATE		SCALE	NTS
JOB NO.	DPC-1002	DRAWING NO.	DPC-1002-1H	PAGE	6
		REV.			7

V-1620
 LOW TEMPERATURE SEPARATOR
 36" OD x 192" S/S
 MAWP: 3103 kPag @ -40 TO 93°C
 C.A.: 1/8"
 c/w 12-3/4" O/D x 10" BOOT

HTR-1620
 IMMERSION HEATER FOR BOOT
 CALORITTECH MODEL: CXFT3013F214X-00X,
 1 KW, 3/60/480VAC
 CLASS 1 DIV. 2
 C/W INTERNAL 'T' STAT



- NOTES:**
1. N/A
 2. LEVELS MEASURED FROM VESSEL SHELL BOTTOM ID.
 3. PEDESTAL TO BE 3 POINT WITH PIN.
 4. N/A
 5. N/A
 6. DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND FITTINGS DOWNSTREAM OF DRAIN VALVE.
 7. N/A

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PROD. APP'L		DATE		JOB NO.	DPC-1002
SCALE	NTS	DRAWING NO.	DPC-1002-11	PAGE 7 OF 10	REV. 7



P-1695
GLYCOL INJECTION PUMP
NEPTUNE 625-N3 M6012
CAP. 2USOPM
@ 500 PSIG
BY BRIDGE TECHNICAL SERVICES.

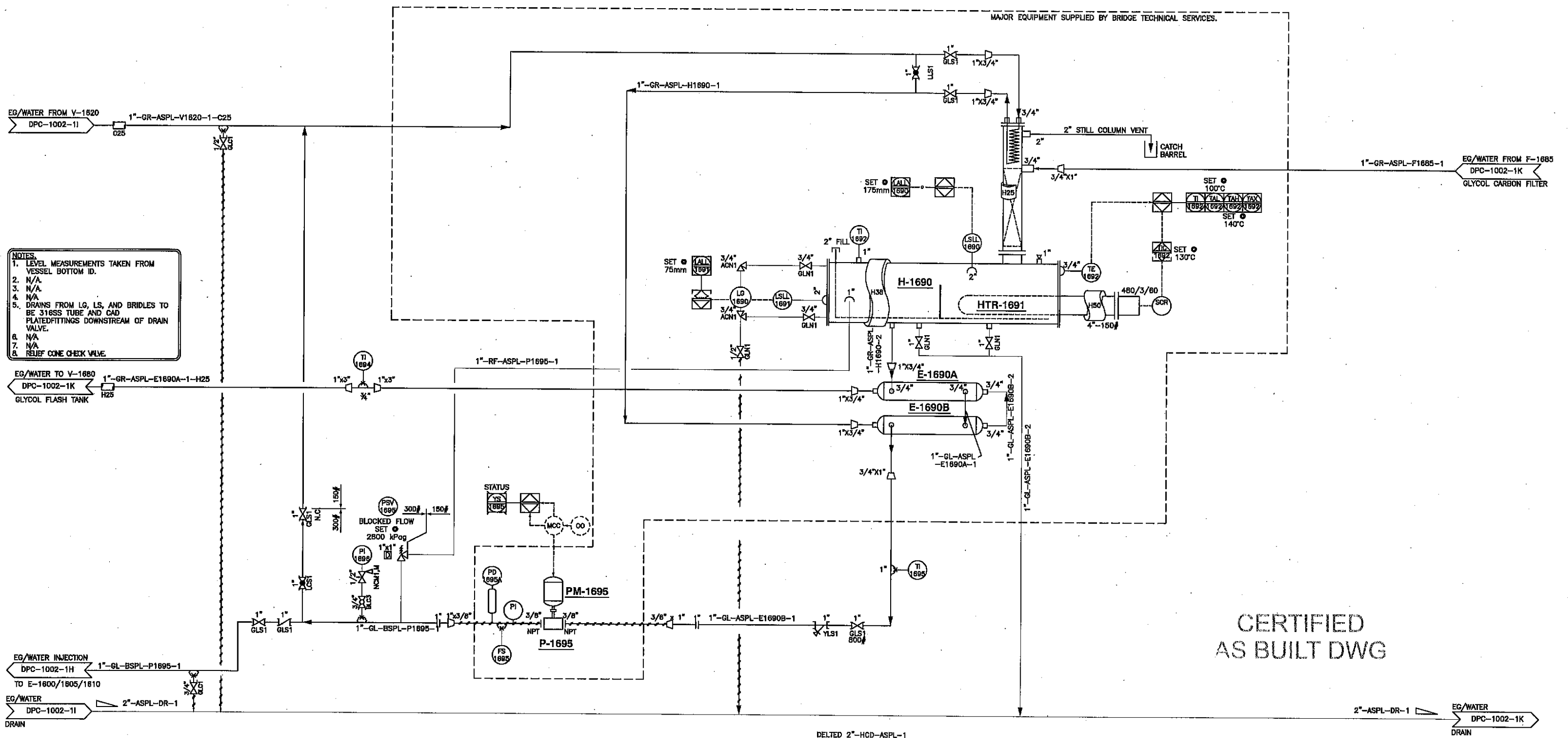
PM-1695
GLYCOL INJECTION PUMP MOTOR
1.0HP, 1800 RPM
3/60/480VAC
CLASS 1 DIV. 2
BY BRIDGE TECHNICAL SERVICES.

H-1690
GLYCOL REGENERATOR
DUTY: 12 KW
MAWP: 1034 kPag @ -29 TO 288°C
12 3/4"O.D. x 60" LG REBOILER/SURGE
BY BRIDGE TECHNICAL SERVICES.

HTR-1691
HOT OIL HEATER
DUTY: 12 KW, 480/3/60
BY BRIDGE TECHNICAL SERVICES.

E-1690A/B
LEAN/RICH GLYCOL EXCHANGER
AC-MODEL B-130
250 PSIG D.P. @ 400°F
BY BRIDGE TECHNICAL SERVICES.

MAJOR EQUIPMENT SUPPLIED BY BRIDGE TECHNICAL SERVICES.



- NOTES:**
1. LEVEL MEASUREMENTS TAKEN FROM VESSEL BOTTOM ID.
 2. N/A
 3. N/A
 4. N/A
 5. DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND CAD PLATED FITTINGS DOWNSTREAM OF DRAIN VALVE.
 6. N/A
 7. N/A
 8. RELIEF CONE CHECK VALVE.

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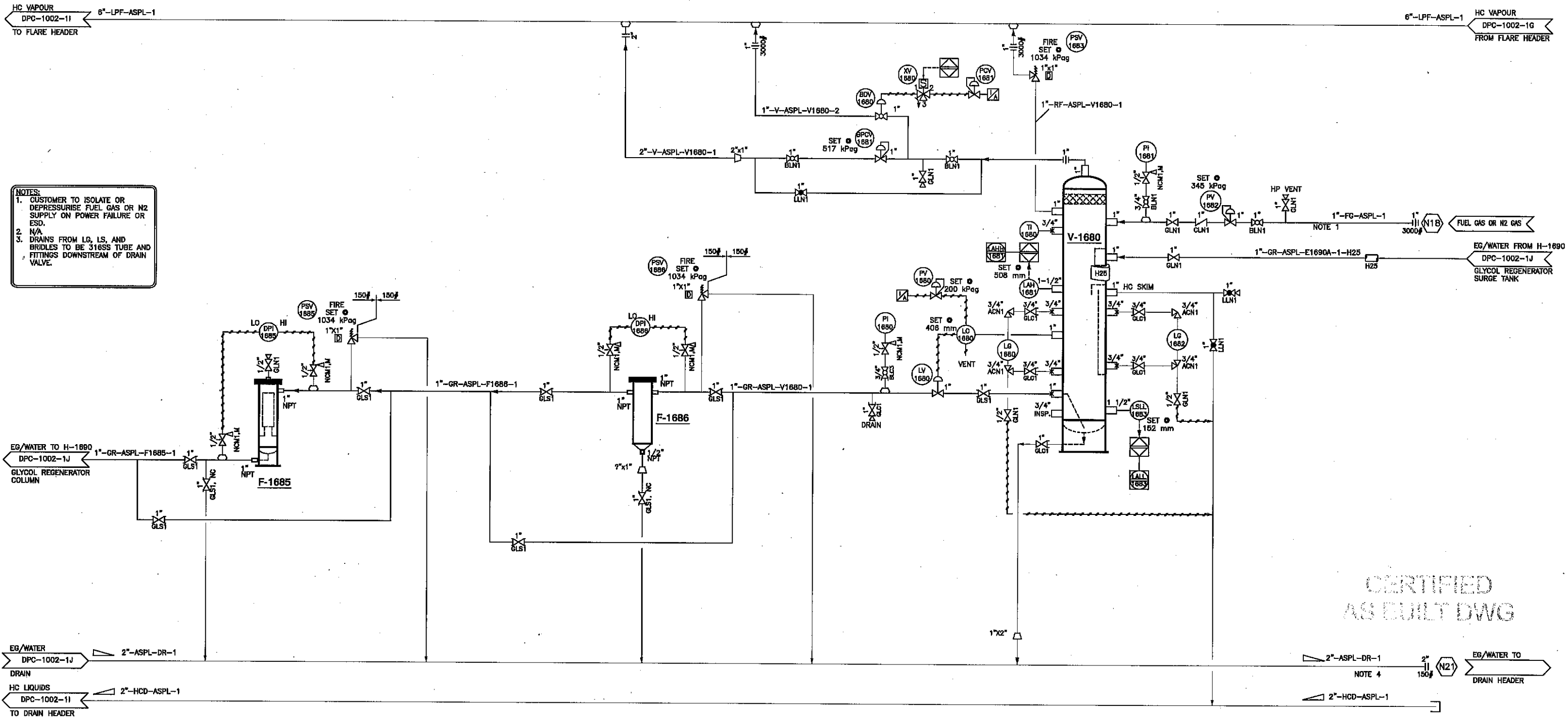


DRAWN DINA DING	DATE 11-05-02	CUSTOMER GASFRAC ENERGY SERVICES INC.
CHECKED	DATE	TITLE COMPRESSOR TRAILER AND VESSEL TRAILER P&ID
ENG. APPL. D.B.	DATE 11-05-31	JOB NO. DPC-1002
PRD. APPL.	DATE	SCALE NTS
		DRAWING NO. DPC-1002-1J
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F-1685
GLYCOL CARBON FILTER
TBA
MAWP: 1034 kPag @ -XX TO 149°C
BY BRIDGE TECHNICAL SERVICES.

F-1686
GLYCOL FILTER
TBA
BAG FILTER
MAWP: 1034 kPag TBC TO 149°C
BY BRIDGE TECHNICAL SERVICES.

V-1680
GLYCOL FLASH TANK
12" O.D. x 80" S/S
MAWP: 1724 kPag @ -40 TO 149°C
C.A.: 1/16"



NOTES:
1. CUSTOMER TO ISOLATE OR DEPRESSURISE FUEL GAS OR N2 SUPPLY ON POWER FAILURE OR ESD.
2. N/A
3. DRAINS FROM LG, LS, AND BRIDLES TO BE 316SS TUBE AND FITTINGS DOWNSTREAM OF DRAIN VALVE.

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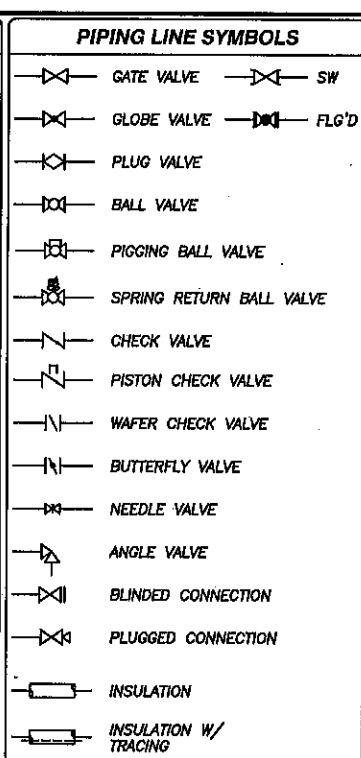
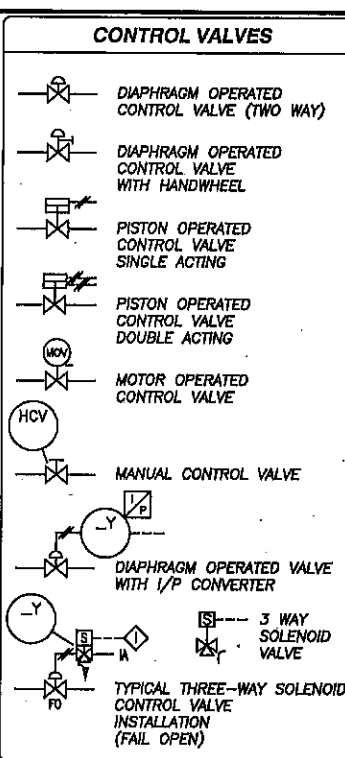
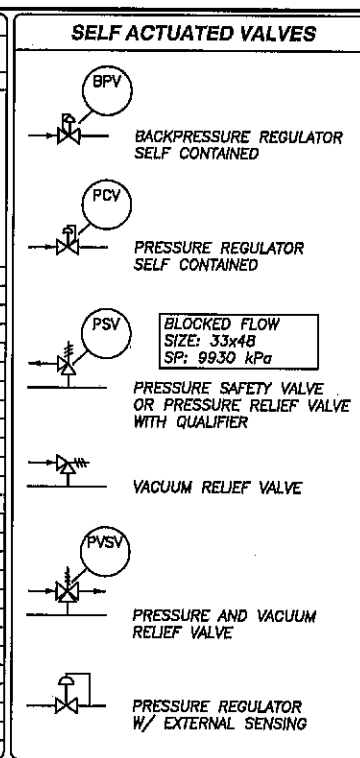
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				1	10-09-27	DD	LB	UPDATED AS SHOWN.						
				2	10-12-06	DD	LB	ISSUED FOR CONSTRUCTION						PRIMER
				3	10-12-29	DD	LB	UPDATED AS SHOWN.						PAIN
				4	11-01-19	DD	LB	UPDATED AS SHOWN.						
				5	11-02-07	DD	LB	UPDATED AS SHOWN.						

DRAWN	DINA DING	DATE	10-07-06	CUSTOMER	GASFRAC ENERGY SERVICES INC.
CHECKED		DATE		TITLE	COMPRESSOR TRAILER AND VESSEL TRAILER P&ID
ENG. APP'L	<i>d.b.</i>	DATE	11-05-02	SCALE	NTS
PROD. APP'L		DATE		DRAWING NO.	DPC-1002-1K
JOB NO.	DPC-1002	PAGE	9	REV.	7
		OF	10		

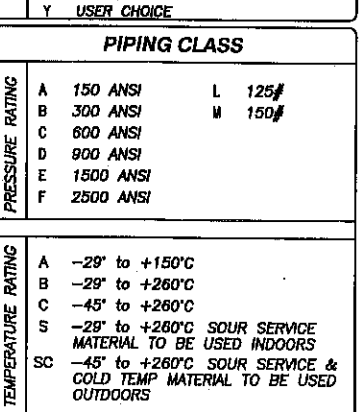
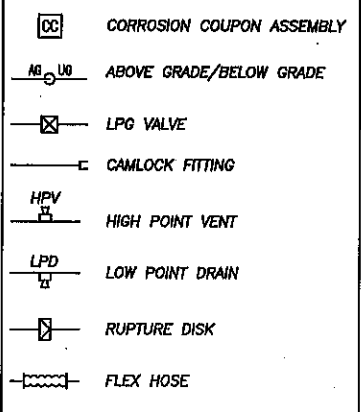
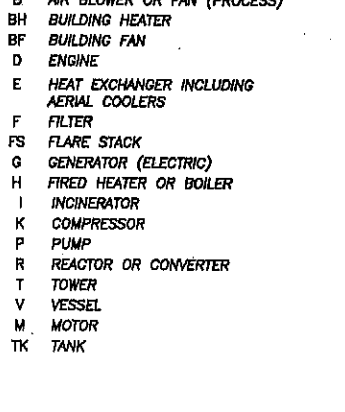
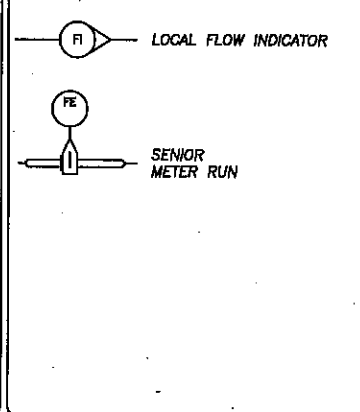
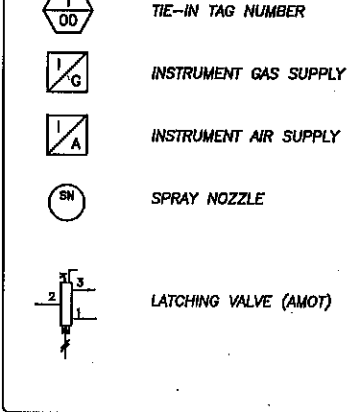
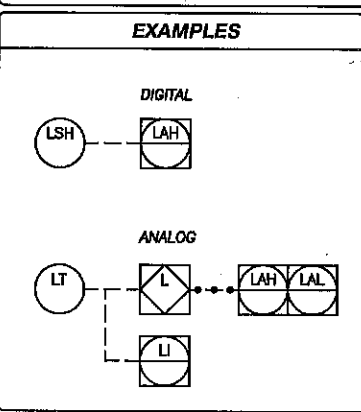
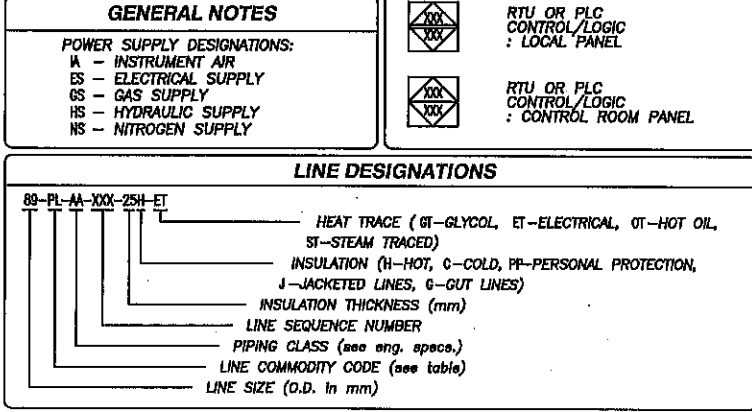
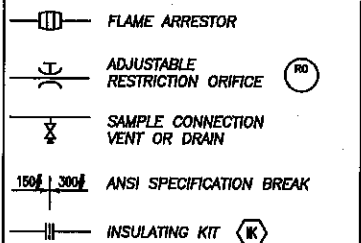
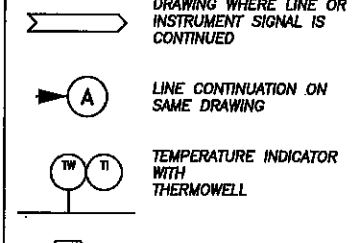
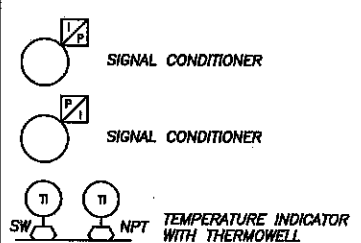
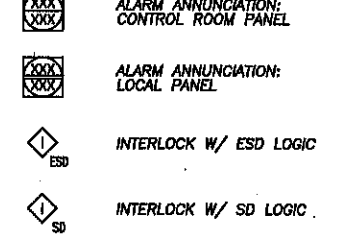
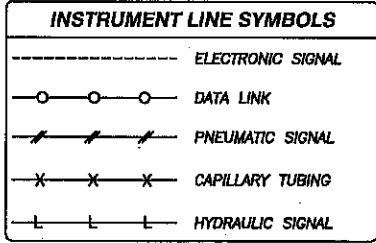
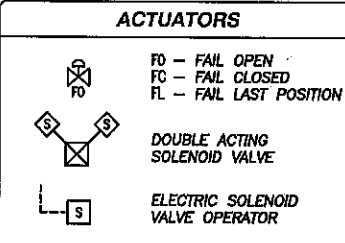
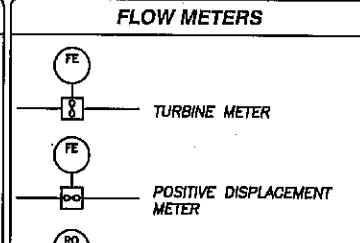
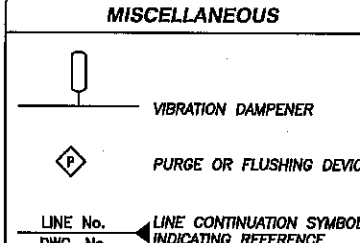
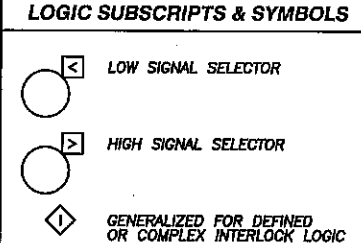
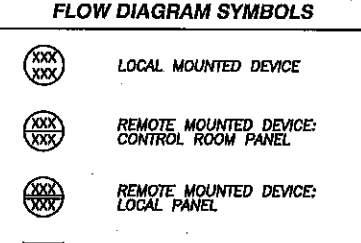
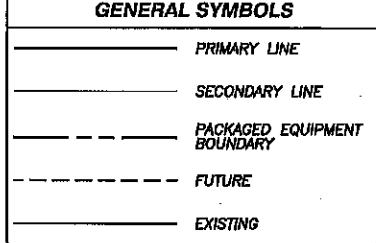


SYMBOLS	INSTRUMENT IDENTIFICATION - SECOND AND SUCCEEDING LETTERS																						
	PRIMARY ELEMENT		READ OUT DEVICES		TRANSMITTERS		CONTROLLERS		FINAL ELEMENT		ALARMS				SWITCHES				MISCELLANEOUS				
	E	R	I	T	DT	IC	C	CV	V	A	AL	ALL	AH	AHH	S	SL	SLL	SH	SHH	Y	Q	SV	G
MEASURED/CONTROLLED VARIABLE																							
ANALYZER	AE	AR	AI	AT	AT	ARC	AIC	AC			AL	ALL	AH	AHH									
BURNER	BE	BR	BI	BT	BIT	BRC	BIC	BC		BA													BG
DENSITY OR SP. GR.	DE	DR	DI	DT	DIT	DRC	DIC	DC															
VOLTAGE	EE	ER	EI	ET	ET	ERC	EIC	EC		EA													
FLOW	FE	FR	FI	FT	FIT	FRC	FIC	FC	FCV	FA	FAL	FALL	FAH	FAHH	FSL	FSL	FSH	FSHH	FY	FQI		FG	
HAND	HE	HR	HI	HT	HT	HRC	HIC	HC	HCV	HA													
CURRENT	IE	IR	II	IT	IT	IRC	IRC	IC		IA													
POWER	JE	JR	JI	JT	JIT	JRC	JIC	JC		JA													
TIME	KE	KR	KI	KT	KIT	KRC	KIC	KC		KA													
LEVEL	LE	LR	LI	LT	LIT	LRC	LIC	LC	LCV	LA	LAL	LALL	LAH	LAHH	LSL	LSL	LSH	LSHH	LY			LG	
MOISTURE OR HUMIDITY	ME	MR	MI	MT	MIT	MRC	MIC	MC		MAL	MALL	MAH	MAHH										
PRESSURE OR VAC.	PE	PR	PI	PT	PDT	PRC	PIC	PC	PCV	PA	PAL	PALL	PAH	PAHH	PSL	PSL	PSH	PSHH	PY			PSV	
QUANTITY	QE	QR	QI	QT	QIT	QRC	QIC	QC															
RADIATION	RE	RR	RI	RT	RT	RRC	RIC	RC															
SPEED	SE	SR	SI	ST	SIT	SRC	SIC	SC															
TEMPERATURE	TE	TR	TI	TT	TIT	TRC	TIC	TC	TCV	TA	TAL	TALL	TAH	TAHH	TSL	TSL	TSH	TSHH	TY				
MULTIVARIABLE	TE	TR	TI	TT	TIT	TRC	TIC	TC	TCV	TA	TAL	TALL	TAH	TAHH	TSL	TSL	TSH	TSHH	TY				
VIBRATION	VE	VR	VI	VT	VIT					VAH	VAH												
WEIGHT	WE	WR	WI	WT	WIT	WRC	WIC	WC															
UNCLASSIFIED																							
POSITION/STATUS	ZE	ZR	ZI	ZT	ZIT	ZRC	ZIC	ZC	ZCV	ZV					ZSH	ZSH						ZG	



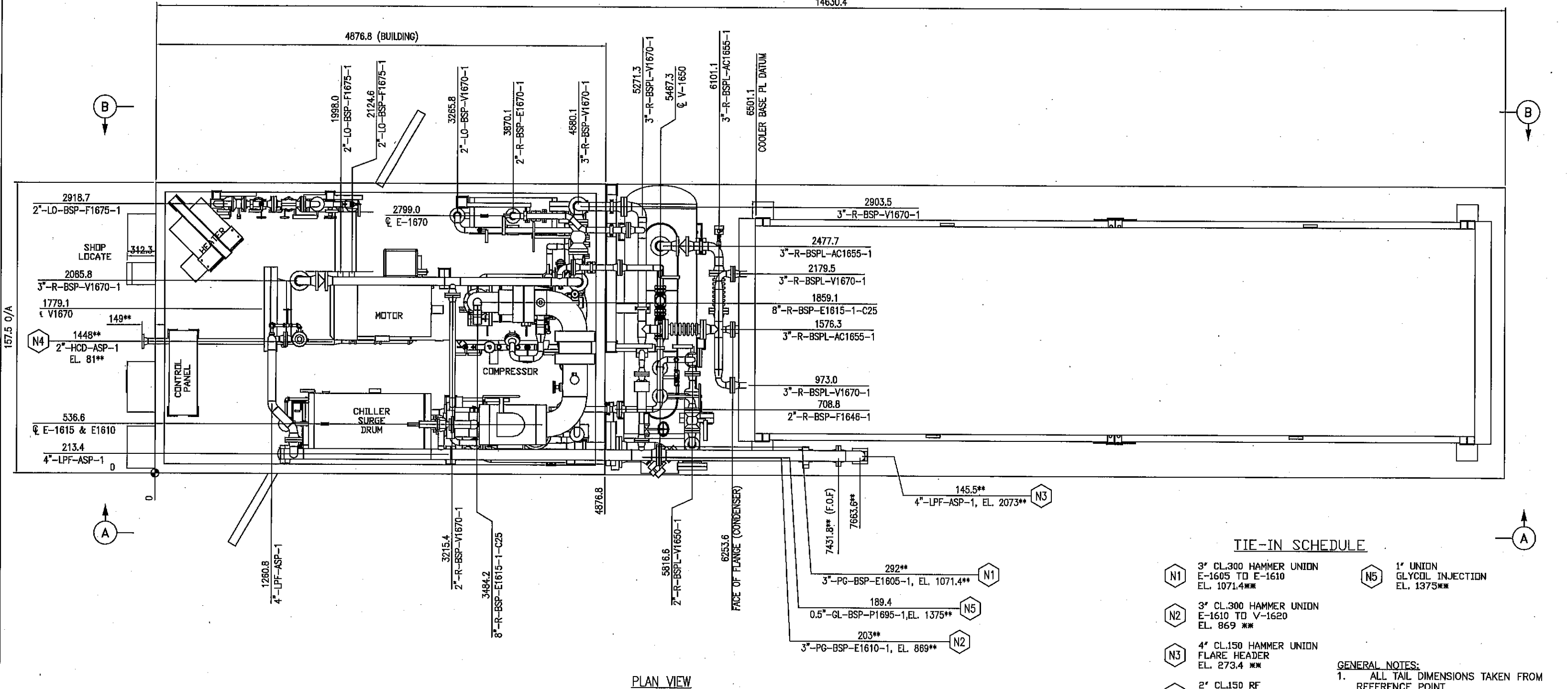
LINE COMMODITY CODE

AA	ACID (* MODIFIER FOR ACID TYPE)
AGF	ACID GAS FLARE
AMD	AMINE DRAIN
AML	LEAN AMINE
AMR	RICH AMINE
BD	BLOWDOWN
BFW	BOILER FEED WATER
BG	BLANKET GAS
CA	COMBUSTION AIR
CD	CLOSED DRAIN
CH	HIGH PRESSURE STEAM CONDENSATE
CL	LOW PRESSURE STEAM CONDENSATE
CM	MED. PRESSURE STEAM CONDENSATE
CW	COOLING WATER
DR	DRAIN
DW	DRINKING WATER (POTABLE)
EX	EXHAUST GAS
FG	FUEL GAS
FO	FUEL OIL
FRP	FIBREGLASS REINFORCED PLASTIC
FW	FIRE WATER
G	GLYCOL
GL	GLYCOL LEAN
GR	GLYCOL REGENERATION
H	HYDROGEN
HCD	HYDROCARBON DRAIN
HMR	HEAT MEDIUM RETURN
HMS	HEAT MEDIUM SUPPLY
HPF	HIGH PRESSURE FLARE
HS	HIGH PRESSURE STEAM
I	INSTRUMENT AIR
JW	JACKET WATER
LO	LUBE OIL
LPF	LOW PRESSURE FLARE
LPG	LIQUID PETROLEUM GAS
LS	LOW PRESSURE STEAM
MCH	METHANOL
MS	MEDIUM PRESSURE STEAM
N	NITROGEN
P	INCOMING STREAM (GAS, EMULSION, OIL)
PO	PROCESS OIL
PG	PROCESS HYDROCARBON GAS
PGS	SOUR PROCESS GAS
PL	PROCESS LIQUIDS
PLS	SOUR PROCESS LIQUIDS
PS	SOUR PROCESS
PU	PURGE GAS
PW	PROCESS WATER
R	REFRIGERANT (PROPANE, ETC.)
RF	RELIEF FLARE
RW	RAW WATER (WELL/RIVER WATER)
SRF	SOUR RELIEF FLARE
SA	START AIR
SG	START GAS
SU	SULPHUR
TW	TREATED WATER (DEMINERALIZED)
UA	UTILITY AIR OR PLANT AIR
UW	UTILITY WATER
V	VENTS/FLARE LINES
Y	USER CHOICE



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 NTS
 DRAWING NO. DPC-1002-1L
 PAGE 10 OF 10
 REV. 7

14630.4



TIE-IN SCHEDULE

- | | | | |
|----|--|----|--|
| N1 | 3" CL.300 HAMMER UNION
E-1605 TO E-1610
EL. 1071.4** | N5 | 1" UNION
GLYCOL INJECTION
EL. 1375** |
| N2 | 3" CL.300 HAMMER UNION
E-1610 TO V-1620
EL. 869 ** | | |
| N3 | 4" CL.150 HAMMER UNION
FLARE HEADER
EL. 273.4 ** | | |
| N4 | 2" CL.150 RF
DRAIN
EL. 81** | | |

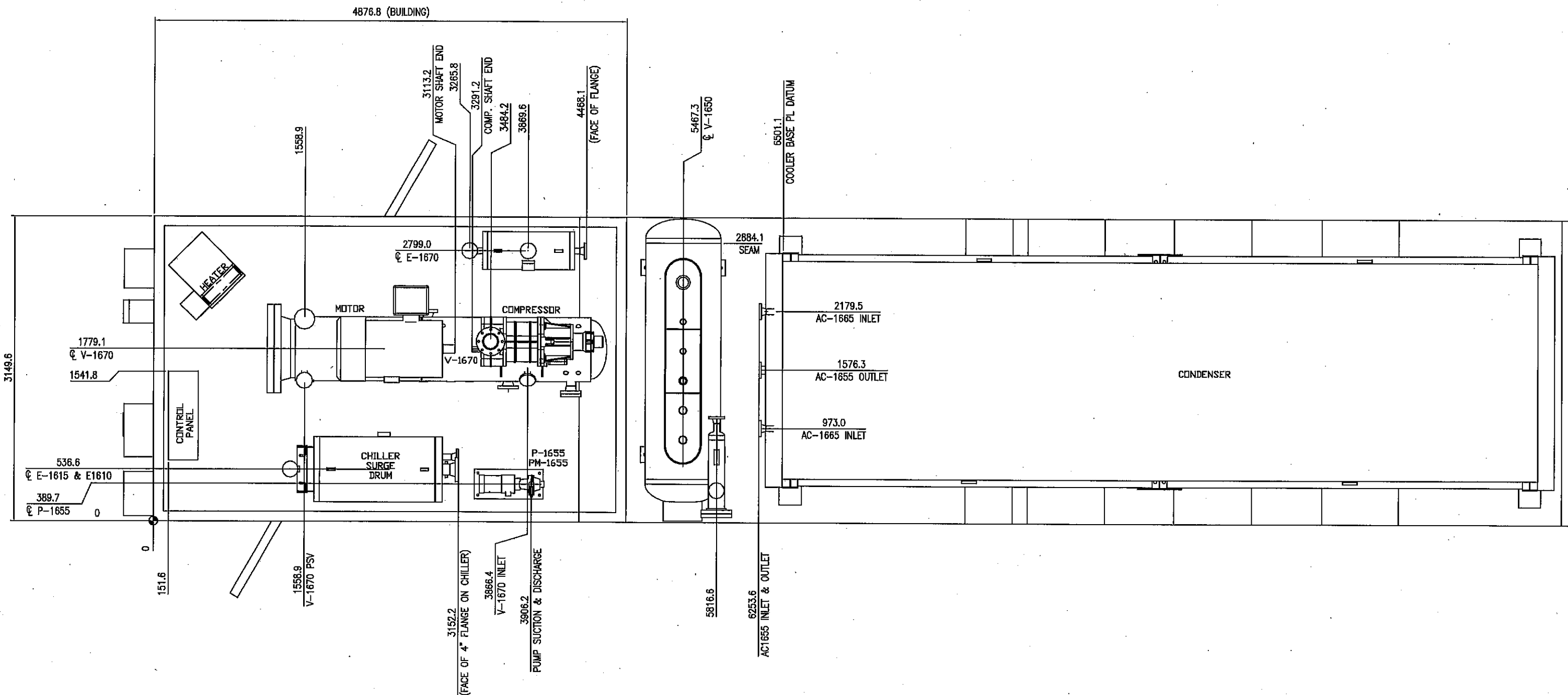
GENERAL NOTES:
 1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
 2. DIM WITH ** MEANS AS BUILT CHECKED

PLAN VIEW

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DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION	NO.	DATE	BY	AP'D	DESCRIPTION	DESCRIPTION		
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				B	10-11-15	DD	LB	ISSUED FOR APPROVAL			
				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION			
				1	11-6-16	DD		AS BUILT			


SHIP WEIGHT		DRAWN	DD	DATE	11-06-16
SANDBLAST		CHECKED		DATE	
PRIMER		ENG. APPL	<i>[Signature]</i>	DATE	11-06-17
PAINT	N/A	PROD. APPL		DATE	
		ABSA VESSEL DRAWING No.			
		VESSEL JOB No.			

CUSTOMER	GASFRAC ENERGY SERVICES INC.	
TITLE	PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT PLAN VIEW	
SCALE	DRAWING NO.	SHT 1 REV.
AS SHOWN	DPC-1002-2-2A-1	1 OF 7 1

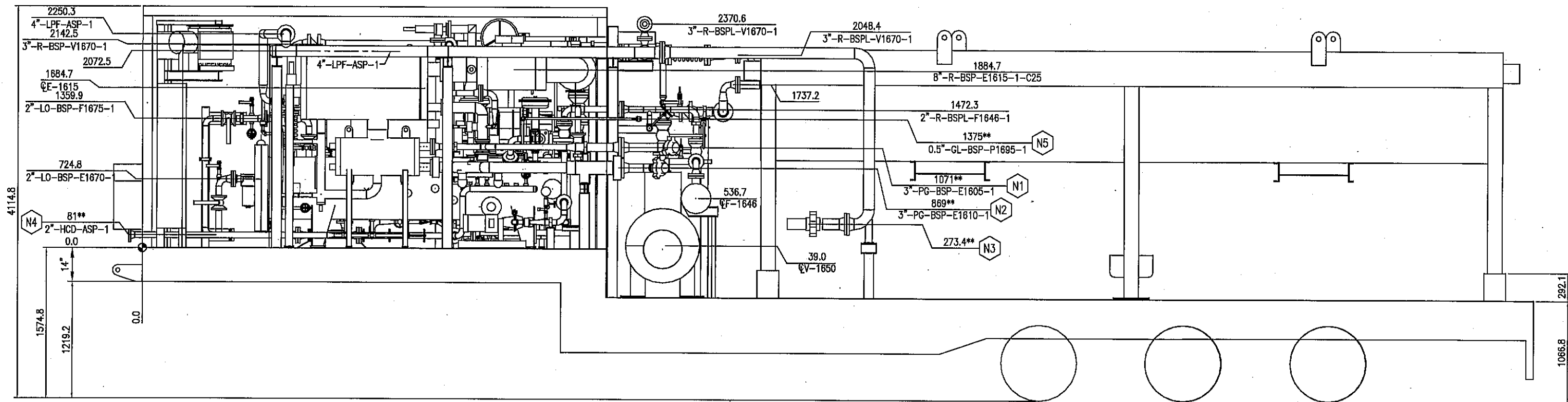


PLAN VIEW

- GENERAL NOTES:
 1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
 2. DIM WITH ** MEANS AS BUILT CHECKED

REFERENCE DRAWINGS				REVISIONS								SHIPPING WEIGHT		 REFRIGERATION • COMPRESSION • PROCESS SOLUTIONS
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				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION						
				1	11-06-16	DD		AS BUILT						

SANDBLAST PRIMER PAINT N/A	DRAWN DD CHECKED ENG. APP'L <i>A.B.</i> PROD. APP'L ABSA VESSEL DRAWING No. VESSEL JOB No.	DATE 11-06-16 DATE 11-06-17	CUSTOMER GASFRAC ENERGY SERVICES INC.	TITLE PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT PLAN VIEW (EQUIPMENT ONLY)
SCALE AS SHOWN	DRAWING NO. DPC-1002-2-2A-2	SHT 2 OF 7	REV. 1	



ELEVATION A-A VIEW

GENERAL NOTES:

1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
2. FOR VIEW DIRECTIONS SEE SHT DPC-1002-2-2A-1
3. DIM WITH ** MEANS AS BUILT CHECKED

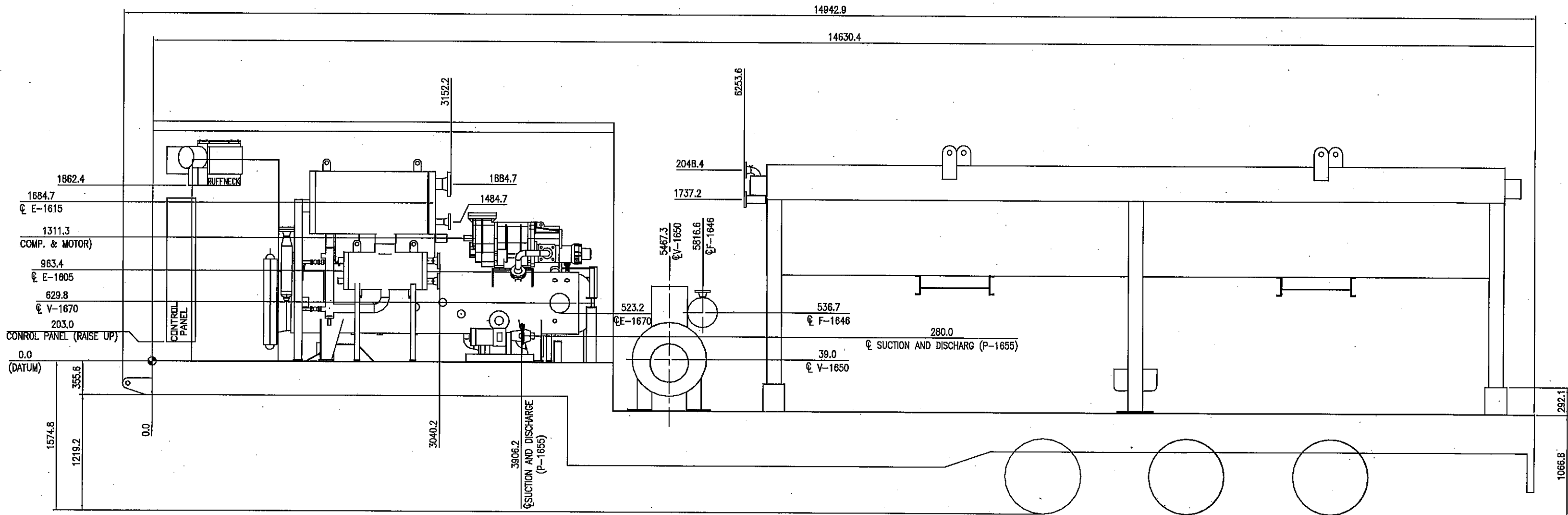
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				B	10-11-15	DD	LB	ISSUED FOR APPROVAL							CHECKED	DATE	
				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION							ENG. APP'L	DATE	
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															VESEL JOB No.		PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT ELEVATION A-A VIEW
																	SCALE
																	AS SHOWN
																	DRAWING NO.
																	DPC-1002-2-2B-1
																	SHT
																	3
																	REV.
																	1



CUSTOMER: GASFRAC ENERGY SERVICES INC.

TITLE: PORTABLE PROPANE RECOVERY UNIT
GENERAL ARRANGEMENT
ELEVATION A-A VIEW

SCALE: AS SHOWN
 DRAWING NO.: DPC-1002-2-2B-1
 SHT 3 OF 7
 REV. 1

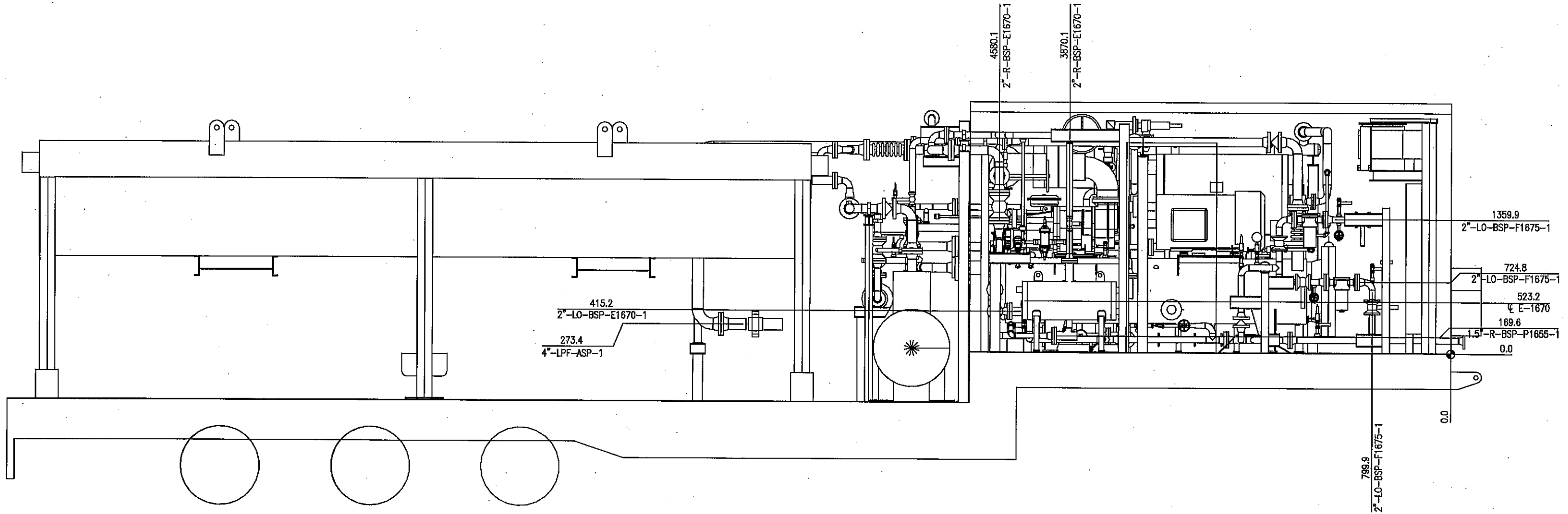


ELEVATION A-A VIEW
EQUIPMENT ONLY

- GENERAL NOTES:**
1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
 2. FOR VIEW DIRECTIONS SEE SH1
 3. DIM WITH ** MEANS AS BUILT CHECKED

REFERENCE DRAWINGS				REVISIONS								SHIPPING WEIGHT	SANDBLAST	DRAWN DD DATE 11-06-18	CHECKED DATE	CUSTOMER GASFRAC ENERGY SERVICES INC.				
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				B	10-11-15	DD	LB	ISSUED FOR APPROVAL												
				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION												
				1	11-06-16	DD		AS BUILT												
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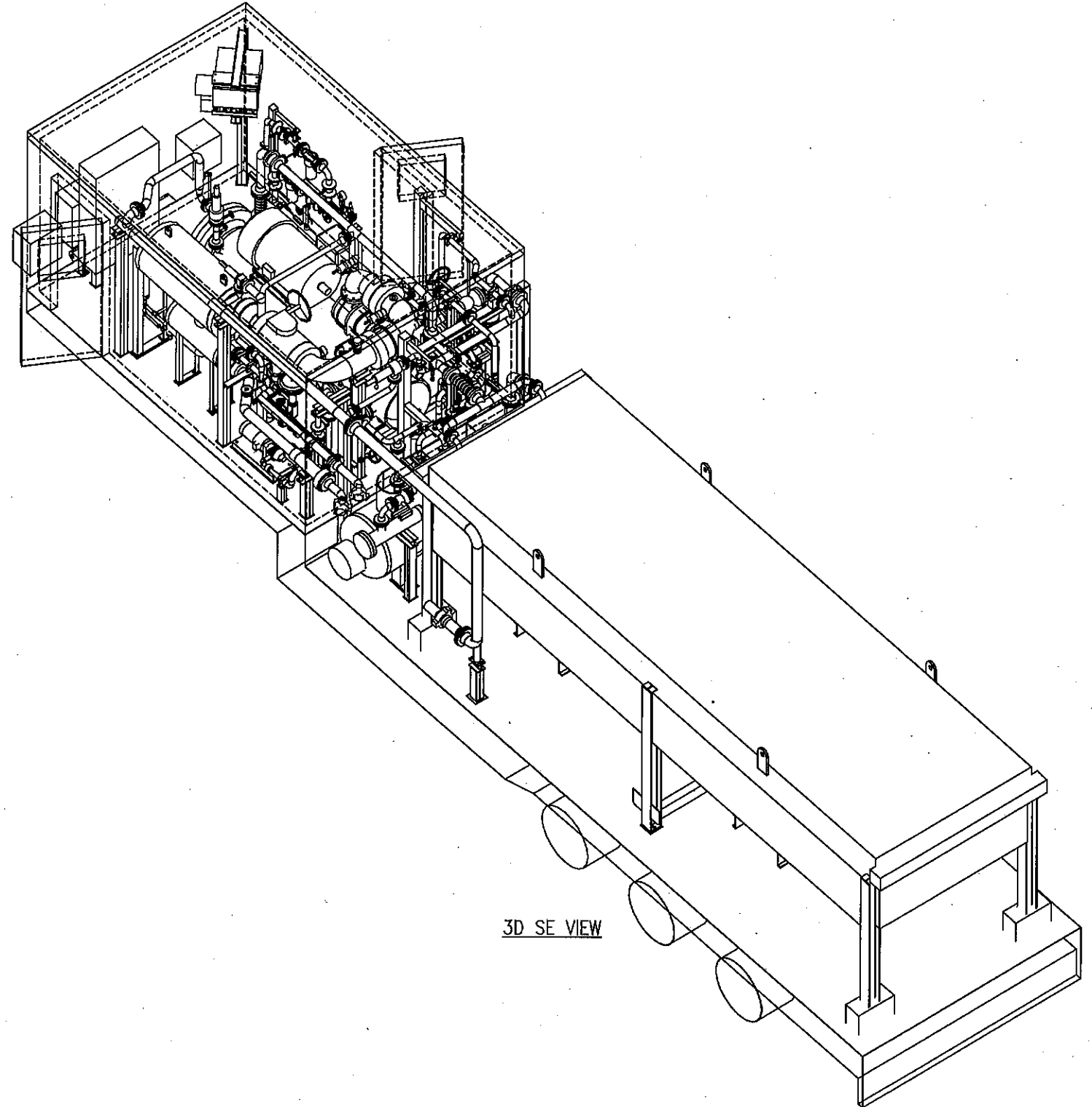
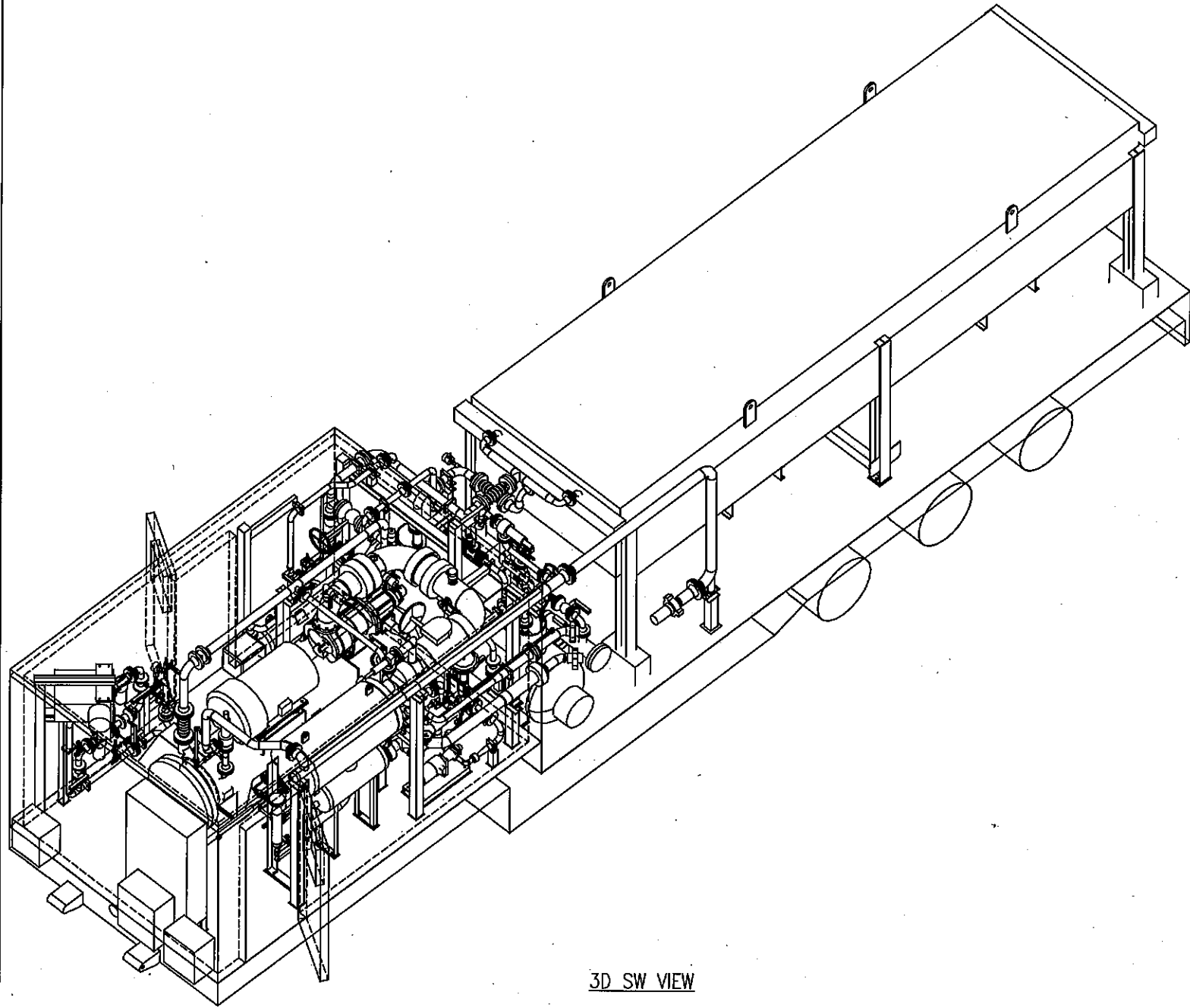


ELEVATION B-B VIEW

- GENERAL NOTES:**
- ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
 - DIM WITH ** IS AS BUILT CHECKED

REFERENCE DRAWINGS				REVISIONS												SHIPPING WEIGHT		STARTEC REFRIGERATION • COMPRESSION • PROCESS SOLUTIONS	
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				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION								ENG. APPL	DATE		
				1	11-05-09	DD		AS BUILT								PROD. APPL	DATE		
																		TITLE	PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT ELEVATION B-B VIEW
																		SCALE	AS SHOWN
																		DRAWING NO.	DPC-1002-2-2B-3
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																		REV.	1
																		TITLE	OF 7

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REFERENCE DRAWINGS				REVISIONS								SHIPPING WEIGHT		DRAWN		CUSTOMER
DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION	NO.	DATE	BY	AP'D	DESCRIPTION	NO.	DATE	BY	AP'D	DESCRIPTION	DATE	DATE	
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				B	10-11-15	DD	LB	ISSUED FOR APPROVAL								
				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION								
				1	11-05-09	DD		AS BUILT								
																TITLE
																PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT 3D VIEW - SW & SE
																SCALE
																AS SHOWN.
																DRAWING NO.
																DPC-1002-2-2C-1
																SHT 6
																REV. 1
																TTL OF 7



CUSTOMER
GASFRAC ENERGY SERVICES INC.

TITLE
PORTABLE PROPANE RECOVERY UNIT
GENERAL ARRANGEMENT
3D VIEW - SW & SE

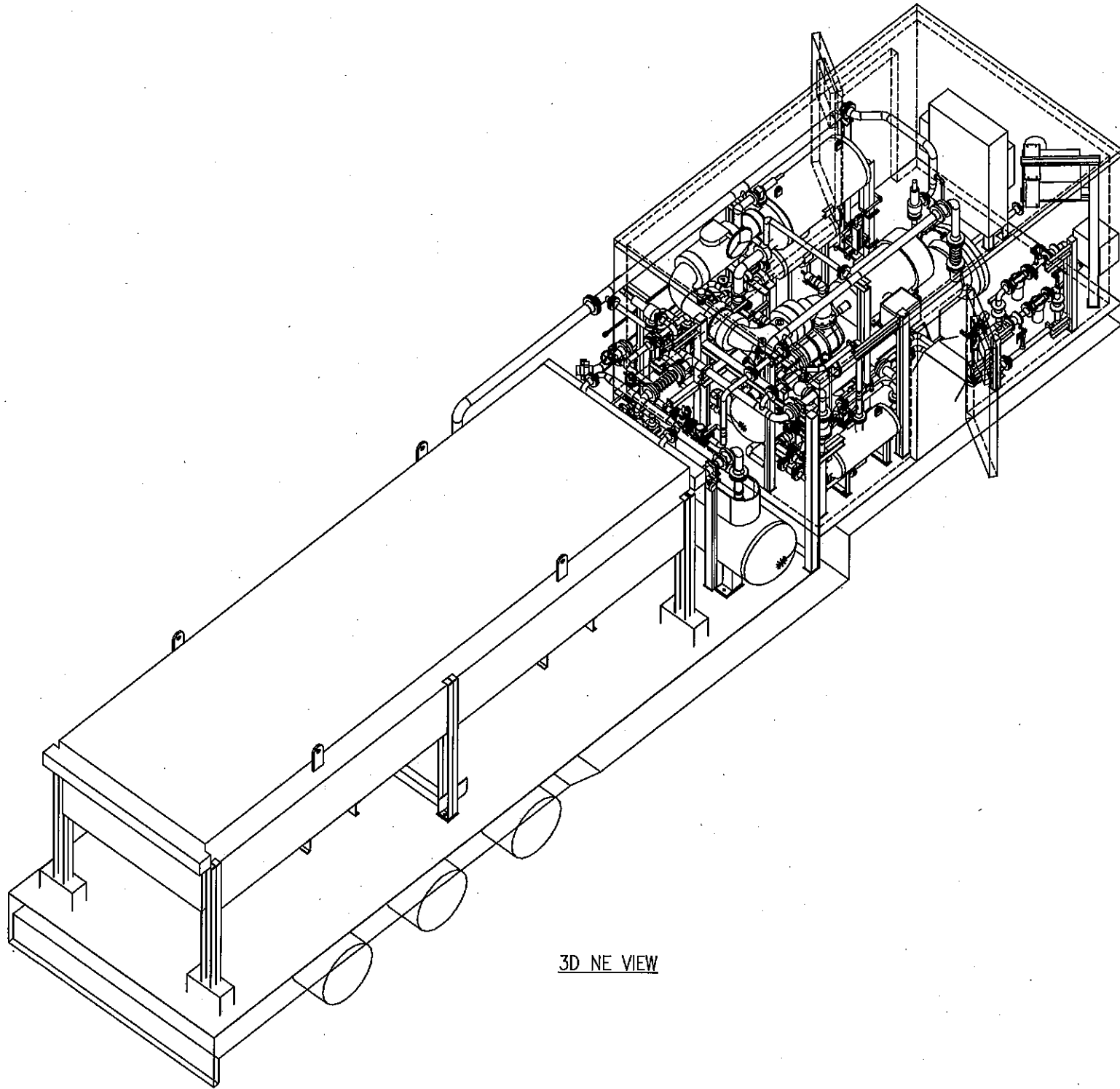
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AS SHOWN.

DRAWING NO.
DPC-1002-2-2C-1

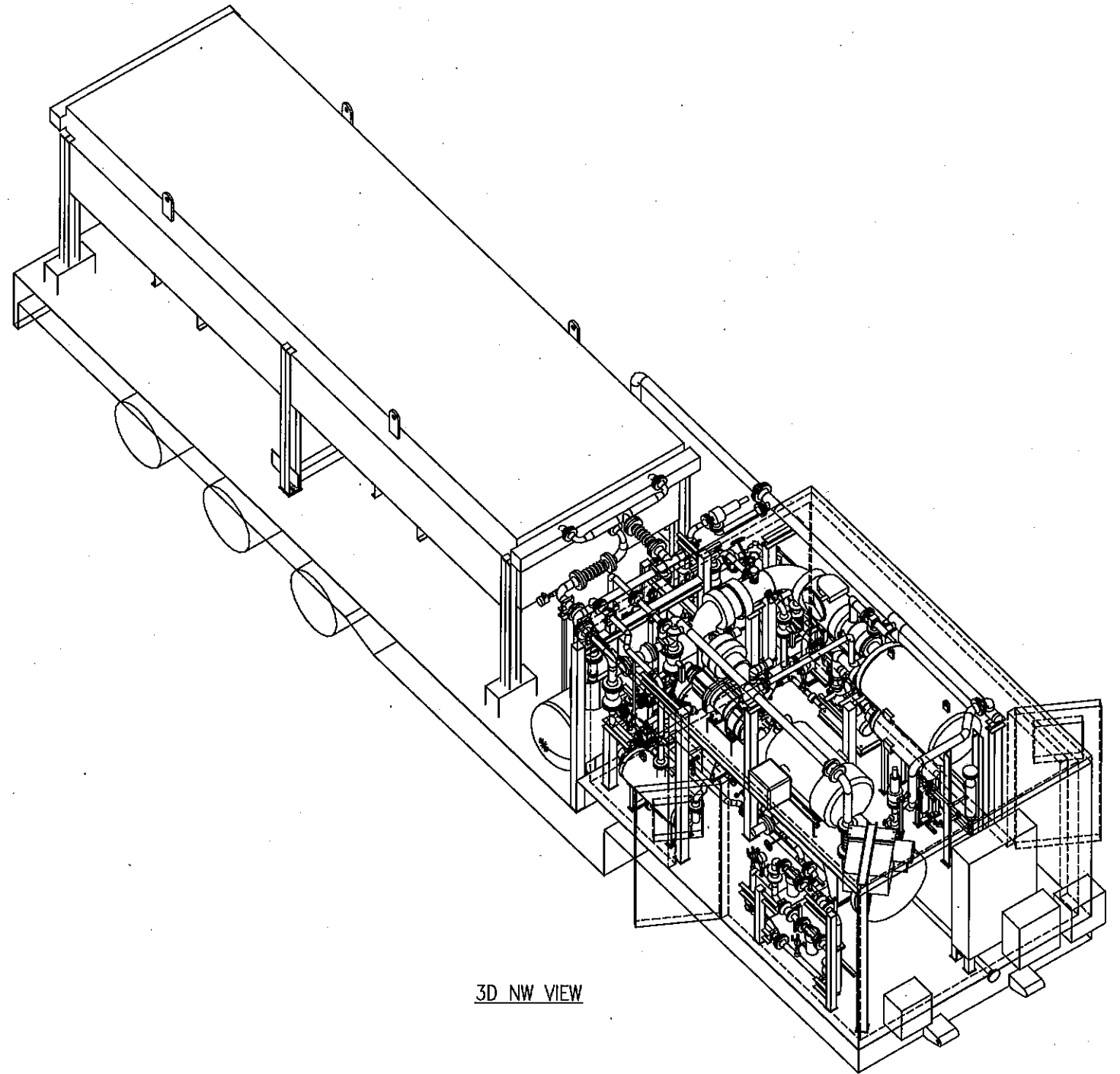
SHT 6
REV. 1

TTL OF 7


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3D NE VIEW



3D NW VIEW

REFERENCE DRAWINGS				REVISIONS								SHIPPING WEIGHT		 REFRIGERATION • COMPRESSION • PROCESS SOLUTIONS		
DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION	NO.	DATE	BY	AP'D	DESCRIPTION	NO.	DATE	BY	AP'D	DESCRIPTION			
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				B	10-11-15	DD	LB	ISSUED FOR APPROVAL								
				0	11-01-11	DD	LB	ISSUED FOR CONSTRUCTION								
				1	11-05-09	DD		AS BUILT								
														SANDBLAST	DRAWN DD	DATE 11-05-09
														PRIMER	CHECKED	DATE
															ENG. APP'L. <i>LB</i>	DATE 11-06-17
															PROD. APP'L.	DATE
														PAINT	ABS VESSEL DRAWING No.	
														N/A	VESSEL JOB No.	
				SCALE AS SHOWN		DRAWING NO. DPC-1002-2-2C-2		SHT 7 OF 7		REV. 1		CUSTOMER GASFRAC ENERGY SERVICES INC.		TITLE PORTABLE PROPANE RECOVERY UNIT GENERAL ARRANGEMENT 3D VIEW - NE & NW		

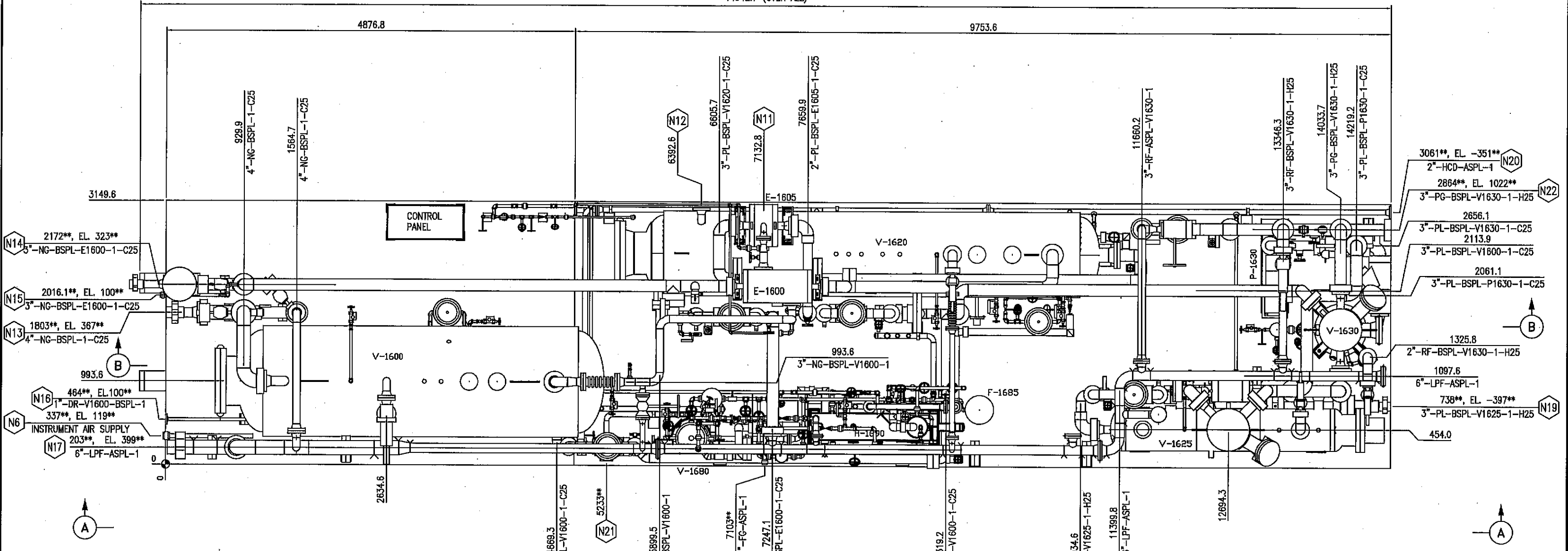
STARTEC
 REFRIGERATION • COMPRESSION
 • PROCESS SOLUTIONS

CUSTOMER
 GASFRAC ENERGY SERVICES INC.

TITLE
 PORTABLE PROPANE RECOVERY UNIT
 GENERAL ARRANGEMENT
 3D VIEW - NE & NW

SCALE AS SHOWN DRAWING NO. DPC-1002-2-2C-2 SHT 7 OF 7 REV. 1

14942.7 (OVER ALL)



TIE-IN SCHEDULE

- N11 3" CL.300 FLANGE E-1605 TO E-1610 EL. 1072
- N12 3" CL.300 FLANGE E-1610 TO V-1620 EL. 855
- N13 4" CL.300 HAMMER UNION FROM CUSTOMER INLET COMP. EL. 367**
- N14 3" CL.300 HAMMER UNION TO CUSTOMER SALE GAS EL. 323**
- N15 1" UNION FROM E-1600 TO CUSTOMER FUEL GAS EL. 100**
- N16 1" CL 300 FLANGE FROM V-1600 TO CUSTOMER DRAIN EL. 100**
- N17 6" CL HAMMER UNION CUSTOMER FLARE LINE EL. 399**
- N18 1" 3000# UNION FROM CUSTOMER FUEL GAS DR N2 GAS CONN. TO V-1680 EL. 653**
- N19 3" CL300 HAMMER UNION FROM V-1625 TO CUSTOMER CONN. EL. -397**
- N20 2" CL 300 FLANGE FROM 2"-HCD-ASPL-1 TO CUSTOMER CONN. EL. -351**
- N21 2" CL 300 FLANGE FROM 2"-ASPL-DR-1 CUSTOMER CONN. EL. -397**
- N22 3" CL 300 FLANGE FROM 3"-PG-BSPL-V1630-1-H25 TO CUSTOMER CONN. EL. 1022**
- N6 1-1/2" 3000# CPLG INSTRUMENT AIR SUPPLY FROM CUSTOMER EL. 119**

PLAN VIEW

GENERAL NOTES:
 1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
 2. DIM WITH ** MEANS AS BUILT CHECKED

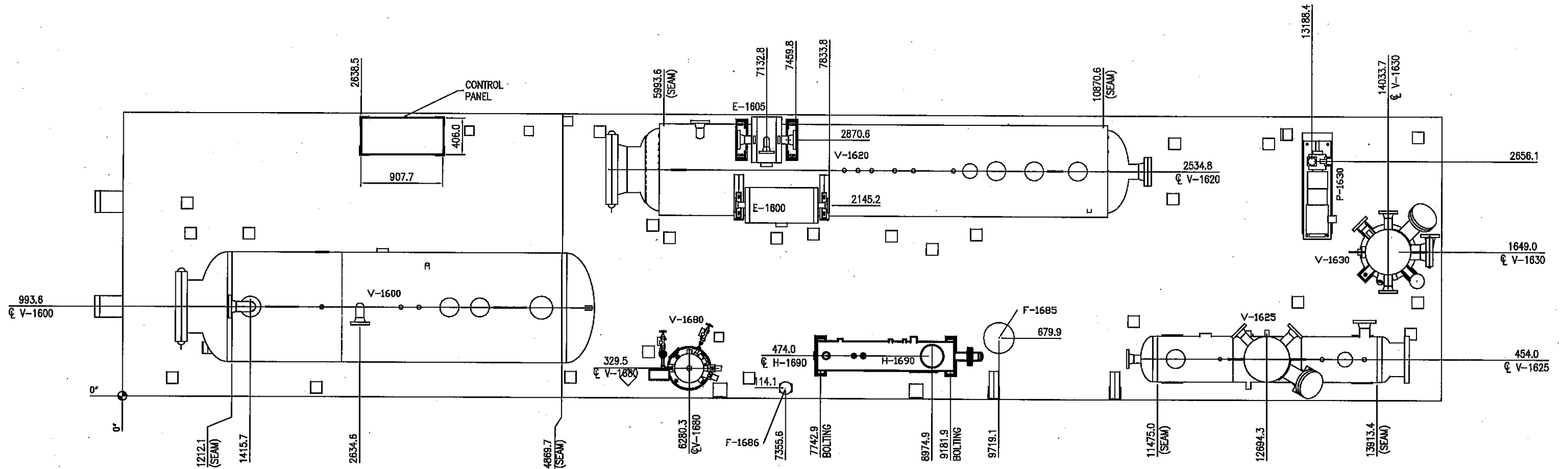
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				B	10-11-01	DD	LB	ISSUED FOR APPROVAL											
				0	11-02-01	DD	LB	ISSUED FOR CONSTRUCTION											
				1	11-05-09	DD		AS BUILT							11-06-14		VESSEL TRAIL GENERAL ARRANGEMENT PLAN VIEW		



CUSTOMER GASFRAC ENERGY SERVICES INC.

TITLE VESSEL TRAIL GENERAL ARRANGEMENT PLAN VIEW

SCALE DRAWING NO. DPC-1002-2A-2A SHT 1 REV. 1



EQUIPMENT - PLAN VIEW

GENERAL NOTES:

1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
2. FOR VIEW DIRECTIONS SEE SHT DPC-1002-2A-2A
3. DIM WITH ** MEANS AS BUILT CHECKED

REFERENCE DRAWINGS

REVISIONS

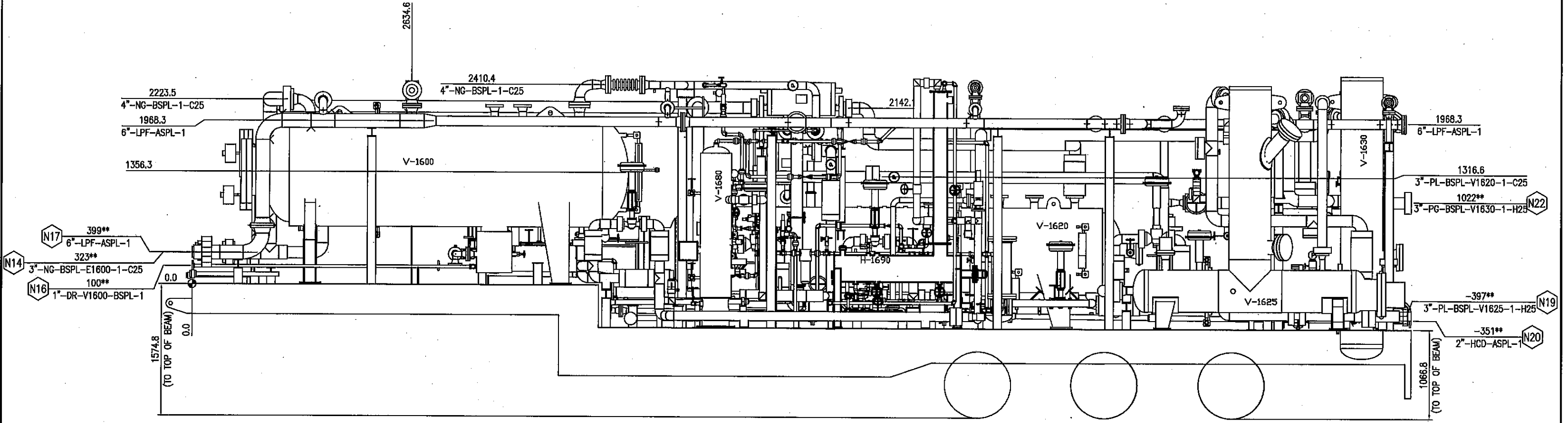
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				0	11-02-01	DD	LB	ISSUED FOR CONSTRUCTION						
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TITLE
VESSEL TRAIL
GENERAL ARRANGEMENT
EQUIPMENT PLAN VIEW

SCALE
DRAWING NO. DPC-1002-2A-2A
SHT 2
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REV. 1



ELEVATION VIEW A-A
(DATUM IS ON TOP OF BEAM)

- GENERAL NOTES:**
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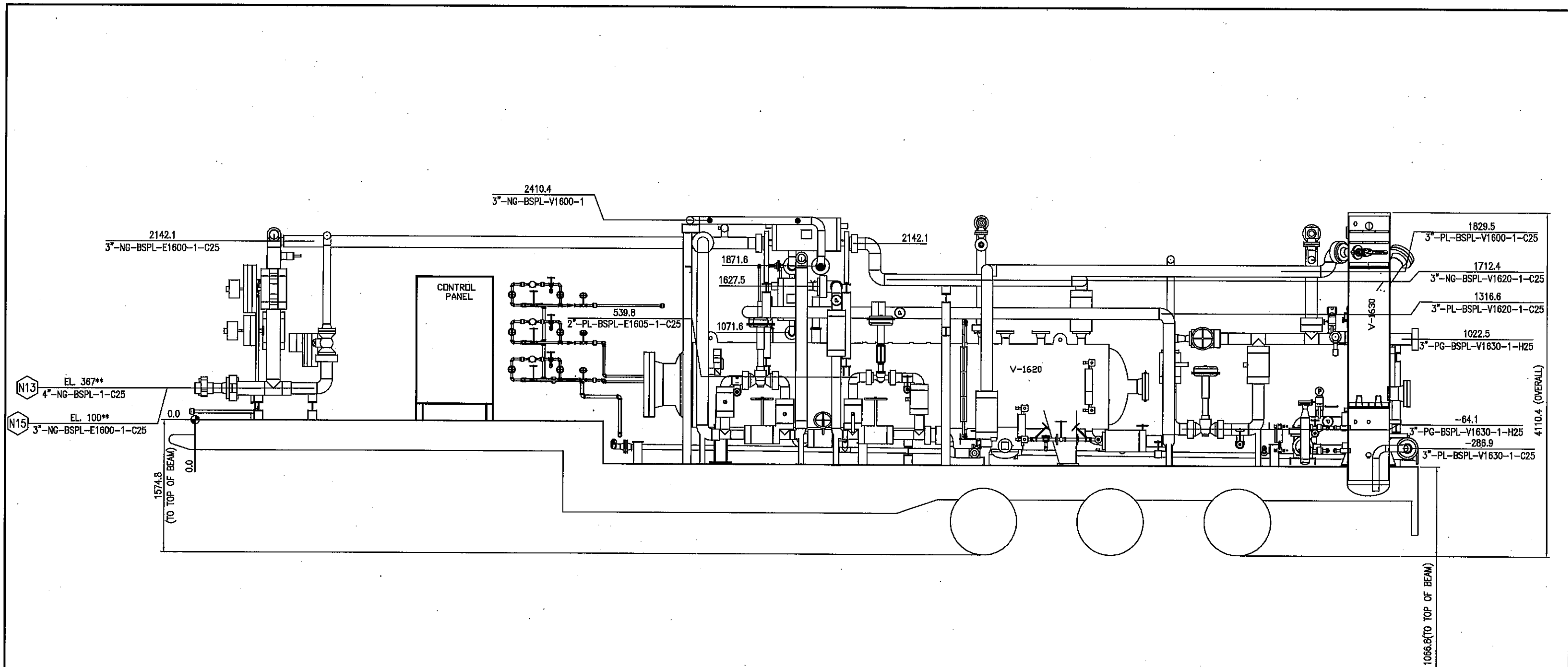
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TITLE
VESSEL TRAILER
GENERAL ARRANGEMENT
ELEVATION VIEW A-A

SCALE
DRAWING NO. DPC-1002-2A-2B
SHT 3
REV. 7 1



ELEVATION VIEW B-B
DATUM IS ON TOP OF BEAM)

GENERAL NOTES:

1. ALL TAIL DIMENSIONS TAKEN FROM REFERENCE POINT.
2. FOR VIEW DIRECTIONS SEE SHT DPC-1002-2A-2A
3. DIM WITH ** MEANS AS BUILT CHECKED

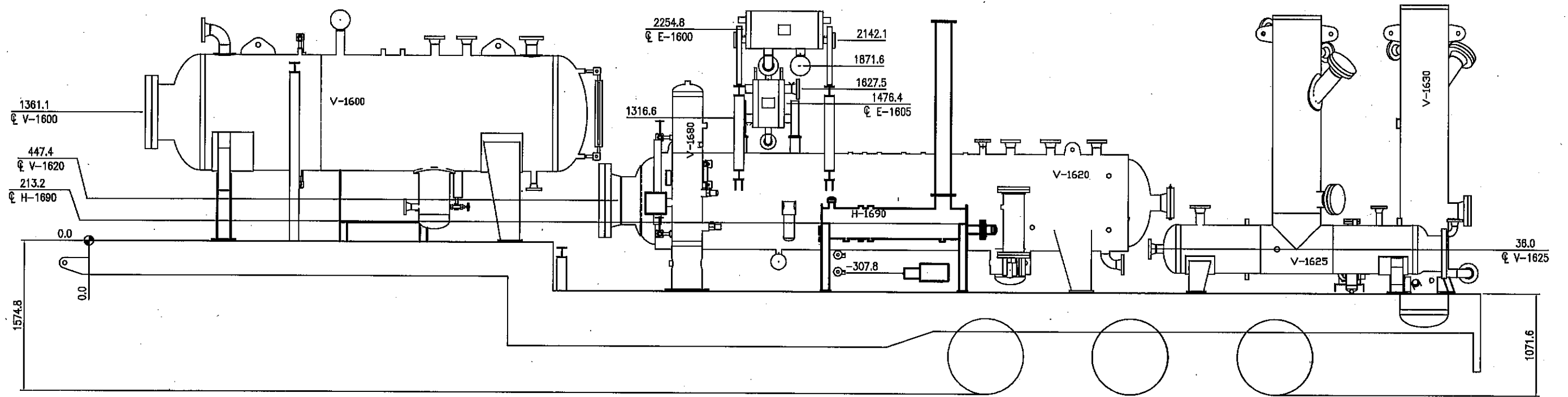
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TITLE
VESSEL TRAILER
GENERAL ARRANGEMENT
ELEVATION VIEW B-B

SCALE
DRAWING NO.
DPC-1002-2A-2B
SHT 4
ITL 7
REV. 1

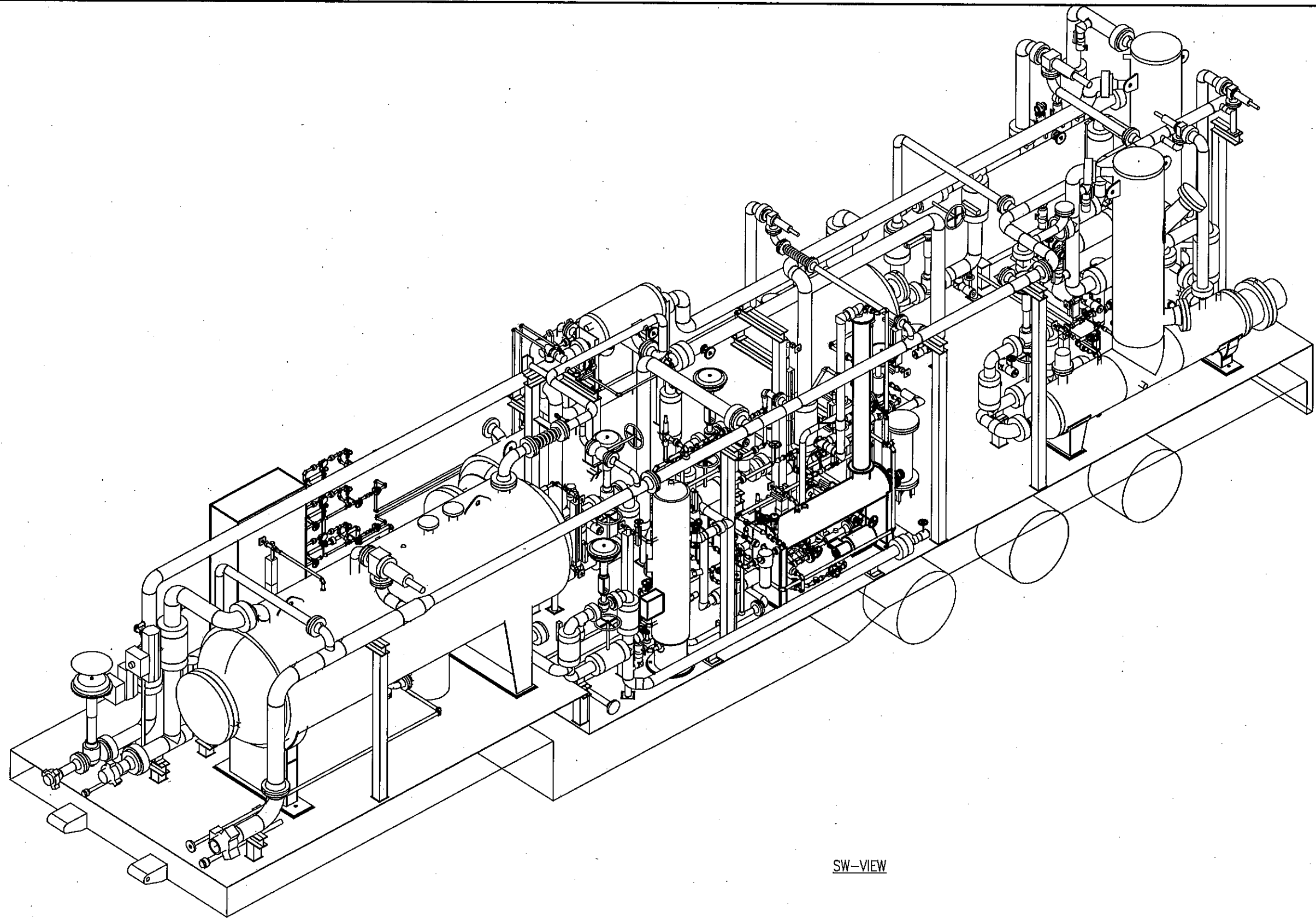


EQUIPMENT - ELEVATION VIEW
DATUM IS ON TOP OF BEAM)

- GENERAL NOTES:
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 2. DIM WITH ** MEANS AS BUILT CHECKED

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SW-VIEW

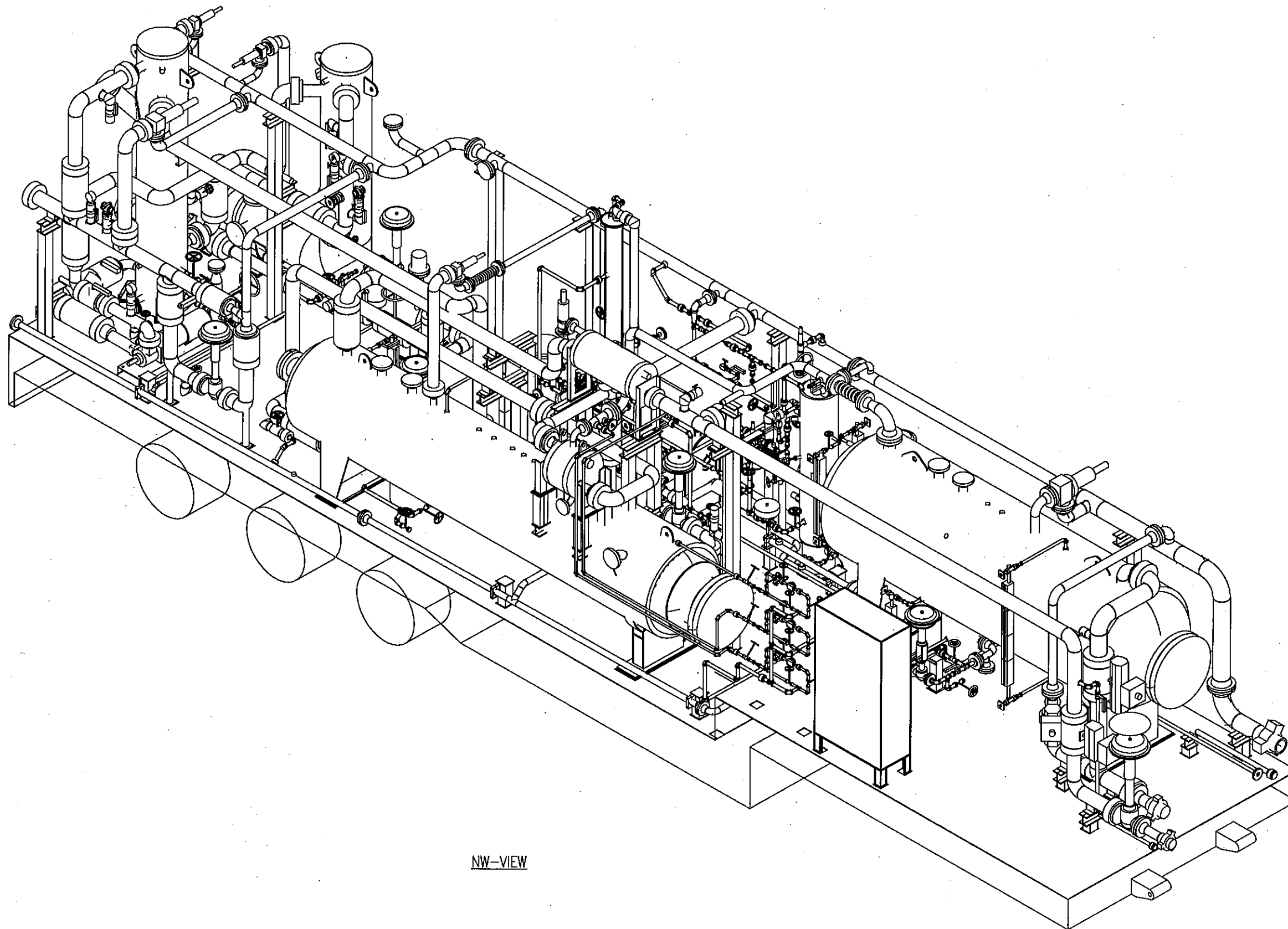
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TITLE
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GENERAL ARRANGEMENT
3D VIEW - SW

SCALE
DRAWING NO.
DPC-1002-2A-2C
SHT 6
REV. 7



NW-VIEW

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CUSTOMER
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TITLE
VESSEL TRAILER
GENERAL ARRANGEMENT
3D VIEW - NW

SCALE
DRAWING NO.
DPC-1002-2A-2C

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VESSEL JOB No.
N/A

SHT 7
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REV. 1

**GASFRAC PROPANE RECOVERY UNIT
 STARTEC COMPRESSION & PROCESS SOLUTIONS
 FOR
 GASFRAC ENERGY SERVICES Inc.**

Document Title: Propane Recovery Plant Process, Operation and Control Description

0	19 July 2011	Issued For Shop Asbuilt	LP	LB	LB
A	6-Oct-10	Issued For Comment	Startec	DTL	AMM
REV	DATE	DESCRIPTION	BY	CHECKED	APPROVED

**PROJECT DOCUMENTS ARE CONTROLLED DOCUMENTS.
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CLIENT: GASFRAC Energy Services	CLIENT REF:
	Startec REF: DPC-1002



**STARTEC COMPRESSION & PROCESS SOLUTIONS for
GASFRAC ENERGY SERVICES Inc.**

4.0 mmscfd Propane Recovery Plant

(Startec job DPC-1002)

Process, Operation, and Control Description

Startec Compression and Process Solutions

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1. INTRODUCTION

This Manual provides a description of the equipment and its operation and control. The process is described together with the suggested start and stop sequences. The individual control loops are also described. Lists of alarms, trips and PSVs are provided as Appendices.

This propane recovery plant is designed and built by Startec Compression & Process Solutions, Calgary, Canada, for GASFRAC Energy Services Inc. (Calgary). They are also the end user and will use the plant throughout the western provinces of Canada and in the United States in their well stimulation business.

The propane recovery plant is designed to treat up to 4.0 mmscfd of Flow Back well stimulation fluid, producing dry gas and the recovered propane liquid as products.

The package consists of two trailered units being a propane refrigeration plant and a gas process unit with interconnecting hose and facilities for quick connection of the required utilities.

2. PROCESS OVERVIEW

2.1 DESIGN CASES, FEEDS AND PRODUCTS

The gas and liquid feed stream for the propane recovery plant are fracture fluids that are flowed back from a fractured well to complete the well fracturing process.

The flow back process flow composition is not constant. Higher proportions of the propane fracturing fluid are seen at the start of the flow back and the proportion of the propane fracturing fluid declines as the well flow gradually lifts out the fracturing fluid from the well. The process simulation for the recovery process covered a range of propane compositions from 90% down to 10% and the equipment has been provided to meet the worst case sizing requirement for the 4.0 mmscfd design flow.

The gas feed enters the plant at the inlet separator V-1600 and the propane rich off gas goes on to a typical Dew Point control system of heat exchangers and a propane refrigerate chiller to remove additional LPG liquids from the gas stream. These liquids are then combined with the free hydrocarbon liquid separated initially in the inlet separator and this hydrocarbon liquid feed goes to the deethanizer unit V-1625 / V-1630 to fractionate to meet the required HD5 propane specification of the bottoms product.

Note: throughout this Manual the design controller setpoints, design alarm and trip setpoints, design pressures, temperatures and flows are used. These will vary during commissioning and operation and should be used as an initial set of values for starting the plant. The final operating values for alarms, trips and controller setpoints will be determined during commissioning and the first few months of operation. Some setpoints related to the compressor lube oil system are manufacturer specified and should not be changed without approval of Startec.

The feed and product conditions are noted in the following tables:

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2.2 SIMPLIFIED PROCESS DESCRIPTION

2.2.1 Normal Case

Fracturing Fluids and well effluent from the client's targeted wellbore are first filtered of any suspended frac sand or propanant prior to a choked well flow control manifold. This flow is vaporized using an indirect fired line heater. The proprietary chemicals used to gel the propane are removed and the vapour stream is sent to the propane recovery plant. This fluid stream enters the inlet separator where any free liquids are retained and separation of any hydrocarbon liquids from formation water can take place in this 3 phase separator. The gas stream off the top of the inlet separator then goes to the dew-point control equipment. The gas stream is then cooled by passing through the shell side of the gas-to-gas exchanger E-1600, further cooled passing through the shell side of gas-to-liquids exchanger E-1605 and is then chilled in Gas Chiller E-1610. A propane (R290) refrigeration system provides cooling for the gas chiller E-1610.

A glycol / water mix is injected at each shell side exchanger inlet mentioned above to prevent hydrate formation. The three-phase flow from E-1610 is separated in a 3-phase low temperature separator (LTS) V-1620. The cold vapour from V-1620 passes to the plate side of the gas-to-gas exchanger E-1600 and is warmed by the incoming gas stream and leaves the dew-point plant as product gas for sale or disposal.

The cold hydrocarbon liquids from the LTS pass to the plate side of the gas-liquids exchanger E-1605 and is warmed by the incoming gas stream and flows through LV-1620. This hydrocarbon liquid stream combines with the hydrocarbon liquid stream accumulated in the inlet separator V-1600 and flows through LV-1600 to the inlet of deethanizer tops tower V-1625. Because of transport height limitations the deethaizer tower has been split into two shorter towers. The tops tower previously mentioned V-1625 and the bottoms tower V-1630 that has the reboiler heating element HTR-1630 that provides the heat to drive off the light ends in the liquid feed stream.

V-1625 is a non-refluxed distillation column designed to remove most of the ethane from the bottoms product. The ethane-rich deethanizer overheads are recycled (compressed) to the plant inlet, sold or disposed of at the flare-stack. The deethaniser bottoms flows to the propane product storage tank ????? to be located elsewhere on the wellsite.

The rich glycol from LTS V-1620 boot flows to a regenerator package H-1690. A 12 KW electric heated reboiler / still unit provide lean glycol for injection. A flash tank, glycol filter, carbon filter and injection pump are also provided.

3. EQUIPMENT LIST AND PLANT ARRANGEMENT

3.1 MAJOR EQUIPMENT LISTING

Please refer to general arrangement drawings DPC-1002-2 (Compressor Trailer) and DPC-1002-2A (Vessel Trailer).

The propane recovery plant is supplied on two 10' 4" wide x 48 ft long trailers as follows:

3.1.1 Compressor Trailer

Please refer to P&ID drawing DPC-1002-01 sheets 1A-1D & 1G-1L.

Compressor Trailer (Trailer #1)		
Description: Propane (R290) Refrigerant System, Process Chiller		
Purpose: Provide refrigerant to chill feed gas		
Tag #	Description	Purpose
K-1660	R290 compressor Howden XRV-204-193-50 oil flooded screw compressor	Compress R290 vapour
KM-1660	R290 Compressor Driver 250hp, 3/60/230/460VAC	Drive R290 Compressor
V-1670	R290 Compressor Oil Separator 24" OD x 120" s/s	Separate R290 and compressor oil
HTR-1670/1671	2 kW immersion heater (each)	Maintain oil temperature when the compressor is not running
AC-1655	R290 Condenser, 1222 kW, fin-fan, 12 x 3.7 kW 3/60/460VAC fan motors	Condense compressed R290 vapour

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Compressor Trailer (Trailer #1)		
Description: Propane (R290) Refrigerant System, Process Chiller		
Purpose: Provide refrigerant to chill feed gas		
Tag #	Description	Purpose
K-1660	R290 compressor Howden XRV-204-193-50 oil flooded screw compressor	Compress R290 vapour
ACM-1655 A to F	Condenser Fan Driver 3.7 kW,1200 rpm, CL 1 Div 2	Provide airflow for aerial condenser
ACM-1656 A to F	Condenser Fan Driver 3.7 kW,1200 rpm, CL 1 Div 2	Provide airflow for aerial condenser
PCV-1650	Hot gas bypass valve for receiver V-1650	Maintain pressure in receiver during low ambient conditions
V-1650	R290 Receiver 30" ID x 96" s/s	Storage / buffer volume for liquid R290
F-1646	R290 filter-drier	Remove free water from refrigerant
P-1655	Propane Coolant Pump	Circulate liquid propane to E-1670 oil cooler
PM-1655	Propane Coolant Pump Driver 1.5 hp, 3/60/230/460VAC	Drive Propane Coolant pump
E-1670	R290 Compressor Oil Cooler	Cool compressor oil
F-1675A/B	R290 Compressor Oil Filter	Filter compressor oil
DPCV-1670	Compressor Discharge differential pressure control valve	Maintain pressure in oil separator V-1670 during low ambient temperatures
TCV-1668	Temperature control valve for compressor oil	Bypass oil to oil cooler
PCV-1610	Propane Hot gas bypass valve	Provide hot R290 to chiller (false load)
E-1610	Gas chiller, Plate & Shell with surge, Duty 169 kW	Chill and partially condense cooled feed gas
E-1615	Gas chiller surge drum, 670mm OD x 1200mm s/s	Separate liquid from refrigerant vapour, provide surge volume for startup and upsets

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Compressor Trailer (Trailer #1)		
Description: Propane (R290) Refrigerant System, Process Chiller		
Purpose: Provide refrigerant to chill feed gas		
Tag #	Description	Purpose
K-1660	R290 compressor Howden XRV-204-193-50 oil flooded screw compressor	Compress R290 vapour
LV-1610	Level control valve for Propane R290 Chiller E-1610	Control refrigerant level in chiller
Glycol Metering FI-1615	Glycol injection for hydrate control (manual)	Meter and inject EG/water into exchanger inlets for hydrate control
RIO #1	Remote IO Junction Box, Class 1 Div 2 Terminal Box	Control and monitor propane refrigeration plant
UH-100	Building Heater, 10 kW, 460/3/60	Electric heater for compressor room

3.1.2 Vessel Trailer

Please refer to P&ID drawing DPC-1002-01 sheets 1A-1D & 1G-1L.

Vessel Trailer (Trailer #2)
Description: Gas Cooling, Gas-Liquids Separation, EG Regeneration, RIO
Purpose: Produce and separate NGL from feed gas, Produce HD5 spec Deethanizer bottoms product

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Tag #	Description	Purpose
V-1600	Inlet Separator, 48" OD x 144" S/S w/ 12.75" OD Boot x 18" LG	3 phase separation of liquids from the inlet gas stream
E-1600	Gas-to-gas exchanger, Plate & Shell, 26" Duty 97 kW	Cool feed gas, warm sales gas
E-1605	Gas-to-liquids exchanger, Plate & Shell, Duty 70 kW	Cool feed gas, warm NGL
LV-1600	Level control valve for inlet separator HC phase	Control level of hydrocarbon level in the inlet separator
LV-1601	Level control valve for inlet separator H2O phase	Control level of produced water in the inlet separator
V-1620	Low temperature separator, 36" ID x 192" s/s, 12" OD x 10" glycol boot	Separate natural gas, NGL and rich glycol
LV-1620	Level control valve for LTS NGL phase	Control level of hydrocarbon liquids in LTS
LV-1624	Level control valve for LTS rich glycol phase	Control level of rich glycol in LTS
HTR-1620	LTS Boot heater, 1.0 kW, 460/3/60	LTS boot heater to aid in the glycol separation
USD-1600	Pneumatically Actuated Ball valve	Closes the inlet flow to the unit on ESD
USD-1601	Pneumatically Actuated Ball valve	Closes the outlet flow from the unit on ESD
FLR-1603	Pneumatically Actuated Ball valve	Opens a path to Flare bypassing the recovery plant
Glycol Metering FI-1600, FI-1605	Glycol injection for hydrate control (manual)	Meter and inject EG/water into exchanger inlets for hydrate control
H-1690	Glycol regeneration package (reboiler, surge, packed still), 12" OD x 60" s/f	Regenerate rich glycol from LTS V-1620
HTR-1691	12 kW electric heater for glycol reboiler	Heat rich glycol in reboiler
P-1695	Glycol injection Pump, 2.0 usgpm,	Pump lean glycol into high pressure gas

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Vessel Trailer (Trailer #2)		
Description: Gas Cooling, Gas-Liquids Separation, EG Regeneration, RIO		
Purpose: Produce and separate NGL from feed gas, Produce HD5 spec Deethanizer bottoms product		
Tag #	Description	Purpose
V-1600	Inlet Separator, 48" OD x 144" S/S w/ 12.75" OD Boot x 18" LG	3 phase separation of liquids from the inlet gas stream
	triplex piston type	exchangers
PM-1695	Driver for glycol pump, 1.0 hp, 3/60/460VAC	Drive glycol pump
E-1690 A/B	Lean/Rich Glycol Exchanger	Cools the Lean Glycol for pumping
F-1686	Glycol bag filter	Filter larger particulates
F-1685	Glycol carbon filter	Polishing filter – removes hydrocarbons
LV-1680	Level control valve for glycol flash tank V-1680	Control EG level in flash tank
V-1680	Glycol flash tank, 12" OD x 60" s/s	Separate hydrocarbons from rich glycol stream
LV-1680	Level control valve for glycol flash tank V-1680	Control EG level in flash tank
BPCV-1681	Backpressure control valve for glycol flash tank V-1680	Maintain pressure in flash tank
V-1625	Deethanizer Bottoms, packed, 20" OD x 80" vertical c/w reboiler section	Add heat to concentrate ethane in overheads and produce spec liquid product
HTR-1630	Deethanizer Reboiler heater, 173 kW, 5 stage, 480/3/60	Provides heat to boil off the ethane and lighter vapours
LV-1625	Level control valve for deethanizer V-1625 bottoms	Control level of NGL in deethanizer bottoms and deliver propane product
V-1630	Deethanizer Top, packed, 20" OD x 120" S/S	Concentrate ethane in overheads
P-1630	Propane Transfer Pump, 80.0	Pumps liquids from the bottom V-1630 to the

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Vessel Trailer (Trailer #2)		
Description: Gas Cooling, Gas-Liquids Separation, EG Regeneration, RIO		
Purpose: Produce and separate NGL from feed gas, Produce HD5 spec Deethanizer bottoms product		
Tag #	Description	Purpose
V-1600	Inlet Separator, 48" OD x 144" S/S w/ 12.75" OD Boot x 18" LG	3 phase separation of liquids from the inlet gas stream
	usgpm, Blackmer LGLD2E	top of V-1625
PM-1630	Driver for propane transfer pump, 5.0 hp, 3/60/460VAC	Drive propane transfer pump
PV-1638	Deethanizer pressure control valve (future)	Maintain pressure in deethanizer V-1630
PV-1639	Deethanizer to Flare control valve	Maintain pressure in deethanizer V-1630 by venting overheads to flare
RIO #2	Remote IO Junction Box, Class 1 Div 2 Terminal Box	Control and monitor gas process plant

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3.2 EQUIPMENT ARRANGEMENT

The equipment in Startec's scope of work is mounted on two mobile trailer (TARE 80,000 lbs each) units that are moved from location to location as required by GASFRAC and their clients.

The trailers are designed to be situated on the lease in a side-by-side configuration so as to facilitate the connection of the interconnecting low temperature pressure hoses as required by the process.

All interconnecting hose between the two trailers is provided by Startec. Piping from the trailer units to other site equipment is provided by others.

All control system cabling on the two trailers is provided by Startec and are wired back to the RIO panel boxes located at the front end of both trailers.

All control system cabling from the skids to the plant PLC located in the utility trailer is provided by others.

Power cabling is by others.

The propane recovery plant is tied into the wellsite fracturing equipment via the high pressure hoses at the appropriate customer connections as defined in the P&ID. On site hook-up of the propane recovery plant and final site installation configuration is the responsibility of others.

The compressor building is provided by Startec. The compressor building electrical (ie. Lighting and power outlets etc.) is provided and installed by others.

4. CONTROL AND ELECTRICAL OVERVIEW

4.1 GENERAL

The propane recovery plant is designed for a Class 1 Division 2 hazardous area. All electrical equipment is CSA approved for Class 1 Division 2; all wiring is CSA cable and conduit for Class 1 Div 2. The RIO skid edge terminal boxes are NEMA 4.

The plant requires power to be supplied at 3/60/460 VAC for motors, heaters etc.. The control system requires a 24 VDC supply with the end devices (supplied by Startec) operating on 24 VDC. The control system is provided by Kilowatts as part of the Utility and power generation and distribution requirement contracted to them.

4.2 CONTROL SYSTEM

The control system will be based on a control philosophy and shutdown key provided by Startec.

The PLC (by Kilowatts) provides control logic for the various PID loops in the propane recovery plant and also provides machinery and plant protection. Transmitters and switches are provided for level, pressure, temperature etc. and used by the PLC to provide control, alarms and shutdowns. All setpoints are operator-configurable from the HMI.

There are skid-edge terminal boxes on each trailer to allow connection of the devices on the trailers to the PLC . The cabling (multi-core flex for CSA Class 1 Division 2) is run from the terminal boxes across the lease to the PLC on the utility trailer.

Note that motor control is directed and executed by Kilowatt's PLC – please see the P&IDs for the signal flow.

5. DETAILED PROCESS AND EQUIPMENT DESCRIPTION

5.1 INLET SEPARATION

In the following sections, values are provided for process variables and setpoints. The values given are the design values. These values will change or need to be adjusted during commissioning and as the feed conditions or composition change.

On completion of the well fracturing process the well is put on flow back. This begins the propane recovery process and cleans the well in preparation for production. The fluid from the wellbore are heated and its pressure is controlled and directed to the Propane Recovery Plant.

The Propane recovery Plant can be isolated from the upstream facilities in the event of an ESD event. The plant is equipped with solenoid actuated inlet (USD-1600) ball valve and outlet (USD-1601) ball valve to isolate and an on unit ball valve to flare (FLR-1603).

The hydrocarbon feed is a water-saturated mixture of hydrocarbons, containing a range of hydrocarbons from methane & Ethane, to propane and small amounts of heavier hydrocarbons. The feed is predominantly propane (90%) as the flow back starts and will gradually reduce to 10 -20% propane and a point where the flow back is deemed complete. The recovery of the propane reduces significantly the recurring expense of replenishing the propane requirement for each fracturing operation.

The propane recovery process plant provides the required liquid separation and subsequent dewpoint control of the gas by cooling the feed gas stream, condensing the heavier hydrocarbons (predominantly propane) and physically separating them in a fractionating tower.

The inlet separator is a 48" OD x 144" S/S 3 phase horizontal separator that is equipped with a boot to collect the separated heaviest component in the inlet stream, usually produced water. The vessel is also equipped with an additional liquid / liquid coalescing element to enhance the separation of the water and hydrocarbon in the separator. The gas stream has a second separation enhancement at the outlet of the separator with the addition of a vane pack and mesh pad.

The hydrocarbon being lighter than the water phase collects on top of the water and spills over an internal weir plate into the hydrocarbon collection compartment of the separator. The level of the hydrocarbon in the compartment is monitored by LIT-1600 (guided wave radar level transmitter) and the level is controlled through LV-1600 by LIC-1600. This hydrocarbon goes to the deethanizer top tower V-1630 for further processing.

The produced water level that is collected in the boot of the separator has the interface level of the water in the boot monitored by LIT-1601 (guided wave radar level

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transmitter) and the level is controlled through LV-1601 by LIC-1601. The produced water is taken from the propane recovery plant and collected in a storage tank elsewhere on the lease for intermittent disposal as required.

The inlet separator has been provided with MeOH connection points as a means of hydrate control in the separator in the event of its occurrence.

The gas stream from the inlet separator now goes on for further gas conditioning and additional liquid separation in the LTS (V-1620).

V-1600 Inlet Separator - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1600	Separator shell
Control Valves	LV-1600	Hydrocarbon out
	LV-1601	Water Boot out
Thermocouple	TE-1600	Separator shell
Temperature Gauge	TI-1600	Separator shell
Inlet Shut-off	USD-1600	Separator Inlet line
Level Gauge	LG-1600	Separator shell (Hydrocarbon level)
Level Gauge	LG-1601	Separator shell (Vessel level)
Level Gauge	LG-1602	Separator shell (Boot level)
Level Transmitter	LIT-1600	Separator shell (HC level)
Level Transmitter	LIT-1601	Separator shell (Boot level)

5.2 GAS CONDITIONING PORTION OF THE DEWPOINT PLANT

The following detailed description of the gas conditioning portion (HP side) of the dewpoint plant process should be read in conjunction with the Process and Instrumentation Drawings (P&ID) DPC-1001-A,B, G, H-K.

High pressure gas from the customer's inlet separator and recycle gas from the customer's deethaniser overheads recycle compressor are combined to form the feedstream to the Dewpoint Control Plant.

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5.2.1 Gas-Gas Exchanger E-1600A/B and Gas-Liquids Exchanger E-1605

The high pressure gas feedstream at 4930 kPag and 45 °C enters the tubesides of heat exchangers E-1600A and E-1600B. Cold gas at -24 °C from Low Temperature Separator (LTS) V-1620 on the shell sides of E-1600A/B cools the rich inlet gas. The tube side gas exits E-1600A/B at 4895 kPag and -5 °C and enters the tubeside of gas-liquids exchanger E-1605 where it is cooled further by heat exchange with the LTS liquids at -24 °C on the shellside. E-1600A/B and E-1605 are provided with spray nozzles in the tube side bonnets to facilitate the continuous injection of lean glycol to prevent the formation of hydrates.

These exchangers are TEMA type NEN with fixed tubesheets. The following instrumentation is provided:

E-1600A/B Gas-Gas Exchanger - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1600	Tubeside inlet (Feed)
	PI-1601	Shellside outlet (Sales Gas)
	PI-1603	Tubeside outlet (to G-L)
Pressure Transmitter	PT-1600	Tubeside inlet (Feed)
	PT-1602	Shellside outlet (Sales Gas)
Temperature Gauge	TI-1600	Tubeside inlet
	TI-1602	Tubeside outlet
	TI-1601	Shellside outlet (Sales Gas)
Glycol Flowmeter	FI-1600A	Tubeside of shell A
	FI-1600B	Tubeside of shell B

E-1605 Gas-Liquids Exchanger - Instruments		
Instrument	Tag	Location
Temperature Gauge	TI-1611	Tubeside outlet
	TI-1606	Shellside outlet
	TI-1605	Shellside inlet
Pressure Gauge	PI-1613	Tubeside outlet
	PI-1605	Shellside outlet

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E-1605 Gas-Liquids Exchanger - Instruments		
Instrument	Tag	Location
Glycol Flowmeter	FI-1605	Tubeside

5.2.2 Gas Chiller E-1610

Gas from the tube side of E-1605 leaves at 4861 kPag and -7 °C. To provide suitable LPG products from the fractionation plant and meet sales gas HC dewpoint, the feed gas must be finally cooled to -24 °C in chiller E-1610. Liquid propane refrigerant (R290) at -29 °C is evaporated to provide the chilling duty. This exchanger is TEMA BEU type with removable tube bundle with a surge vessel. A separate manually-drained oil collection pot is provided. Hot gas from the discharge of the refrigeration compressor can be injected into the chiller via valve PV-1610 to maintain operation at low process duty.

The liquid refrigerant level is maintained close to or just over the top of the tube bundle by guided wave level transmitter LT-1611 and level controller LIC-1611 and level control valve LV-1611. The top row of tubes may be exposed if superheat is required for the vapour. The BEU shell is not designed for any vapour / liquid separation, which is achieved in the surge drum.

Note: the oil-flooded screw compressors used in the refrigeration plant allow oil to pass into the refrigerant stream. This oil will collect in the colder parts of the system, usually the chiller. At this point, the oil is denser than the propane refrigerant and will, over time, collect in the chiller shell. The lower portion of the oil pot shell is uninsulated – if no oil is present this portion will be covered in ice; if oil is present the portion of the boot below the oil-propane interface will be free of ice. When sufficient oil is present the oil pot may be manually drained (note that R290 vapour will flash off the oil).

To prevent the formation of hydrates lean glycol is continuously injected into the tube side bonnet of E-1610.

The following instrumentation is provided on the gas chiller:

E-1610 / E-1615 Gas Chiller / Surge Vessel - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1611	Shellside outlet (propane)
Pressure Transmitter	PT-1601	Shellside outlet (propane)
Temperature Gauge	TI-1612	Tubeside outlet (gas)
	TI-1610	Shellside outlet (propane)
PSV	PSV-1612	Shellside (tube rupture)

E-1610 / E-1615 Gas Chiller / Surge Vessel - Instruments		
Instrument	Tag	Location
Glycol Flowmeter	FI-1610	Tubeside
Level Gauge	LG-1611	Shellside (propane)
Level Transmitter	LT-1611	Shellside
Level Switch	LSHH-1610	Shellside

5.2.3 Low Temperature Separator V-1620 (LTS)

The process side discharge from E-1610, which comprises three phases (hydrocarbon vapour, condensed hydrocarbon liquid and rich glycol), is then directed to the Low Temperature Separator V-1620 which under normal operating conditions operates at -27.4 °C.

The fluid enters the Low Temperature Separator and is separated into the three phases by gravity over time; both the hydrocarbon liquids and glycol phases have a design retention time of 30 minutes. An inlet diverter and two full diameter premium coalescing elements aid initial separation of vapour and liquids and mist in the separated vapour stream is removed by a meshpad in the LTS vapour outlet. A weir separates the liquid-liquid separation section and boot from the LTS HC Liquid section – the product overflows the weir into the product section where it leaves the LTS. A vortex breaker is provided for the hydrocarbon liquid outlet and an internal siphon for the rich glycol.

The hydrocarbon liquid level in the LTS is measured by guided wave level transmitter LT-1620 on the product section, which is used by LIC-1620 to control level control valve LV-1620. Note that there is a significant pressure drop across this valve: upstream is LTS pressure of 2100 kPag, downstream is deethanizer pressure of 1100 kPag. The fluid is liquid upstream of LV-1620, two-phase downstream.

The rich glycol collects in the boot section of the LTS; the interface level in the boot is measured by guided wave radar level transmitter LT-1624 and is controlled by LIC-1624 acting on level control valve LV-1624. Note that the rich glycol level is set high in the boot compartment.

Rich glycol passes through LV-1624 to the glycol regeneration skid H-1690 where the absorbed water is removed and the glycol is regenerated to a 85 wt% EG/15 wt% water mixture. The glycol boot contains an electric heater to aid in the glycol separation. Note that there is a significant pressure drop across valve LV-1620: upstream is LTS pressure of 2100 kPag, downstream is glycol flash tank V-1680 pressure of 345 kPag. The fluid is liquid upstream of LV-1624, two-phase downstream.

The following instrumentation is provided on the LTS:

V-1620 LTS - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1621	LTS shell
Pressure Transmitter	PT-1622	LTS shell
Temperature Gauge	TI-1621	LTS shell
Thermocouple	TE-1620	LTS shell
PSV	PSV-1620	LTS shell (fire)
Level Gauge	LG-1620	LTS HC liq compartment
	LG-1621	LTS shell / Glycol boot
	LG-1622	LTS shell
Level Transmitter	LT-1620	LTS HC liq bridle
	LT-1624	LTS shell / Glycol boot bridle

5.2.4 Sales Gas from LTS to Skid Edge

The cold, dry vapour from LTS V-1620 is directed back to the plate side of gas-gas heat exchangers E-1600, where it cools the feed stream and is warmed prior to leaving the propane recovery plant for the customer's dispersal or disposal.

5.2.5 Hydrocarbon Liquids from LTS V-1620 to Gas/Liquids Exchanger E-1605

The condensed hydrocarbon liquid collects in the hydrocarbon liquid compartment of the LTS and flows out to the plate side of the gas-liquids heat exchanger E-1605 where it warmed against the gas feed. As it is possible to form hydrates at the inlet of the deethanizer . The liquid flow is controlled by control valve LV-1620. The liquid at -11 °C from the plate side of E-1605 flows to the V-1630 deethanizer top vessel. The LTS hydrocarbon liquid level control valve LV-1620 is installed downstream of the Gas/Liquids exchanger E-1605 to ensure that exchanger remains flooded.

5.2.6 High Pressure Side Blowdown

Blowdown valve BDV-1600 and orifice RO-1600 allow the high pressure gas / liquid portion of the dewpoint plant to be depressurised. This valve is controlled from the PLC and is operated via solenoid BYV-1600.

Orifice plate RO-1600 is sized to blow down the LTS skid to 690 kPag within 15 minutes

Note: the dewpoint plant PLC does not control process isolation valves or ESD valves, which are all off-skid, provided by others. Start, Stop and Blowdown of the dewpoint plant is dependant upon cooperation between the customer's DCS and the dewpoint plant PLC.

During blowdown, the material stresses will be within allowable limits at the corresponding pressures and temperatures.

During re-start and re-pressurisation, the DCS should prevent pressure from rising until the LTS low temperature alarm (TAL-1620) has cleared. The MDMT of the LTS is -45 °C, and the Low temperature alarm is set at -40 °C.

5.3 FRACTIONATION PORTION OF THE PROPANE RECOVERY PLANT

The following detailed description of the fractionation portion (LP side) of the propane recovery plant process should be read in conjunction with the Process and Instrumentation Drawings (P&ID) DPC-1002-01 sheets C & D.

5.3.1 Deethanizer Top V-1630 & Deethanizer Bottom V-1625

Because of the mobility requirement for the Propane Recovery Plant the deethanizer needs to be split to provide the design requirement for a 11 foot long packed section to meet the bottoms product specification while the overall travelling height is below the 13.5' maximum.

The deethanizer is designed to split its feed stream into two product streams, one vapour and one liquid. The overhead vapour stream is relatively free of heavier components suitable for liquid products and the liquid stream contains only trace amounts of components too light for liquid product.

This deethanizer is designed to provide a bottoms product with an ethane to propane mole ratio of 0.15; this ensures the majority of the ethane in the feed streams is sent to the overheads.

The deethanizer top V-1630 is fed the combined stream of liquid hydrocarbon from the LTS (V-1620) and the Inlet Separator (V-1600). The liquid enters this vessel just below the meshpad near the top of the tower. This nozzle has an internal inlet distributor to distribute the flow across the diameter of the bed. The deethanizer top tower V-1630 contains a 5.5' section of random packing. The liquid trickles down through the tower packing and is cross flowing with the vapours from V-1625 that

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have entered the bottom of V-1630 and provides the heat required to strip the liquid stream of its light ends (methane & ethane). The accumulated liquid level at the bottom of the tower is monitored by LIT-1635 (Guided wave Level transmitter) and then pumped by the Liquid Transfer Pump P-1630 on a control signal from LIC-1635 to the top liquid connection on the V-1625 deethanizer bottom tower.

The deethanizer bottom V-1625 is a reboiled fractionating tower with a 5.5' packed bed and has a single liquid feed near the top of the column that receives the liquid collected in the bottom of the Tops tower V-1630. The liquid entering the tower is again distributed across the tower diameter. The column is 20" OD x 120". Both tower beds consist of 0.5 m³ of IMPT #25 carbon steel random packing.

The deethanizer is controlled by maintaining the overhead design pressure at 1100 kPag and the bottoms design temperature at 35 °C. The overheads pressure is measured by PT-1638 and used by PIC-1639 to control pressure control valve PV-1639. This valve controls the deethanizer pressure by controlling vapour produced and releasing it to the flare system. In the future if a market or requirement for this gas is determined an additional valve (PV-1638) can be installed to control the pressure and deliver the vapour to this use. The existing PT-1638 can be use to control both valves in the future.

The heat input for V-1625 is provided by a 5 stage electric immersion heater HTR-1630. Liquid from the tower section of V-1625 (the deethanizer bottom tower) drops by gravity and is gathered in the reboiler section of this vessel surrounding the immersionheater elements where it is heated. The vapour generated in the reboiler section flows up through the packing as stripping the liquid flow. The liquid in the reboiler section is the deethanized product. The liquid level in the reboiler section is maintained above the immersion heater element by a weir. The liquid product over flows the weir and is collected in the storage compartment at the end opposite the heater element. This level is monitored by guided wave radar level transmitter LT-1625 which is used by LIC-1625 to control level control valve LV-1625. The warm liquid at 35 °C and 1100 kPag flows through LV-1625 to be delivered off skid as the propane product.

Vent valve PV-1629 also allows the deethanizer and reboiler to be depressurised. In this case PV-1629 is operated via solenoid EYV-1629 and controlled by the plant DCS.

Blanket gas is provided from the plant fuel gas system to allow purging prior to maintenance and to maintain pressure as the deethanizer and its reboiler cool. The gas is provided by regulator PCV-1630 set at 345 kpag.

The following instrumentation is provided on the deethanizer bottom V-1625 and deethanizer top V-1630:

V-1625 Deethanizer Bottom - Instruments		
Instrument	Tag	Location

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V-1625 Deethanizer Bottom - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1627	Overheads line
	PI-1630	Reboiler Bottom
Pressure Transmitter	PT-1628	Overheads line
Differential Pressure Transmitter	DPIT-1626	Overheads to Bottoms section
Temperature Gauge	TI-162?	Bottom section
	TI-1626	Overheads line
Thermo couple	TE-1626	Bottom section
	TE-1625	Overheads
PSV	PSV-1624	Reboiler section (fire)
Level Gauge	LG-1625	Bottoms section
Level Valve	LV-1625	Liquid Outlet line
Level Transmitter	LT-1625	Bottoms Storage compartment
Level Switch	LSLL-1630	Reboiler section

V-1630 Deethanizer Top - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1637	Overheads
	PI-1634	Tower Pressure
	PI-1625	Transfer Pump Discharge
	PI-1635	Liquid Feed line
Temperature Gauge	TI-1625	Transfer Pump Discharge
	TI-1635	Liquid Feed line
	TI-1636	Overheads line
Thermocouple	TE-1635	Hot oil supply line
Pressure Transmitter	PT-1638	Overheads line
PSV	PSV-1635	Overheads line (failure of LV-1620)

V-1630 Deethanizer Top - Instruments		
Instrument	Tag	Location
	PSV-1634	Tower Bottom(fire)
Pressure Valve	PV-1639	Overheads line
Differential Pressure Transmitter	DPIT-1636	Overheads to Bottoms section
Level Transmitter	LT-1635	Tower Bottoms (Bridle)
Flow Transmitter	FT-1630 / FE-1630	Hot oil return line

5.4 GLYCOL INJECTION AND REGENERATION SYSTEM

5.4.1 Glycol Regenerator H-1690, Flash Tank V-1680, Glycol Filters F-1685/1686

As the gas stream is cooled in the gas exchangers water is condensed from the gas. At the design pressures and temperatures it is possible to form hydrates in the exchanger tubes which will reduce or stop gas flow. To prevent hydrate formation ethylene glycol is used as a hydrate inhibitor in the plant. In the lean / regenerated form it exists as a mixture of 85% by weight ethylene glycol and 15% by weight water.

The lean glycol is injected into the gas stream at the gas-gas exchangers E-1600, gas-liquids exchanger E-1605 and gas chiller E-1610. As the injected lean glycol passes through the gas exchangers it is diluted by the condensed water down to a rich 80/20 mixture of glycol and water.

The rich glycol stream is recovered from the Dew Point Control Plant in the boot of the Low Temperature Separator V-1620. The boot is level controlled by LT-1624 and LIC-1624 acting on level control valve LV-1624. The LTS boot contains an electric coil and the rich glycol in the boot is warmed slightly. The warming aids the separation of glycol and hydrocarbons in the boot.

The rich glycol from the LTS boot via LV-1624 is returned to the glycol regeneration package H-1690 which consists of

- a 12" OD x 60" regenerator H-1690 with an electric heater HTR-1691 and packed still section
- two small rich/lean heat exchangers in series to cool the glycol pump flow

Note there is a large pressure drop across LV-1624. This valve will need to be tuned along with LV-1680 to avoid LAHH in flash tank V-1680.

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The rich glycol passes through the still coil, condensing vapour in the still to minimise glycol vapour loss and being warmed in the process. From the still coil the warming rich glycol passes through the two lean/rich heat exchangers where it is warmed further. As mentioned this helps to cool lean glycol returning to the Dew Point Control Plant.

After the rich glycol is warmed, it enters the glycol flash tank V-1680 where gas and heavier hydrocarbons (absorbed at the high pressure and low temperature in the Dew Point Control Plant) are separated and removed from the system. The glycol flash tank is fitted with a manual hydrocarbon liquid skimmer to provide for the removal of any hydrocarbon liquid carried through from the Low Temperature Separator V-1620.

The glycol flash tank has a pneumatic level controller LC-1680 which acts on level control valve LV-1680 to maintain a constant level in V-1680. A blanket gas supply is provided via regulator PCV-1682 to maintain the flash tank pressure at 345 kPag and the flash tank also has an overheads pressure regulator BPCV-1681 set at 517 kPag. If the pressure generated by the separated vapour is greater than 517 kPag then BPCV-1681 will control the flash tank pressure. If the pressure cannot be maintained above 345 kPag then PV-1682 will open and allow blanket gas to maintain the vessel pressure and circulate glycol to the reboiler. The flash tank has a blowdown valve BDV-1680 and also a meshpad to remove any mist in the vapour.

From V-1680 the rich glycol is filtered to remove particulates in bag filter F-1686 and dissolved hydrocarbons in activated carbon filter F-1685 before it enters the packed section of the glycol still at the top, where it is counter current contacted with reboiler vapours to effectively strip the water from it. The glycol drains down through the glycol still ending up in the reboiler H-1690, which is on temperature control by TIC-1692 at 130 °C, to yield regenerated glycol. The reboiler overflows a weir to the surge compartment of the H-1695 regenerator vessel.

The atmospheric regenerator section is heated by a stab-in electric immersion heater HTR-1691 capable of 12 kW of duty. The temperature in the regenerator is measured by TE-1692 and used by TIC-1692 to control HTR-1691. The glycol regenerator is maintained at 130 °C. The heater HTR-1691 has an internal thermocouple that monitors the heating element temperature and will shut down the heater if this temperature exceeds its design limit.

Water stripped from the glycol exits the still column at atmospheric pressure and is collected in a local container for intermittent disposal.

H-1690 Glycol Regenerator - Instruments		
Instrument	Tag	Location
Temperature Gauge	TI-1692	Regenerator shell
	TI-1695	Glycol Pump suction
	TI-1694	E-1690A tubeside out to V-1680

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H-1690 Glycol Regenerator - Instruments		
Instrument	Tag	Location
Thermocouple	TE-1692	Regenerator shell
Cone Relief Device	PRV	Regenerator shell (thermal)
Level Gauge	LG-1690	Surge shell
Level Switch	LSLL-1690	Regenerator reboiler shell
	LSLL-1691	Surge shell

V-1680 Glycol Flash Tank -Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1681	Blanket gas inlet
	PI-1680	Glycol outlet
Temperature Gauge	TI-1680	Flash tank shell
PSV	PSV-1683	Flash tank shell (fire)
Level Gauge	LG-1682	Flash tank shell (hydrocarbons)
	LG-1680	Flash tank shell (glycol)
Level Controller (pneumatic)	LC-1680	Flash tank shell
Level Switch	LSH1681	Flash tank shell
	LSLL-1683	Flash tank shell

F-1685 / 1686 Glycol Filter - Instruments		
Instrument	Tag	Location
Differential Pressure Gauge	DPI-1686	F-1686
	DPI-1685	F-1685
PSV	PSV-1686	F-1686 (fire)
	PSV-1685	F-1685 (fire)

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5.4.2 Glycol Pump P-1695

Lean glycol from the shell side of the Lean/Rich glycol exchangers passes to the injection pump P-1695 where the pressure is raised for injection into the gas exchangers at around 2100 kPag. The pump is a triplex plunger pump with pulsation damper in the discharge line.

The maximum flow from the pump is 2 usgpm which provides significantly more than the theoretical quantity required for hydrate control. This allows for losses and for incomplete coverage by the spray nozzles in each exchanger.

Glycol from the surge compartment passes through a Y-strainer with 60 gauge mesh screen to the pumps.

A 70 psi differential must be maintained across each spray nozzle; this is controlled by the ¾" globe valves in each supply line and by varying pump speed (if available).

As described here, the control scheme is for fixed speed operation.

The driver PM-1695 has an O/O (On -Off) switch HS-1695 which allows the following:

- in Off, the pump is not running and will not start automatically
- in On, the pump is under PLC control and may stop or start automatically without warning

In normal operation, the switches should be set to "On".

Note that selecting "Off" for HS-1695A/B will only stop PM-1695A/B, not the dewpoint plant.

P-1695 Glycol Injection Pumps - Instruments		
Instrument	Tag	Location
Pulsation Dampener	PD-1695A	Pump discharge line
Pressure Gauge	PI-1696	Pump discharge line
Temperature Gauge	TI-1695	Pump common suction line
PSV	PSV-1695	Pump discharge line (blocked flow)

5.5 PROPANE (R290) REFRIGERATION SYSTEM

The Dew Point Control Plant relies on cooling the gas to condense heavier hydrocarbons and water. The cooling is provided by the propane refrigeration system. The refrigeration system is a closed loop, using propane (R290) as the refrigerant. The principal of operation is to compress low-pressure refrigerant vapour from the shellside of chiller E-1610, allowing the refrigerant to condense at high pressure using the atmosphere as the heat sink.

The refrigerant plant comprises 1 x 100% duty electric motor driven oil-flooded screw compressor complete with chiller surge drum, oil separator, propane coolant pump, oil cooler, oil filter, fin-fan condenser, accumulator and propane filter-driers.

The sections below describe the operation of the R290 loop, starting at the gas chiller E-1610.

5.5.1 Propane / Process Portion

5.5.1.1 Gas Chiller E-1610 (see also section 5.2.2 above)

The chiller E-1610 is a plate & shell flooded-type evaporator, 169 kW of duty and 18.8 sq.m transfer surface. Warm process gas in the tubes at 2100 kPag and -7 °C boils off liquid propane refrigerant at 117 kPaa and -38 °C in the chiller shell.

Refrigerant liquid from the accumulator V-1650 at 1310 kPag and 20 °C flows to the gas chiller E-1610 via level control valve LV-1610. The evaporating temperature in the chiller sets the pressure in the chiller (117kPaa) and thus the refrigerant compressor's suction pressure. The chiller is thus at low pressure and there is a pressure drop across LV-1611, resulting in cold liquid refrigerant and some flash vapour due to the Joule-Thompson effect. The cold two-phase flow enters the chiller where the cold low pressure liquid is fully evaporated by the warm HP gas in the chiller tubes and returns to the compressor via surge drum E-1615 to start a further cycle. The refrigerant level in the chiller is controlled to maintain the top tubes covered or to have the first row uncovered if some superheat is desired. The chiller shell level is measured by LT-1610 and is used by LIC-1610 to control LV-1610. The surge drum E-1615 acts as a scrubber to ensure separation of liquid droplets and allows for the R290 level to fluctuate during start without damaging the compressor.

As the HP gas flow varies the chiller duty will vary, resulting in changes in chiller pressure. As the chiller pressure varies it is measured by pressure transmitter PT-1615 and used by PIC-1610 to control the compressor slide valve. This allows the compressor capacity to match the required chilling duty by maintaining the required evaporating temperature (saturation temperature) via the evaporating pressure (saturation pressure).

A glycol injection connection is provided at the process gas inlet of E-1610. The chiller has a drip leg provided to remove compressor oil (as described in section 5.2.2)

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and the drip leg will be heated with heat tape to facilitate the removal of this oil from the system on an intermittent basis.

E-1610 / E-1615 Gas Chiller / Surge Vessel - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1615	Chiller Surge vessel (propane)
Pressure Transmitter	PT-1615	Chiller Surge vessel (propane)
Temperature Gauge	TI-1611	Process Gas In (gas)
	TI-1610	Process Gas Out (gas)
PSV	PSV-1615	Chiller Surge outlet line(fire)
Glycol Flowmeter	FI-1615	Process side (gas)
Level Gauge	LG-1610	Chiller Bridle (propane)
Level Transmitter	LT-1610	Chiller Bridle (propane)
Level Valve	LV-1610	Propane inlet to chiller

5.5.1.2 Propane Compressor K-1660

The refrigerant compressor K-1660 is a Howden XRV 204-193-5.0 oil-flooded screw compressor. This type of rotary positive displacement compressor uses two meshing helical rotors to form pockets of reducing volume allowing compression of the vapour. The male rotor is driven by the electric motor KM-1660 and in turn drives the meshed female rotor. The rotors seal against the compressor casing and the slide valve to generate pressure as the pocket volume reduces. The volumetric capacity of the compressor is steplessly variable between 10% and 100% by use of a hydraulically-actuated slide valve. The slide valve is positioned directly below the rotors and can be moved axially along part of the rotors' length. As the slide valve moves it increases or decreases the portion of the rotors' volume that is available for compression, thus increasing or decreasing the throughput.

Compressor oil is injected into the compressor casing to lubricate bearings and shaft seal, to seal the clearances between the rotors and the casing and to remove some of the heat of compression. The oil is pressure fed to the compressor. Note that there are two oil supplies to the compressor casing

- a filtered oil flow to the bearings and mechanical seal (bearing oil)
- a strained oil flow to the rotors (injection oil)

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The compressor has a fixed $V_i - V_i$ being the ratio of volume of gas in the rotors at suction conditions to the volume of gas in the rotors at discharge conditions. For a particular V_i , a change in suction pressure results in a change in discharge pressure. Changes in either the suction or discharge conditions for the compressor may require a change in V_i to prevent over-compression or under-compression within the compressor rotors. If the customer wishes to change the operating conditions of the compressor it is recommended that Startec or other qualified screw compressor service Company review the suitability of the machine for the revised conditions.

There is a cone type strainer with 60 gauge mesh in the suction line of the compressor (immediately above the compressor suction flange).

Cold refrigerant vapour at design conditions of 114 kPaa and -35 °C is compressed to 1414 kPaa and 95 °C in K-1660.

K-1660 Propane Compressor - Instruments		
Instrument	Tag	Location
Differential Pressure Gauge	DPI-1660	Suction line (across strainer)
Pressure Transmitter	PT-1660	Suction line (d/s strainer)
	PT-1615	Chiller Surge
Temperature Gauge	TI-1664	Suction line
Thermocouple	TE-1663	Suction line
Vibration Switch	VSHH-1661	Compressor casing
Position Transmitter	ZT-1660	Compressor slide valve casing

5.5.1.3 Propane Compressors Driver KM-1660

The driver is a 3/60/460VAC TEFC induction motor, nominal speed 3600rpm, CSA approved for Class 1 Div 2. The motor delivers 250 HP and is suitable for VFD duty with a turndown of 2:1. The motor has a space heater.

The compressor is driven via a spacer type disc pack coupling (DBSE 7"); the coupling hubs are attached to the motor and compressor shafts and are removable in position.

KM-1660 Propane Compressor Driver - Instruments		
Instrument	Tag	Location
Space Heater	HTR-1661 / TS-1661	Motor

KM-1660 Propane Compressor Driver - Instruments		
Instrument	Tag	Location
Vibration Switch	VSHH-1662	Motor casing

5.5.1.4 Propane Compressor Oil Separator V-1670

The hot compressed refrigerant / oil mixture is separated in oil separator V-1670. The separator is a vertical vessel (24" OD x 120" s/s).

The oil is separated by change in direction, gravity and finally by coalescing elements within the oil separator shell. The discharged propane vapour will contain no more than 10ppm (by weight) of compressor oil. The coalescing elements are replaceable, accessed via the man-way.

The separator contains immersion heaters HTR-1670 & HTR-1671 to maintain the oil at a minimum temperature when the compressors are not running. Ensure these heaters are energised when the compressors are off, de-energised when the compressors are running. The heaters have a built-in adjustable thermostat to control the oil temperature. TE-1672 is provided to measure oil temperature and provide a startup permissive and setpoint for the temperature control.

The retention allowed in the oil separator provides discharge oil with minimal entrained gas. Note that the oil will absorb propane, which reduces viscosity (allowed for in the oil selection) and will froth easily when de-pressured. The oil separator is also the reservoir for the compressor oil.

Fill and drain valves are provided. The drain allows the oil to be dumped to the drain header or to be collected for re-use.

V-1670 Oil Separator - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1671	Oil separator shell
Pressure Transmitter	PT-1675	Oil separator shell
Temperature Gauge	TI-1671	Oil separator shell
Thermocouple	TE-1670	Oil separator shell, vapour
	TE-1672	Oil separator shell, oil
PSV	PSV-1672	Oil separator shell (blocked flow)
Sight Glass	SG-1670	Oil separator shell

V-1670 Oil Separator - Instruments		
Instrument	Tag	Location
Sight Glass	SG-1671	Oil separator shell
Level Switch	LSL-1671	Oil separator shell
Heaters	HTR-1670	Oil separator shell
	HTR-1671	Oil separator shell
Flow Indicator	FI-1670	Secondary oil return

5.5.1.5 Propane Condenser AC-1655

From the compressors the hot refrigerant vapour goes to differential pressure control valve DPCV-1670 then to the condenser AC-1655 which is a fin-fan type with twelve (12) fan motors ACM-1655A/B/C/D/E/F and ACM-1656A/B/C/D/E/F that are staged in pairs to come on and off as the condensing load changes. The outlet temperature can also be controlled by an adjustment to the air flow by opening and closing the auto-louvres situated on top of the condenser. The condenser cools the hot refrigerant vapour against ambient air – firstly de-superheating the vapour and then totally condensing the vapour. The condensing (saturation) temperature sets the (saturation) pressure in the condenser and thus the compressors' discharge pressure. The condensing temperature is measured by TE-1655 and used by TIC-1655 to control the fan motors ACM-1655/1670 and the louvres TV-1655 to maintain 46 °C. At times of low ambient this system will not be able to control the condensing conditions and a winter pressure control system is provided to compensate (see section 5.5.1.9 below for description).

AC-1655 Propane Condenser - Instruments		
Instrument	Tag	Location
Thermocouple	TE-1655	Discharge line
PSV	PSV-1655	Inlet line (fire)
Vibration Switch	VSHH-1655A/B	Fan motors
Vibration Switch	VSHH-1656A/B	Fan motors

5.5.1.6 Propane Accumulator V-1650

This pressure vessel has a TCRN registration provided by the transport authorities that allows for the transport of the propane which is considered a hazardous material. The condensed liquid refrigerant from AC-1655 flows by gravity to the accumulator V-1650 (30" OD x 96" s/s). This vessel is designed to hold the entire refrigerant charge when the propane recovery plant needs to be transported to a new location or when the system requires maintenance. It also provides a buffer

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volume to accommodate process changes, process upsets and the reduced circulation rate required in winter. Normally the vessel will run around 20% full and will hold the entire charge when 80% full.

Note that the accumulator can also be described as "receiver".

V-1650 Propane Accumulator - Instruments		
Instrument	Tag	Location
Temperature Gauge	TI-1657	Accumulator shell
PSV	PSV-1652	Accumulator shell (fire)
Level Gauge	LG-1650	Accumulator shell (float gauge)
Level Transmitter	LT-1650	Accumulator shell

5.5.1.7 Propane Filter-Driers F-1646

The propane may contain water; water in the refrigeration system is not desirable as it may freeze. The filter-driers F-1646 contain absorbent cores which will remove water and maintain the system's dryness. This design uses one filter-drier vessel with the entire propane flow passing continually through the three.

The filter can also be used in a slipstream mode. The amount of flow that bypasses the filter is controlled by the manual 2" globe valve between the filter inlet and outlet connections. The bypass flow is typically 10% of the total flow. During startup the drier cores will have to be changed frequently as any water in the propane charge is removed. After startup the charge should be clean and dry and, unless propane is added to the system, it will not be necessary to change cores often. Inspection/replacement frequency can be advised by the Startec startup mechanic after he has assessed the system.

F-1646 Propane Filter-Drier - Instruments		
Instrument	Tag	Location
Differential Pressure Gauge	DPI-1646	Filter shell

5.5.1.8 Hot Gas Bypass

The propane refrigeration system has a hot gas bypass valve (HGBP) PCV-1610. This allows hot gas from the compressor discharge to flow into the propane side of gas chiller E-1610. The hot gas is de-superheated and evaporates some of the liquid in the chiller shell and is used to maintain flow to the compressor when the process

load is below the turndown of the compressor (<10% capacity). Also known as a phantom load, the HGBP can be used to run the R290 system during commissioning or after maintenance when process gas may not be available. The HGBP valve is a regulator-type control valve and is controlled by sensing pressure from the compressor suction line.

5.5.1.9 Low Ambient Pressure Control

The propane refrigeration system has winter pressure control for low ambient operation. When the ambient temperature is low it is possible for the condensing pressure to drop below that needed to circulate refrigerant from the accumulator to the chiller. To compensate for this and ensure that sufficient pressure is available to circulate refrigerant, the following controls are installed:

- a discharge differential pressure control valve DPCV-1670. This valve maintains a minimum compressor discharge pressure of 1034 kPag. This prevents oil carry over which may occur at low oil separator pressure and provides a minimum pressure to maintain refrigerant circulation. Note this valve is usually fully open.
- accumulator pressure maintenance control valve PCV-1650, set at 900 kPag. This valve allows hot gas from the compressor discharge to enter the cold accumulator. This maintains pressure in the accumulator to circulate refrigerant.
- check valve in the line from the condenser AC1655 to the accumulator V-1650. This valve allows liquid to back up into the condenser, flooding some of the tubes and reducing the effective capacity. This allows the condensing temperature to rise and hence the condensing pressure. When the condensing pressure becomes greater than the accumulator pressure, the check valve allows liquid to flow to the accumulator. The accumulator pressure is now above the setpoint of PCV-1650 and this valve closes. With liquid flowing from the condenser the flooded tube volume decreases, the condensing pressure drops, PCV-1650 opens and the condenser starts to flood again. This cycle repeats for as long as low ambient conditions exist

5.5.2 Compressor Oil and Oil Cooling Portion

5.5.2.1 General

The screw compressor requires a continuous supply of oil to lubricate and seal the machine. Oil that is injected into the compressor is mixed with the refrigerant vapour and discharged to the oil separator

V-1670. The oil is separated from the refrigerant vapour by gravity settling and the majority of the remaining oil mist is removed in the coalescing section of the oil separator. The discharged refrigerant stream will contain no more than 10ppm by weight of oil when properly maintained and operated.

5.5.2.2 Positive Compressor Oil Delivery

The separated oil flows by source pressure delivery from the oil separator V-1670 to the oil cooler E-1670. Positive delivery of the oil to the compressor is ensured by

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monitoring the lube oil delivery header pressure (PT-1677) to compressor suction pressure (PT-1615) and the lube oil delivery header pressure (PT-1677) to the oil separator/compressor discharge pressure (PT-1675). a differential of 207 kPa between the oil separator and the oil supply header. ??????? more information on XRV control.

5.5.2.3 Compressor Oil Cooler E-1670 and Oil Filters F-1675A/B

Oil from V-1670 flows to the oil cooler E-1670 to be cooled prior to its delivery to the compressor.

The oil is cooled against propane to 66 °C. From E-1670 the oil stream splits:

- One stream is strained and flows to the rotor injection port. This oil is injected into the rotor flutes to cool, lubricate and seal the rotor / casing clearance. A manual globe control valve is provided for flow control – this will be used to match the oil flow to the desired discharge temperature during commissioning. Improper adjustment of this valve can lead to compressor performance problems or failure – Startec's Mechanic will adjust this valve and advise on its operation.
- The remainder flows to oil filters F-1675A/B. These 10 micron elements filter the oil that is provided to the compressor bearings and shaft seal. There are 2 x 100% filters; the elements are replaceable in operation. **Note: each filter body has two isolation valves – during operation three of the four valves must be open to prevent damage to the off-line filter body by liquid expansion.** A differential pressure gauge DPI-1675 is also provided across the elements providing a measure of performance.

Oil from the filters flows to the oil supply header for distribution into the compressor bearings and seal. The oil supply temperature is monitored by TE-1675 to prevent either low or high oil temperatures.

The oil injected via the rotor port and the bearing / seal ports is discharged to the oil separator to start another cycle.

Compressor Oil Cooler E-1670 and Oil Filter F-1675A/B - Instruments		
Instrument	Tag	Location
Pressure Gauge	PI-1669	Oil pump discharge line
	PI-1676	Oil cooler oil outlet
	PI-1678	Oil header
Differential Pressure Gauge	DPI-1675	Across oil filters

Compressor Oil Cooler E-1670 and Oil Filter F-1675A/B - Instruments		
Instrument	Tag	Location
Pressure Transmitter	PT-1675	Oil Separator
	PT-1677	Oil header
Temperature Gauge	TI-1672	Oil from Oil Separator
	TI-1677	Oil cooler outlet (oil)
Thermocouple	TE-1675	Oil header
Temperature Control Valve	TCV-1668	Oil cooler (oil side)

5.5.2.4 Propane Oil Coolant Pump P--1655

The oil is cooled from compressor discharge temperature to the required supply temperature of 66°C. The coolant is liquid propane. The propane coolant is cooled as an additional load added to the propane condenser where it is cooled against ambient air. Propane coolant pump P-1655 circulates the propane liquid to the oil cooler E-1670 and is flashed and develops enough pressure to enter the AC-1655 propane condenser inlet stream.

There are no controls on this circuit other than manual globe flow control valve at P-1655 discharge. This valve should be set to maintain the pump's desired operating point on its curve while delivering the propane flow required to cool the compressor oil.

The driver PM-1655 has an HOA (Hand-Off-Auto) switch HS-1655 which allows the following:

- in Off, the pump is not running and will not start automatically
- in Auto, the pump is under PLC control and may stop or start automatically without warning
- in Hand, the pump is running and is under local control by the operator

In normal operation, the switch should be set to "Auto".

Note that selecting "Off" for HS-1655 will only stop PM-1665, not the propane recovery plant. The propane recovery plant may stop automatically shortly after as a result of stopping PM-1665 because some process variable has gone beyond it's safe limit.

Propane Oil Coolant Pump P-1655 - Instruments
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Instrument	Tag	Location
Pressure Gauge	PI-1655	Propane coolant pump discharge line

5.6 INSTRUMENT AIR

Each trailer has an instrument air header to supply the pneumatic devices on that skid. The header has valved off-takes, including a spare, and a drain. The air is provided from the utility trailers instrument air system – note there is no initial pressure reduction or filtering on the skids, only at the individual devices if required. Instrument air vented by various users is released to the atmosphere. The minimum air header pressure required for valve actuator operation is 80 psig.

5.7 FUEL GAS / BLANKET GAS

There is only one fuel gas requirement. On the vessel trailer fuel gas is used to blanket / pressurize the glycol flash tank V-1680. The fuel gas is regulated by self-contained Fisher outlet pressure regulator PV-1682.

Fuel gas is vented from BPCV-1681 on the flash tank to the flare header. Blanket gas for the distillation column and is discharged via the overheads to the process. Note: this may result in off-spec product from the debutaniser for a short period after restart.

During a blowdown, BDV-1681 on the flash tank will open and vent fuel gas to the flare. To avoid the loss of fuel gas, Customer should ensure that the fuel gas supply is isolated during blowdown.

5.8 DRAINS AND VENTS

The skids are provided with the following drains and vents:

	Skid#1	Skid #2	Discharge From

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Sweet Flare Header (Common to both skids)	Yes	Yes	PSVs, BDVs, PVs
Sweet Liquid Drain (Separate drain for each skid)	Yes	Yes	hydrocarbon liquids from process and instruments, hot oil, glycol
EG/Water Drain	No	Yes	EG from LTS, vent condenser, glycol regenerator, glycol filters.

All flare headers and drain headers are provided as skid edge connections for the customer to pipe to.