SECTION 6.0
METHANOL SYNTHESIS AND DISTILLATION
(Areas 213, 214, 219)

6.1 DESIGN BASIS

6.1.1 Methanol synthesis will be by the ICI low pressure process.

6.1.2 Three trains of equal capacity will be provided for converting the upgraded synthesis gas to methanol.

6.1.3 Operating pressure will be at 100 atmospheres.

6.1.4 Purge and flash gas will be collected and sent to a reformer for converting CH_4 to H_2 and CO which will be returned to the converter.

6.1.5 Each of the three distillation columns will be designed to produce 2,500 stpd of fuel grade methanol.

6.1.6 Bottoms water will be directed to the wastewater treatment area for cleanup prior to discharge.

6.2 PROCESS DESCRIPTION

6.2.1 Methanol Synthesis (Area 213, Dwg. 5530-213-Y-001)

The synthesis gas charged to the methanol converter is composed of makeup gas, reformed gas, and recycled loop gas. A fraction of the synthesis gas is preheated to reaction temperature and enters the top of the converter as feed gas. The following overall reactions take place over the copper based methanol synthesis catalyst.

$$CO + 2H_2 \rightleftharpoons CH_3OH$$

$$CO_2 + H_2 \rightleftharpoons CO + H_2O$$

The overall reaction from CO, CO_2 and H_2 to methanol is exothermic. The remaining synthesis gas is preheated (to a temperature substantially below reaction temperature) and is injected into the converter at appropriate points along the length of the converter. This "warm shot" gas is used to quench the reacting gas passing down through the catalyst beds. It moderates the reacting gas temperature and subsequently reacts to form methanol as it passes over the catalyst bed below.

The converter effluent gas is cooled by heat exchange in the warm shell interchanger, in the saturator water heater and in the distillation column gas reboiler. The remaining heat is removed in the cold shell interchanger. The air cooled crude methanol condenser removes waste heat from the exit gas and the condensate (crude methanol) is knocked out in the methanol separator. A fraction of the gas from the separator is purged to maintain the proper inerts level in the loop. This purge is used as part of the reformer feed and fuel. The remaining gas is recycled through the circulator compressor and the interchangers back to the converter. The makeup gas addition is at the suction of the circulator compressor.

Crude methanol is flashed at a pressure above atmospheric to remove some of the gases physically dissolved at the loop pressure. The crude methanol then passes under its own pressure to the crude methanol tank.

The flashed gases are sent to the reformer as part of the feed.

The methanol converter is a pressure vessel of single wall design constructed of low alloy steel which holds a single bed of catalyst. Temperature control is effected by injecting "warmshot" gas at appropriate levels directly into the catalyst bed using specially developed distributors called lozenges. The lozenges provide excellent gas mixing while allowing free flow of catalyst between them, thus allowing rapid catalyst charging and discharging. Catalyst changeout times of less than 36 hours from hot shutdown to start of reduction of new catalyst are consistantly achieved.

The synthesis loop also contains a steam heated start-up heater which serves to heat the circulating gases at start-up and for catalyst reduction.

6.2.2 Reforming (Area 219, Drawings 5530-219-Y-001, Y-002)

The purge gases produced by synthesis and distillation are steam reformed to supplement the makeup gas required from gasifiers as feed to the synthesis loops. In practice, not all of the purge gases can be fed to the reformer and returned to the methanol synthesis loops because the synthesis gas also contains nitrogen which would build up if some purge were not maintained. Thus 75% of loop purge and all of loop flash and distillation light ends are fed to the reformer as feed and 25% of loop purge is used as fuel to the reformer which is supplemented by No. 2 fuel oil. Purge gas feedstock is supplied at 100°F and 350 psig. The feedstock is mixed with process steam and heated to 900°F in the mixed feed preheater.

Preheated mixed feed is distributed equally to tubes packed with natural gas reforming catalyst.

The reforming furnace is of "modular" design which combines economical structural costs with simplicity of design. Heat of reaction is provided by downfired burners, situated in the roof of the furnace. The burners are designed for firing purge gas and No. 2 fuel oil.

Steam and purge gases enter the reforming tube centrally through a top blind flange, pass through a 35 foot bed of reforming catalyst reacting to form reformed gas which leaves through the outlet pigtail.

In the event of accidental tube failure, it is possible to isolate individual tubes by a hydraulic nipping device which pinches shut the "pigtail" connections at inlet and outlet. This operation may be carried out with the furnace on-line.

The reforming reaction is basically the reaction between hydrocarbon and steam to produce carbon monoxide and hydrogen. The presence of excess steam promotes the shift reaction which will alter the final equilibrium composition of the reformed gas. Typical equations representing the overall reactions are given below:

Reforming Reaction

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2$$

Shift Conversion Reaction

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

Heat is recovered from hot reformed gas by generation of steam in the reformed gas boiler, preheating the mixed feed and boiler feedwater heating in the boiler feedwater heater.

Final cooling of the reformed gas to 100°F is done in the air cooled reformed gas cooler.

Generation of steam at the 1500 psig level has been selected so as to be compatible with plant wide steam generating system.

Steam generation is achieved by heat recovery from reformed gas and radiant box flue gas. The steam generation boilers and the superheater utilizes a common steam drum and, for reliability, natural boiler feedwater circulation.

The flue gas from the furnace is also used to produce superheated steam, and to preheat combustion air.

6.2.3 Distillation (Area 214, Dwg. 5530-214-Y-001)

One of the major advantages of the ICI low pressure methanol process is the excellent selectivity of the converter catalyst and the consequent low level of organic impurities. A simple distillation system can thus achieve high efficiency without requiring high reboil heat loads. A single column distillation system is therefore provided. A part of the reboil heat is provided by the effluent gases from the methanol converter and effluent gases from the hydrolysis unit and the rest is provided by 50 psig saturated steam.

The crude methanol is pumped from the crude methanol tank to the distillation system and is heated with the distillation column overheads. To prevent corrosion, a premixed aqueous solution of 1% sodium hydroxide is metered into the crude feed at a rate sufficient to neutralize any organic acids present. The heated liquid is then fed to the distillation column.

The distillation column is used to separate dissolved gases and water from the product methanol. This column is fitted with an overhead condenser system, two gas reboilers and a steam reboiler.

The overheads from the distillation column are partially condensed in the overheads condenser. The remaining methanol vapor is condensed in the light ends cooler at 100°F. Such a split cooling duty avoids subcooling of the methanol reflux more than is absolutely necessary and yet maintains very low losses of methanol in the off gas purge from the secondary methanol separation. This gaseous purge contains the remaining dissolved gases not separated in the letdown vessel and light organic by-products such as dimethyl ether, aldehydes, ketones, etc. The light ends purge gas is compressed in the light ends compressor and is used as part of the feed to the reformer. Light ends from three separate distillation columns will be recycled as feed through a common light ends compressor.

The distillate is drawn as liquid from near the top of the column. This product is cooled and passes to the fuel methanol storage facilities.

A sidestream of fusel oil is extracted from near the bottom of the distillation column. The fusel oil contains the organic heavy ends such as ethanol, propanols and butanols which are valuable as fuel. To remove these higher alcohols from the distillation system the fusel oil, after cooling, is pumped into the distillate stream to yield fuel grade methanol.

The bottoms water, which contains about 12 ppm alcohols, the bulk of which is methanol, is pumped to the wastewater treatment area.

6.3 ENGINEERING DESIGN DATA

Design data pertinent to Reforming, Synthesis and Distillation is detailed in the Process Flow Diagrams immediately following this page, in the Equipment List beginning on Page 6/9, and in the Drawings following Page 6/22.

DRAWINGS RELATING TO METHANOL SYNTHESIS AND DISTILLATION

DRAWING NO.	TITLE
5530-213-Y-001	Methanol Synthesis
5530-214-Y-001	Methanol Distillation
5530-219-Y-001	Reforming
5530-219-Y-002	Reforming

EQUIPMENT LIST

5530-213-P-001	Raw Gas and Methanol Areas - Overall Arrangement
5530-213-P-002	Methanol Unit, Distillation and Synthesis - Plan at Base
5530-213-P-003	Methanol Unit, Distillation and Synthesis - Plan above 22'-0"
5530-213-P-004	Methanol Unit, Distillation and Synthesis - Plan above 38'-0"
5530-213-P-005	Methanol Unit, Distillation and Synthesis - Plan above 54'-0"
5530-213-P-006	Methanol Unit, Distillation and Synthesis - Elevation

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LIST OF CORRECTIONS

Equipment List	Item	Reads	Should Read
213-1301-1	C	117,000	39,000
214-1621	T	Shell and Tube	Fin Fan
219-1604	Des P/T	Shell--310 Tubes--400	Tubes--310 Shell--400
219-1607	T	Horizontal	Vertical
302-1103	C D	200 350	670 1,065

SCALING RULER 1/8" 1/4"

STREAM NO.		1		2		3		4		5
STREAM DESCRIPTION		METHANOL SYNTHESIS FEED		CRUDE METHANOL		PURGE AND FLASH GAS		REFORMER FUEL PURGE GAS		
PHASE		G		L		G		G		
COMPONENT	MOL. WT.	MOL.%	MOL./HR.	MOL.%	MOL./HR.	MOL.%	MOL./HR.	MOL.%	MOL./HR.	
CARBON	12.011									
HYDROGEN	2.016	64.72	643025.79	0.02	5.76	47.58	621274	48.30	202701	
NITROGEN	28.014	9.03	418116	0.01	3.60	23.75	309900	24.29	101268	
SULFUR	32.065									
OXYGEN	32.000									
CHLORINE	35.453									
ASH	--									
WATER	18.016	0.02	13.20	21.36	5972.16	0.04	4.99	0.03	1.11	
CARBON MONOXIDE	28.011	18.69	15518.81	0.01	1.42	4.78	62442	4.84	20244	
CARBON DIOXIDE	44.011	8.25	67534	0.75	187.29	7.82	102077	6.79	28365	
METHANE	16.043	9.29	76937	0.09	23.10	15.45	202996	15.28	63849	
HYDROGEN SULFIDE	34.076									
CARBONYL SULFIDE	60.071									
SULFUR DIOXIDE	64.066									
METHANOL	32.043			77.68	19516.95	0.47	61.84	0.91	15.14	
DIMETHYL ETHER	46.068			0.08	21.15	0.03	4.14	0.02	0.81	
HIGHER ALCOHOL	74.120			0.10	26.10					
(SOLIDS CARRYOVER)	GR/SCF DRY									
(SOLIDS CARRYOVER)	LB/HR									
TOTAL (WET)		100.00	819312.3	100.00	25137.7	100.00	305786	100.00	417927	
FLOW (DRY)	SCFH	31087075				49334.94		196570		
TOTAL FLOW	LB/HR	992268		739845		19711		61309		
PRESSURE	PSIA	1409		75		36v				
TEMPERATURE	°F	100		100		100		100		
HHV	BTU/LB									
HHV (DRY)	BTU/SCF									

218-Y-002

212-Y-001

213-2207 METHANOL CONVERTER

213-1616 LOOP START-UP HEATER

213-1615 WARM SHELL LOOP INTERCHANGER

213-1618 SATURATOR WATER HEATER

COLD IN

TC

TD

305-Y-001 (NORMALLY ZERO)

213 1616 3

213 1615 6

213 1614 6

210-Y-001

213 2207 3

213 1618 3

216-Y-001 SATURATOR WATER

214-Y-001 TO LOOP GAS COLUMN REBOILER 1

214-Y-001 FROM LOOP GAS COLUMN REBOILER 1

213 CIRC

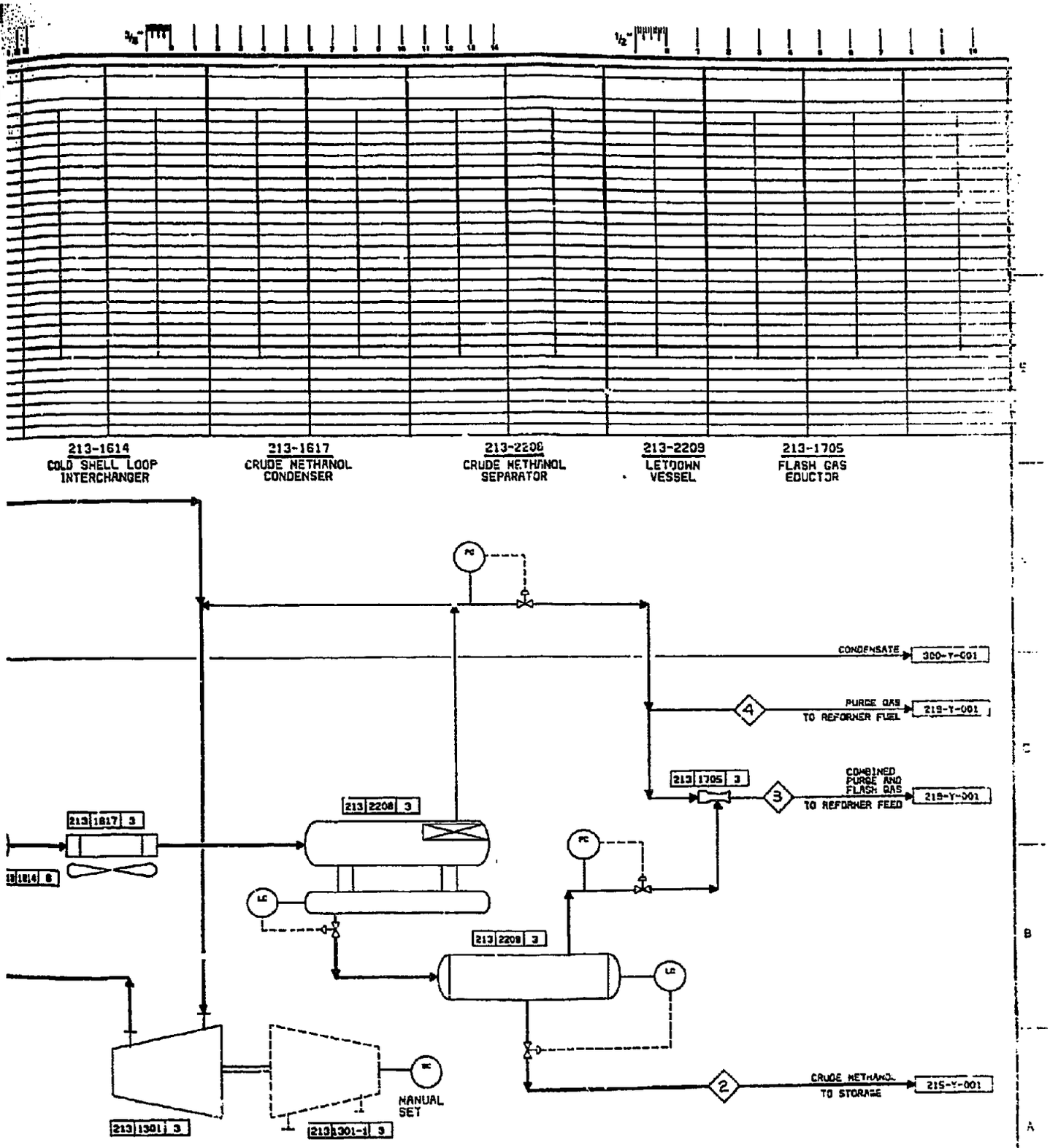
AC1441

REVISIONS NO.	DESCRIPTION	BY	CK.	APPROVED	DATE
A	ISSUED FOR FINAL REPORT	TD			7/7/78

REVISIONS NO. DESCRIPTION BY CK. APPROVED DATE

REFERENCES

1 2 3 4 5



213-1301 CIRCULATOR

213-1301-1 CIRCULATOR TURBINE

CLIENT
CIRI/PLACER
BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DESIGNED		
DRAWN		
CHECKED	EPL	7/81
APPROVED 1	TLS	7/81
APPROVED 2		
APPROVED 3		

DATE TO: CLIENT / FIELD

TITLE
METHANOL
SYNTHESIS

SCALE _____ DRG NO. 5530-213-Y-001

REVISION 0

6 7 8 9 10

SCALING RULER 1/8" 1/4"

STREAM NO.		1		2		3		4		5					
STREAM DESCRIPTION		CRUDE METHANOL		COMPRESSED LIGHT ENDS		PRODUCT METHANOL		BOTTOMS WATER							
PHASE		L		G		L		L							
COMPONENT	MOL. WT.	MOL. %	MOL./HR	MOL. %	MOL./HR	MOL. %	MOL./HR.								
CARBON	12.011														
HYDROGEN	2.016	0.02	6.76	1.59	5.76										
NITROGEN	28.014	0.01	3.60	1.06	3.69										
SULFUR	32.060														
OXYGEN	32.000														
CHLORINE	70.453														
ASH	-														
WATER	18.016	21.56	5372.16			0.28	96.09	100.00	5276.15						
CARBON MONOXIDE	28.011	0.01	1.62	0.48	1.62										
CARBON DIOXIDE	44.011	0.75	127.28	55.06	187.23										
METHANE	16.043	0.09	23.10	6.79	23.10										
HYDROGEN SULFIDE	34.076														
CARBONYL SULFIDE	60.071														
SULFUR DIOXIDE	64.065														
METHANOL	32.043	77.58	19516.95	28.69	97.56	99.42	19419.39	10 PPM	-						
DIMETHYL ETHER	46.069	0.08	21.15	6.22	21.15										
HIGHER ALCOHOL	74.120	0.10	26.10	0.01	0.03	0.30	26.07	2 PPM	-						
(SOLIDS CARRYOVER)	#/SCF DRY														
(SOLIDS CARRYOVER)	LB/HR														
TOTAL (WET)		100.00	25157.67	100.00	340.05	100.00	19541.49	100.00	5726.15						
FLOW (DRY)	SCFH			129046											
TOTAL FLOW	LB/HR	733845		12870		625420		95055							
PRESSURE	PSIA	78		385		29		75							
TEMPERATURE	°F	100		100		100		100							
HHV	BTU/LB														
HHV (DRY)	BTU/SCF														

214-1306 LIGHT ENDS COMPRESSOR

214-2213 HYDROLYZED GAS SEPARATOR

214-1621 LIGHT ENDS COOLER

214-2211 REFLUX DRUM

214-1620 OVERHEADS CONDENSER

214-1619 FEED/OVERHEADS INTERCHANGER

214-2502 CAUSTIC DOSING SET

214- DISTI COLU REBOI

215-Y-001 CRUDE METHANOL FROM CRUDE METHANOL TANK

219-Y-001 DISTILLATION LIGHT ENDS TO REFORMER FEED

214 1621 3

214 1620 3

214 1619 3

214 1306 1

214 2211 3

214 1103 3+3

213-Y-001 LOOP CONVERTER GAS TO DISTILLATION COLUMN REBOILER 1

213-Y-001 LOOP CONVERTER GAS TO COLD SHELL INTERCHANGER

214 1625 3

210-Y-001 HYDROLYZED GAS TO DISTILLATION COLUMN REBOILER 2

210-Y-001 HYDROLYZED GAS RETURN

214 2213 3

302-Y-001 CONDENSATE

214-1103 REFLUX PUMP

214-1104 BOTTOMS PUMP

214-1106 FUSEL OIL PUMP

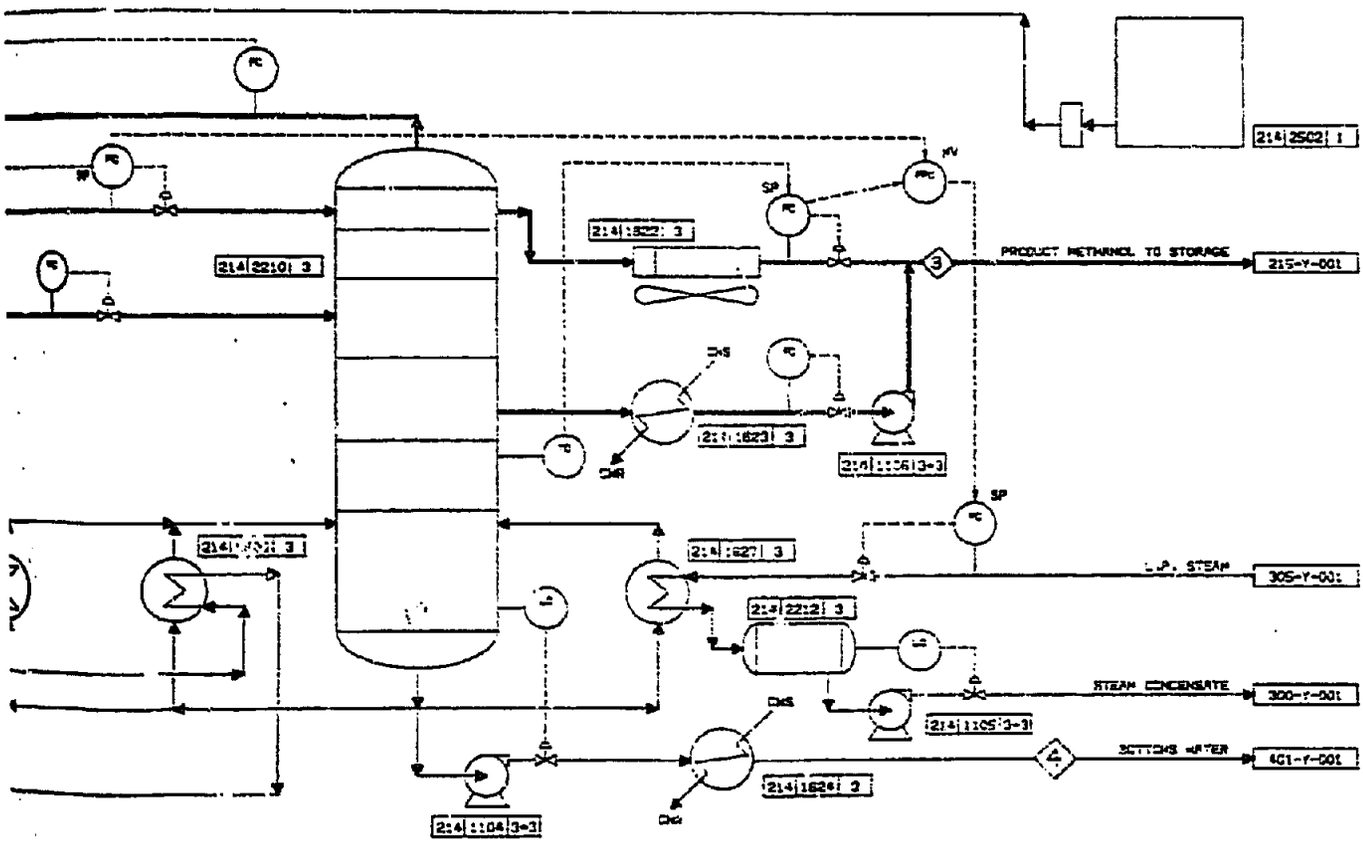
RC1431

REVISIONS NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE
0	ISSUED FOR FINAL REPORT	J.D			9/30/81

REVISIONS NO. DESCRIPTION BY CHK. APPROVED DATE

REFERENCES

NO.	214-1625 DISTILLATION COLUMN GAS REBOILER #1	214-1626 DISTILLATION COLUMN GAS REBOILER #2	214-2210 DISTILLATION COLUMN	214-1624 BOTTOMS COOLER	214-1622 METHANOL COOLER	214-1623 FUSEL OIL COOLER	214-1627 DISTILLATION COLUMN STEAM REBOILER	214-2212 STEAM CONDENSATE DRUM



214-1105
STEAM CONDENSATE PUMP

CLIENT: CIRI/PLACER BELUGA METHANOL PROJECT COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DESIGNED		
DRAWN		
CHECKED		
APPROVED		
APPROVED		
APPROVED		

DISTRIB: CLIENT, FIELD

TITLE: METHANOL DISTILLATION

SCALE: NONE

5530-214-Y-001

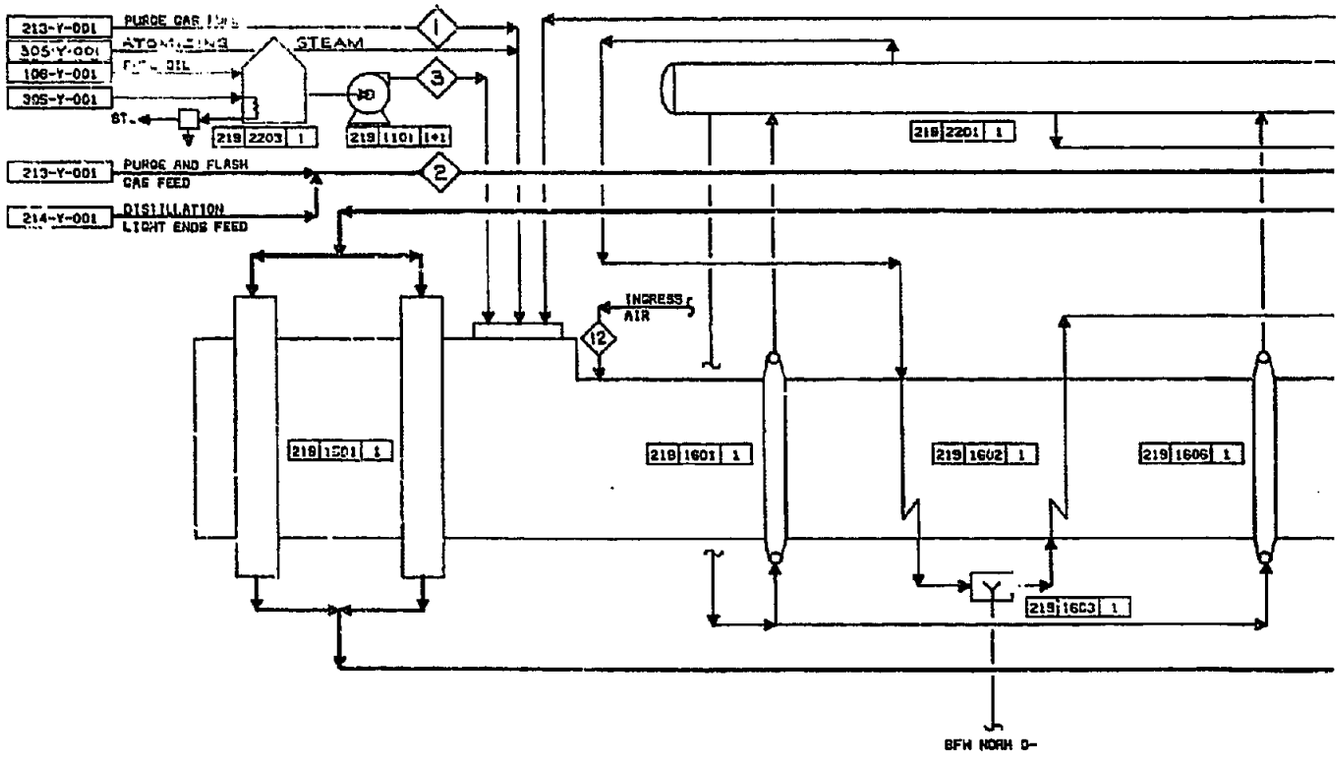
REVISIONS: C

6 7 8 9 10

SCALING RULER 1/8" 1/4"

STREAM NO.	1		2		3		4		5		6		7		8		9	
STREAM DESCRIPTION	PURGE FUEL GAS		REFORMER FEED		FUEL OIL		H.P. BOILER BLOWDOWN		PROCESS STEAM		SUPERHEATED STEAM		FLUE GAS		COMBUSTION AIR		REFOR GAS	
PHASE	G		G		L		L		G		G		G		G		G	
COMPONENT	MOL. WT.	MOL.%	MOL./HR	MOL.%	MOL./HR	WT.%	LB./HR.	WT.%	LB./HR.	MOL.%	MOL./HR.	WT.%	LB./HR.	MOL.%	MOL./HR.	MOL.%	MOL./HR.	MOL.%	MO
CARBON	12.011																	69.88	108
HYDROGEN	2.016	48.55	2027.01	46.41	6218.50													17.13	31
NITROGEN	28.014	29.28	1012.63	28.16	3102.60									76.92	4370.56	78.11	12399.92		
SULFUR	32.060																		
OXYGEN	32.000													4.95	1003.56	20.76	8298.64		
CHLORINE	35.453																		
ASH	--																		
WATER	18.016	0.03	1.11	0.04	4.99			100.00	7300	100.00	6836.55	100.00	236700	18.06	3657.66	1.19	179.83	0.57	6
CARBON MONOXIDE	28.011	4.84	202.44	4.67	526.64													14.19	25
CARBON DIOXIDE	44.011	6.79	283.65	9.02	1208.00									6.07	1230.76			5.80	4
METHANE	16.043	15.28	639.48	18.82	2053.06													0.13	5
HYDROGEN SULFIDE	34.076																		
CARBONYL SULFIDE	60.071																		
SULFUR DIOXIDE	64.066																		
METHANOL	32.043	0.31	13.14	1.19	159.40														
DIMETHYL ETHER	46.068	0.02	0.81	0.19	25.29														
HIGHER ALCOHOL	74.120																		
(SOLIDS CARRYOVER)	GRS/SCF DRY																		
(SOLIDS CARRYOVER)	LB/HR																		
FUEL OIL	LB/HR					100.00	1687												
TOTAL (WET)		100.00	4179.27	100.00	13397.68	100.00	1687	100.00	7300	100.00	6836.55	100.00	236700	100.00	20262.14	100.00	15874.94	100.00	16
FLOW (DRY)	SCFH	1685570		5082468										6901272		595630A		684815	
TOTAL FLOW	LB/HR	61209		209451		1687		7300		114159		236700		554729		456051		28831	
PRESSURE	PSIA			335		50		1065		365		1515		15		ATM.		255	
TEMPERATURE	°F	100		100		80		600		590		920		285		AMB.		100	
HHV	BTU/LB																		
HHV. (DRY)	BTU/SCF																		

219-2207	219-1501	219-1601	219-1602	219-1603	219-1604	219-2201	219-16
FUEL OIL DAY TANK	REFORMING FURNACE	RADIANT SHIELD BOILER	STEAM SUPERHEATER	REFORMER STEAM ATTEMPORATOR	MIXED FEED PREHEATER	STEAM DRUM	REFORM GAS BOILE



219-1101
FUEL OIL PUMP

AC1442

REVISIONS NO.	DESCRIPTION	BY	CH.	APPROVED	DATE
A	ISSUED FOR FINAL REPORT	SD			7/17/80

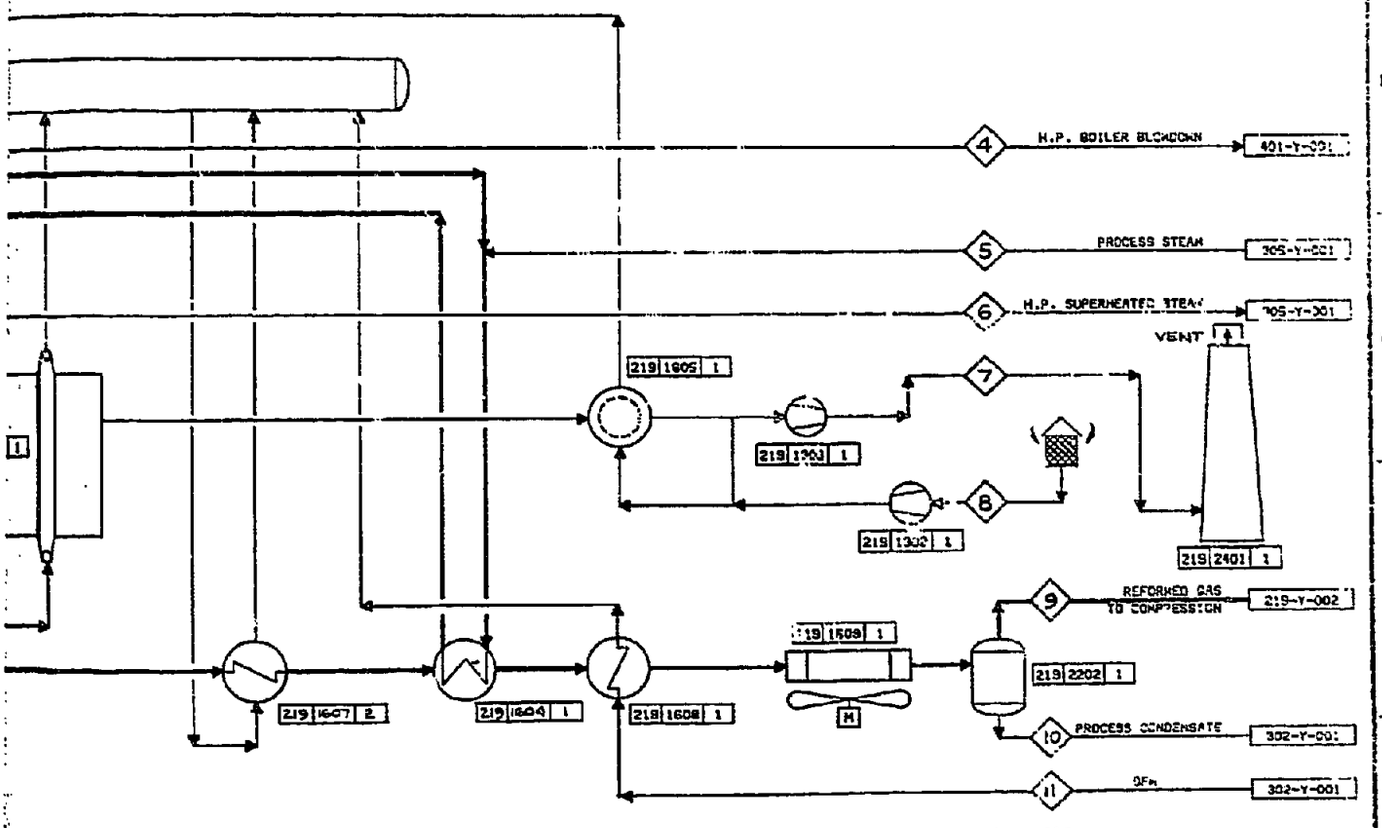
REVISIONS NO. DESCRIPTION BY CH. APPROVED DATE

REFERENCES

1 2 3 4 5

	9 REFORMED GAS G		10 PROCESS CONDENSATE L		11 BOILER FEED WATER L		12 INGRESS AIR G	
	MOL.%	LB./HR.	WT. %	LB./HR.	WT. %	LB./HR.	MOL.%	MOL./HR.
		6345.93						
		390160					78.11	958.18
							20.76	254.66
	0.27	67.58	100.00	90292	100.00	244000	1.13	13.86
		256578						
		95259						
		367.76						
	100.00	881320	100.00	90292	100.00	244000	100.00	1226.70
		6848132						460261
		256918		90292		24.1000		35240
		255		255		1665		ATM.
		100		100		229		AMB.

219-1607	219-1605	219-1608	219-1606	219-1609	219-2401	219-2202
REFORMED GAS BOILER	COMBUSTION AIR PREHEATER	H.P. BFW HEATER	FLUE GAS BOILER	REFORMED GAS COOLER	FLUE GAS STACK	REFORMED GAS SEPARATOR



219-1303	219-1302
I.D. FAN	F.D. FAN

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CLIENT: CIRI/PLACER BELUGA METHANOL PROJECT COOK INLET, ALASKA

Davy McKee ENGINEERS AND CONSTRUCTORS

	DESIGNED	BY	DATE
	DRAWN		
	CHECKED	SR	5/M
	APPROVED	TKS	
	APPROVED		
	APPROVED		

DATE TO: CLIENT / FIELD

TITLE: REFORMING

SCALE: DWG NO. 5530-219-Y-001

REVISION 0

6 7 8 9 10

SCALING RULES 1/8" 1/4"

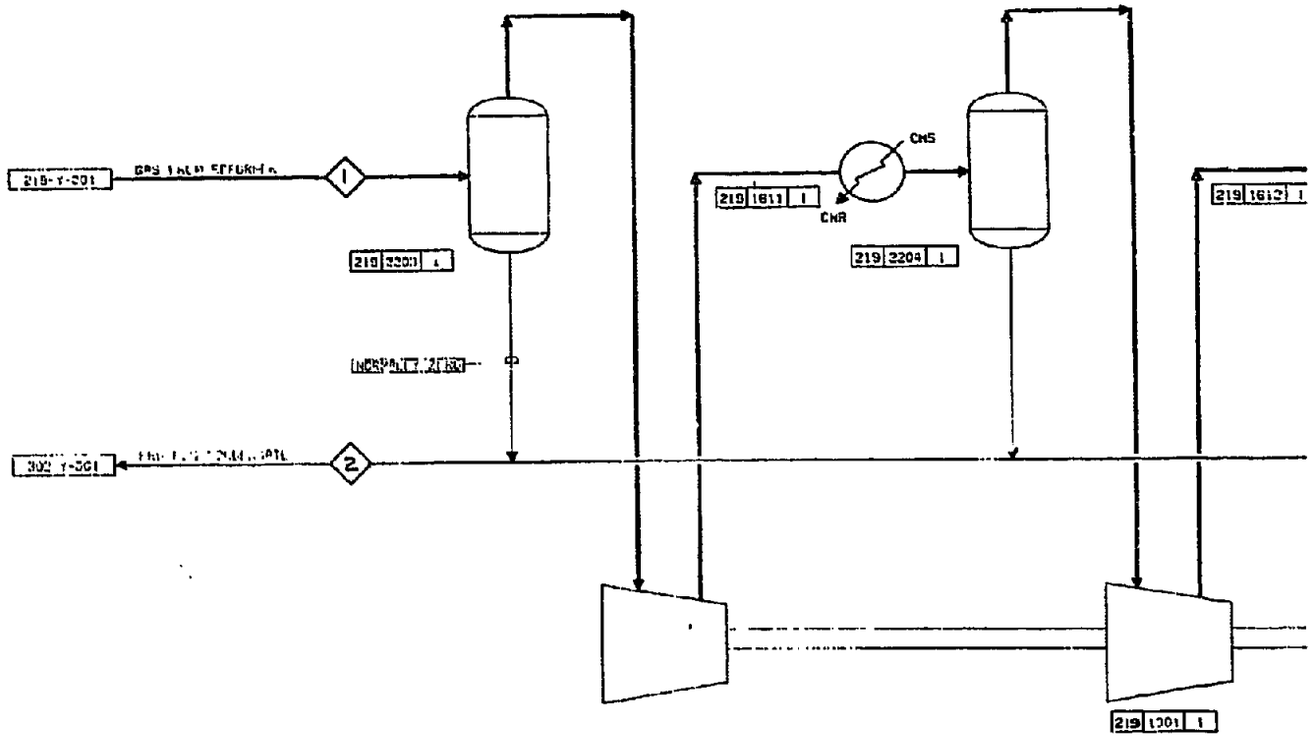
STREAM NO.	1		2		3		4	5
STREAM DESCRIPTION	REFORMED GAS		PROCESS CONDENSATE		COMPRESSED REFORMED GAS			
PHASE	G		L		G			
	MOL.%	MOL./HR.	WT.%	LB./HR.	MOL.%	MOL./HR.		
	59.88	10845.93			60.07	10845.93		
	17.18	3102.60			17.18	3102.60		
	0.37	67.58	100.00	990	0.07	12.63		
	14.19	2562.78			14.29	2562.78		
	5.30	959.89			5.31	959.89		
	3.15	567.76			3.14	567.76		
	100.00	18113.20	100.00	990	100.00	18058.25		
	6848192				6848132			
	289318		990		282528			
	255		255		1402			
	100		100		100			

219-1611
FIRST INTERSTAGE COOLER

219-2204
FIRST INTERSTAGE SEPARATOR

219-1612
SECOND INTERSTAGE COOLER

219-1301
REFORMED GAS COMPRESSOR

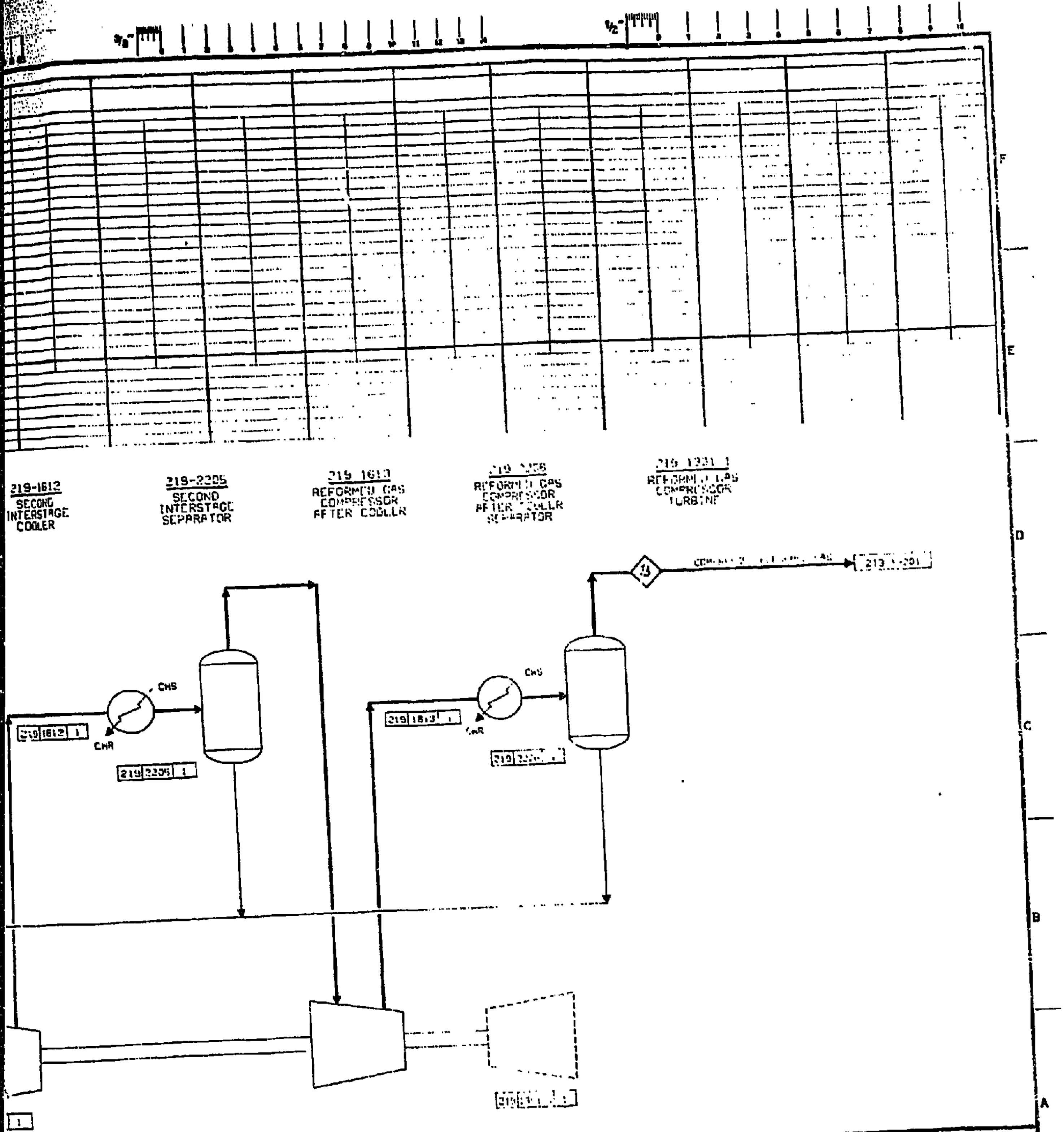


REVISIONS NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE
1	ISSUED FOR FINAL REPORT	F.D.			7/7/76

REVISIONS NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE

REFERENCES

1 2 3 4 5



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CLIENT: BELUGA METHANOL PROJECT, COOK INLET, ALASKA

TITLE: REFORMING

Davy McKee
ENGINEERS AND CONSTRUCTORS

5530-219-Y-002

REVISION 0

NOMENCLATURE:
T - TYPE
C - CAPACITY
S - SIZE
P/T - OPERATING PRESSURE/TEMPERATURE
M - MATERIAL
CS - CARBON STEEL
SS - STAINLESS STEEL
CI - CAST IRON
D - DRIVE
W - WEIGHT
ACC - ACCESSORIES

METHANOL SYNTHESIS - AREA 213

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
213-1301	3	**Circulator**
		T - Single stage centrifugal
		S - 6000 hp
		Pi/Ti - Suction - 1394 psig/100°F
		D - Steam turbine
213-1301-1	3	**Circulator Turbine**
		T - Condensing
		C - 117,000 lb/hr steam
		Pi/Ti/Po - 855 psig/840°F/2" Hg Abs
213-1705	3	**Flash Gas Eductor**
		T - Jet ejector
		C - 4365 lb/hr with MW 23.44
		M - Carbon Steel with SS nozzle
		Des P/T - Suction - 60 psig/100°F
		Discharge - 370 psig
		Motive gas @ 1394 psig, 100°F
		W/MW = 14.69
213-1614	6	**Cold Shell Loop Interchanger**
		T - Shell and Tube
		S - 29,500 sq ft/shell
		M - Shell - Carbon Steel
		Tubes - Ebrite
		Des P/T - Shell - 1663 psig/300°F
		Tubes - 1663 psig/320°F

METHANOL SYNTHESIS - AREA 213

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
213-1615	6	Warm Shell Loop Interchanger
		T - Shell and Tube, 2 shells in series
		S - 14,800 sq ft/shell
		M - 1st Shell - Shell/Tube - C-1/2 Mo 2nd Shell - Shell - Carbon Steel Tubes - Ebrite
		Des P/T - Shell - 1663 psig/515°F Tubes - 1663 psig/570°F
213-1616	3	Loop Start-Up Heater
		T - Shell and Tube
		S - 1700 sq ft
		M - Shell/Tube - C-1/2 Mo.
		Des P/T - Shell - 1020 psig/900°F Tubes - 1663 psig/900°F
213-1617	3	Crude Methanol Condenser
		T - Fin fan
		S - 23,350 sq ft bare area
		M - Tubes - Stainless Steel
		Des P/T - Tubes - 1663 psig/250°F
		D - 20-30 hp electric motors
213-1618	3	Loop Saturator Water Heater
		T - Shell and Tube
		S - 21,480 sq ft
		M - Shell/Tubes - Carbon Steel clad w/304L SS/Carpenter 7 Mo SS
		Des P/T - Shell - 930 psig/470°F Tubes - 1663 psig/570°F
213-2207	3	Methanol Converter
		T - Vertical, Cylindrical, 6 bed catalyst packed
		M - C-1/2 Mo
		Des P/T - 1663 psig/600°F Catalyst ICI Type 51-2

METHANOL SYNTHESIS - AREA 213

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
213-2208	3	Crude Methanol Separator
		T - Horizontal, Cylindrical, double barrel
		S - 10' ID x 30' T-T top barrel 6' ID x 30' T-T bottom barrel
		M - Shell - Carbon Steel, 304 SS lined top barrel Bottom barrel all carbon steel
		Des P/T - 1663 psig/150°F
213-2209	3	Letdown Vessel
		T - Horizontal, Cylindrical mounted w/demister
		S - 8'6" ID x 30' T-T with 6" TK demister pad Demister - 304 SS
		Des P/T - 150 psig/150°F

NOMENCLATURE:
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D - DRIVE
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ACC - ACCESSORIES

METHANOL DISTILLATION - AREA 214

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
214-1103	3 + 3	Reflux Pump
		T - Horizontal, Centrifugal
		M - Casing - Cast Steel
		Impeller - Cast Iron
		D - 100 hp, Electric
214-1104	3 + 3	Bottoms Pump
		T - Horizontal, Centrifugal
		C - 85 GPM @ 60 psi ΔP
		M - Casting - Cast Steel
		Impeller - Cast Iron
		D - 10 hp, Electric
214-1105	3 + 3	Steam Condensate Pump
		T - Horizontal, Centrifugal
		C - 330 GPM @ 20 psi ΔP
		M - Casing - Carbon Steel
		Impeller - Cast Iron
		D - 10 hp, Electric
214-1106	3 + 3	Fusel Oil Pump
		T - Reciprocating
		C - 3 GPM @ 60 psi ΔP
		M - Stainless Steel
		D - 1 hp, Electric
214-1306	1	Light Ends Compressor
		T - 3 stage reciprocating compressor
		C - 129,277 SCFH
		Des P/T - Suction - 1 psig/100°F
		Discharge - 370 psig/100°F
		D - 1000 hp, Electric Motor
214-1619	3	Feed Overheads Interchanger
		T - Shell and tube
		S - 1945 sq ft
		M - Shell/Tubes - Carbon Steel
		Des P/T - Shell - 75 psig to FV/300°F
		Tubes - 150 psig to FV/300°F

METHANOL DISTILLATION - AREA 214

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
214-1620	3	Overhead Condenser
		T - Fin fan S - 30,500 sq ft bare area M - Tubes - Carbon Steel Des P/T - Tubes - 75 psig to FV/300°F D - 20-40 hp electric motors
214-1621	3	Light Ends Cooler
		T - Shell and Tube C - 15.39 MM Btu/hr S - 1350 sq ft bare area M - Tubes - Carbon Steel Des P/T - Tubes - 75 psig to FV/300°F D - 2-15 hp electric motors
214-1622	3	Methanol Cooler
		T - Fin fan C - 8.79 MM Btu/hr S - 2200 sq ft bare area M - Tubes - Carbon Steel Des P/T - Tubes - 75 psig to FV/300°F D - 2-30 hp electric motors
214-1623	3	Fusel Oil Cooler
		T - Double Pipe C - 0.13 MM Btu/hr S - 25 sq ft M - Carbon Steel Des P/T - Outer pipe - 150 psig/300°F Inner pipe - 150 psig/170°F
214-1624	3	Bottoms Cooler
		T - Shell and Tube C - 4.69 MM Btu/hr S - 390 sq ft M - Shell/Tubes - Carbon Steel Des P/T - Shell - 75 psig to FV/300°F Tubes - 150 psig/170°F

METHANOL DISTILLATION - AREA 214

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
214-1625	3	Distillation Column Gas Reboiler No. 1 T - Shell and Tube S - 11,634 sq ft M - Shell/Tubes - Carbon Steel Des P/T - Shell - 75 psig to FV/300°F Tubes - 1663 psig/410°F
214-1626	3	Distillation Column Gas Reboiler No. 2 T - Shell and Tube S - 17,145 sq ft M - Shell/Tubes - Carbon Steel/304 SS Des/P/T - Shell - 75 psig to FV/300°F Tubes - 730 psig/520°F
214-1627	3	Distillation Column Steam Reboiler T - Shell and Tube C - 125 MM Btu/hr S - 9470 sq ft M - Shell/Tubes - Carbon Steel Des P/T - Shell - 75 psig to FV/300°F Tubes - 75 psig/360°F
214-2210	3	Distillation Column T - Valve Tray M - Shell/Trays - Carbon Steel Des P/T - 75 psig to FV/300°F
214-2211	3	Reflux Drum T - Horizontal, Cylindrical S - 8'6" ID x 27' long T-T M - Carbon Steel Des P/T - 75 psig to FV/300°F

METHANOL DISTILLATION - AREA 214

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
214-2212	3	Steam Condensate Drum
		T - Horizontal, Cylindrical S - 6' ID x 13' long T-T M - Carbon Steel Des P/T - 75 psig to FV/300°F
214-2213	3	Hydrolyzed Gas Separator
		T - Vertical, Cylindrical S - 8' ID x 15' High M - Carbon Steel w/304SS lining Des P/T - 775 psig/320°F
214-2502	1	Caustic Dosing Set
		T - Skid mounted tank, pump and agitator for pH control (1% NaOH solution) C - 100 GPH @ 90 psig discharge Tank - 1000 gal M - Carbon Steel, polypropylene lined

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REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-1101	1 + 1	Fuel Oil Pump
		T - Reciprocating
		C - 4 GPM, ΔP = 50 psi
		M - Cast Iron
		D - 1 hp, Electric
219-1102	1 + 1	Turbine Steam Condensate Pump
		T - Horizontal, Centrifugal
		C - 280 GPM @ 46 psi ΔP
		M - Cast Iron
		D - 10 hp, Electric
219-1301	1	Reformed Gas Compressor
		T - 3 Stage Centrifugal
		S - 19,100 hp
		C - 6.85 MM SCFH
		Pi/Ti - 240 psig/100°F
		Po/To - 1394 psig/100°F
		D - Steam Turbine
219-1301-1	1	Reformed Gas Compressor Turbine
		T - Extraction
		C - 228,113 lb/hr Steam
		Pi/Ti/Po - Steam Turbine, 1500 psig, 900°F, 350 psig/4" Hg Abs
219-1302	1	Forced Draft Fan
		T - Centrifugal
		C - 120,954 ACFM @ 14.5" w.c. ΔP
		M - Housing/Impeller - Carbon Steel
		D - Steam Turbine
219-1302-1	1	F.D. Fan Turbine
		T - Condensing
		C - 2600 lb/hr Steam
		Pi/Ti/Po - 350 psig/590°F/4" Hg Abs

REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-1303	1	Induced Draft Fan
		T - Centrifugal C - 233,562 ACFM @ 23" w.c. ΔP M - Housing/Impeller - Carbon Steel D - Steam Turbine
219-1303-1	1	I.D. Fan Turbine
		T - Condensing C - 7630 lb/hr Steam Pi/Ti/Po - 350 psig/590°F/4" HgAbs
219-1501	1	Reforming Furnace
		T - Down fired co-current C - 293.88 MM Btu/hr S - 58'6" long x 47' wide x 35' high Tubes - 312 total required, 13 tubes/bank, 4 banks/row, 6 rows total 4.3" ID x 0.375 thick x 35' long (pull bored) M - Tubes - Manaurite 36-X Catalyst - 1137 ft^3 on natural gas reforming catalyst: 57-3 long rings or equal
219-1601	1	Radiant Shield Boiler
		T - Vertical tubes in duct C - 20.88 MM Btu/hr S - 900 sq ft M - Carbon Steel Des P/T - 1760 psig + static head/670°F
219-1602	1	Steam Superheater
		T - Horizontal coil in duct C - 66.68 MM Btu/hr S - 6250 sq ft M - 2-1/4 Cr 1 Mo Des P/T - 1760 psig/1100°F

REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-1603	1	Reformer Steam Attemporator
		C - 272,200 lb/hr, 1550 psig Steam to 920°F by injection of BFW
219-1604	1	Mixed Feed Preheater
		T - Shell and Tube C - 106.91 MM Btu/hr S - 14,360 sq ft M - Shell - 2-1/4 Cr 1 Mo Tubes -310 SS Inlet channel refractory lined Des P/T - Shell - 310 psig/1050°F Tubes -400 psig/950°F
219-1605	1	Combustion Air Preheater
		T - Rotary C - 75.19 MM Btu/hr, 465,173 lb/hr air Des P/T - Air in @ 10" w.g./62° DB to 700°F D - 20 hp electric motor
219-1606	1	Flue Gas Boiler
		T - Horizontal tubes in duct C - 71.13 MM Btu/hr S - 50,035 sq ft (finned) M - Carbon Steel Des P/T - 1760 psig & static head/670°F

REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-1607	2	**Reformed Gas Boiler** T - Firetube C - 116.69 MM Btu/hr S - 2920 sq ft M - Shell - Carbon Steel Tubes - Carbon Steel Inlet channel & tubesheet refractory lined internally Des P/T - Shell - 1760 psig + static head/660°F Tubes - 300 psig/660°F
219-1608	1	**HP BFW Heater** T - Shell and Tube C - 28.23 MM Btu/hr S - 4310 sq ft M - Shell - Carbon Steel, SS clad Tubes -304 SS Des P/T - Shell - 300 psig/470°F Tubes - 1760 psig/400°F
219-1609	1	**Reformed Gas Cooler** T - Fin fan C - 121.18 MM Btu/hr S - 11,200 sq ft bare area P/T- Tubes - 300 psig/425°F D - 10 x 30 hp electric motors
219-1610	1	**Turbine Steam Condenser** T - Shell and Tube C - 140 MM Btu/hr S - 5200 sq ft M - Shell - Carbon Steel Inhibited admiralty bronze Tubesheet - 90/10 Cu/Ni clad Carbon Steel Des P/T - Shell - 75 psig + full vac/350°F Tubes 150 psig/170°F

REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-1611	1	First Interstage Cooler
		T - Shell and Tube C - 15.53 MM Btu/hr S - 1830 sq ft M - Shell - Carbon Steel Tubes - 304 SS Des P/T - Tubes - 850 psig/300°F Shell - 150 psig/170°F
219-1612	1	Second Interstage Cooler
		T - Shell and Tube C - 15.28 MM Btu/hr S - 1780 sq ft M - Shell - Carbon Steel Tubes - 304 SS Des P/T - Tubes - 850 psig/300°F Shell - 150 psig/170°F
219-1613	1	Reformed Gas Compressor Aftercooler
		T - Shell and Tube C - 16.44 MM Btu/hr S - 1850 sq ft M - Shell - Carbon Steel Tubes - 304 SS Des P/T - 1560 psig/300°F Shell - 150 psig/170°F
219-2201	1	Steam Drum
		T - Horzontal, Cylindrical C - Normal - 236,700 lb/hr steam S - 52'6" T-T x 6' ID M - Carbon Steel Des P/T - 1720 psig/650°F

REFORMING - AREA 219

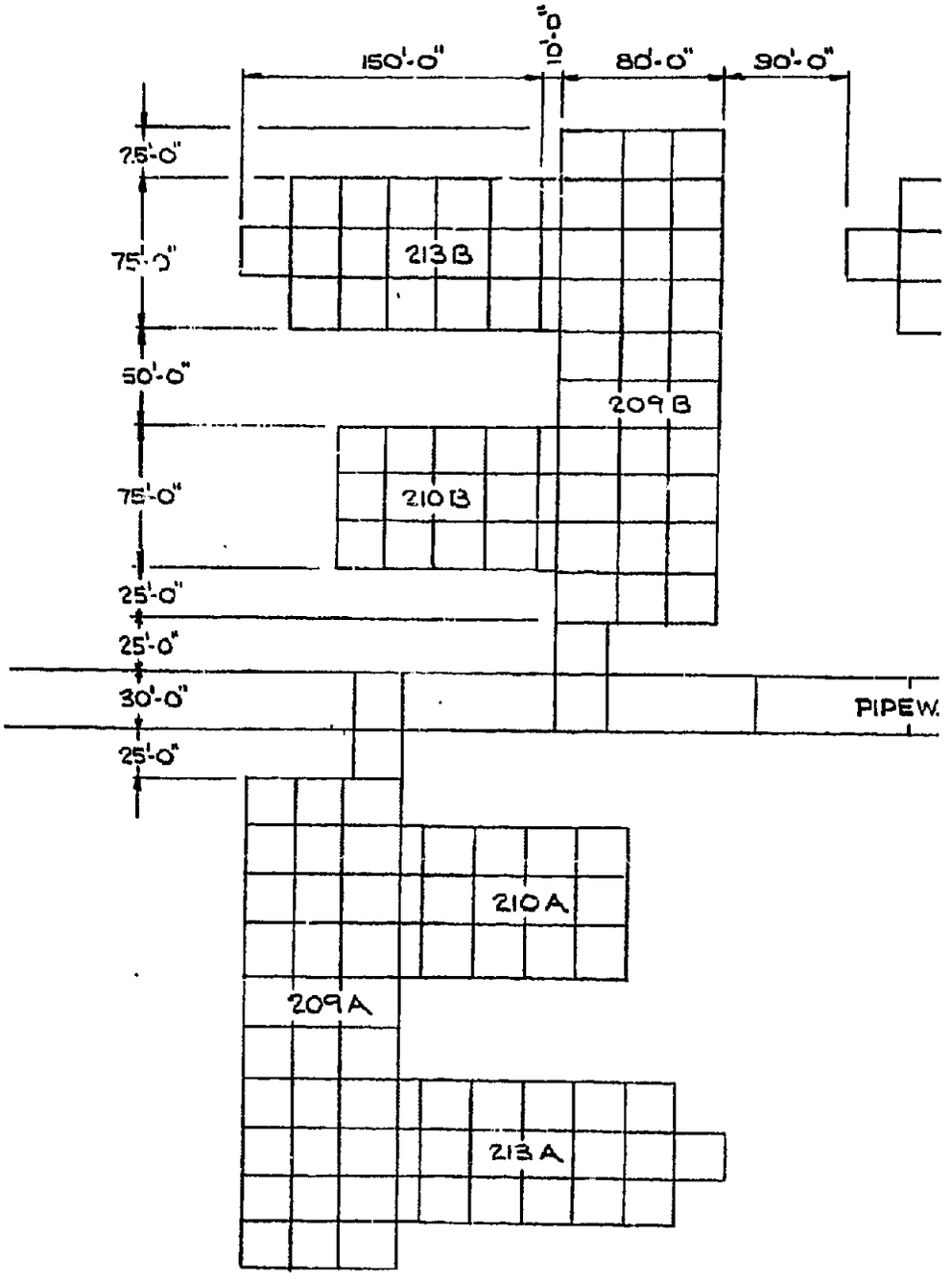
EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-2202	1	Reformed Gas Separator T - Vertical, Cylindrical w/SS demister S - 6'6" ID x 12' T-T M - Carbon Steel w/304 SS lining Des P/T - 300 psig/200°F
219-2203	1	Reformed Gas Compressor Suction Separator T - Vertical, Cylindrical w/demister S - 6'6" ID x 12' T-T M - Carbon Steel w/304 SS lining Des P/T - 300 psig/200°F
219-2204	1	First Interstage Separator T - Vertical, Cylindrical w/SS demister S - 5'6" ID x 10' T-T M - Carbon Steel w/304 SS lining Des P/T - 850 psig/300°F
219-2205	1	Second Interstage Separator T - Vertical, Cylindrical S - 5' ID x 8' T-T M - Carbon Steel w/304 SS lining Des P/T - 850 psig/300°F
219-2206	1	Reformed Gas Compressor Aftercooler Separator T - Vertical, Cylindrical w/SS demister S - 4'6" ID x 8' T-T M - Carbon Steel w/304 SS lining Des P/T - 1560 psig/300°F

REFORMING - AREA 219

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
219-2207	1	Fuel Oil Day Tank
		T - Cylindrical, Vertical
		S - 20'ID x 18' T-T
		M - Carbon Steel
		Des P/T - Atm/Amb
		Acc - Internal Heating Coil
219-2401	1	Flue Gas Stack
		T - Self-supporting, Vertical Cylindrical
		C - 11.02 MM ACFH flue gas w/mol wt = 27.37
		M - Carbon Steel, Gumite lined
		S - 80' tall x 10' ID
		Des P/T - Abmient/335°F



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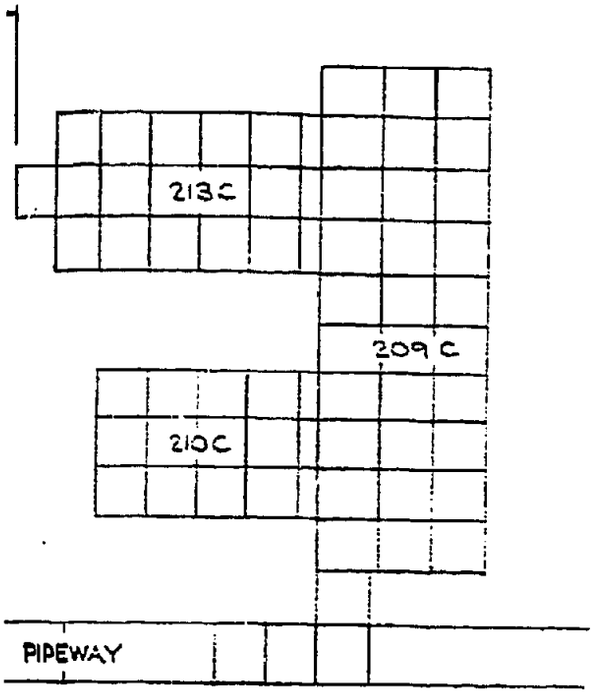
B	ADDED THEATERS	W.J.S.		2-9-81							
C	FINAL UPDATE	G.W.		6-10-81							
D	REVISED	GW		6-24-81							

DWG 1254-1 REV. 4/80



NOTE

DIMENSIONS GIVEN ARE TYPICAL FOR EACH MODULE

CLIENT

CIRI/PLACER
BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DES		
DRAWN	G. WATKINS	6/5/81
CK'D		
APP		7/2/81
APP		

TITLE

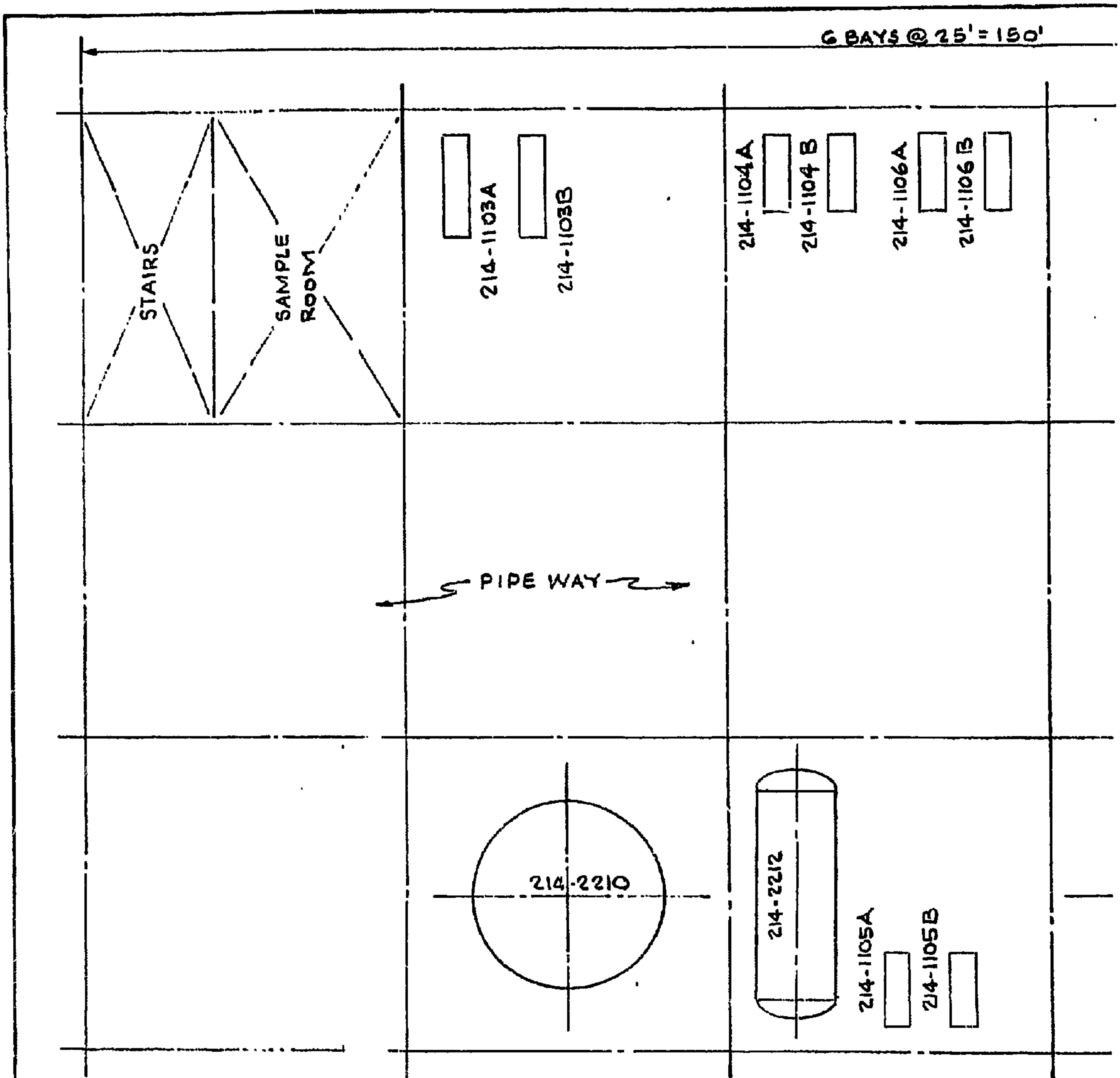
RAW GAS & METHANOL
AREAS
OVERALL ARRANGEMENT

SCALE 1"=80'

REV. 0

DRAWING NO.

5530-213-P-001



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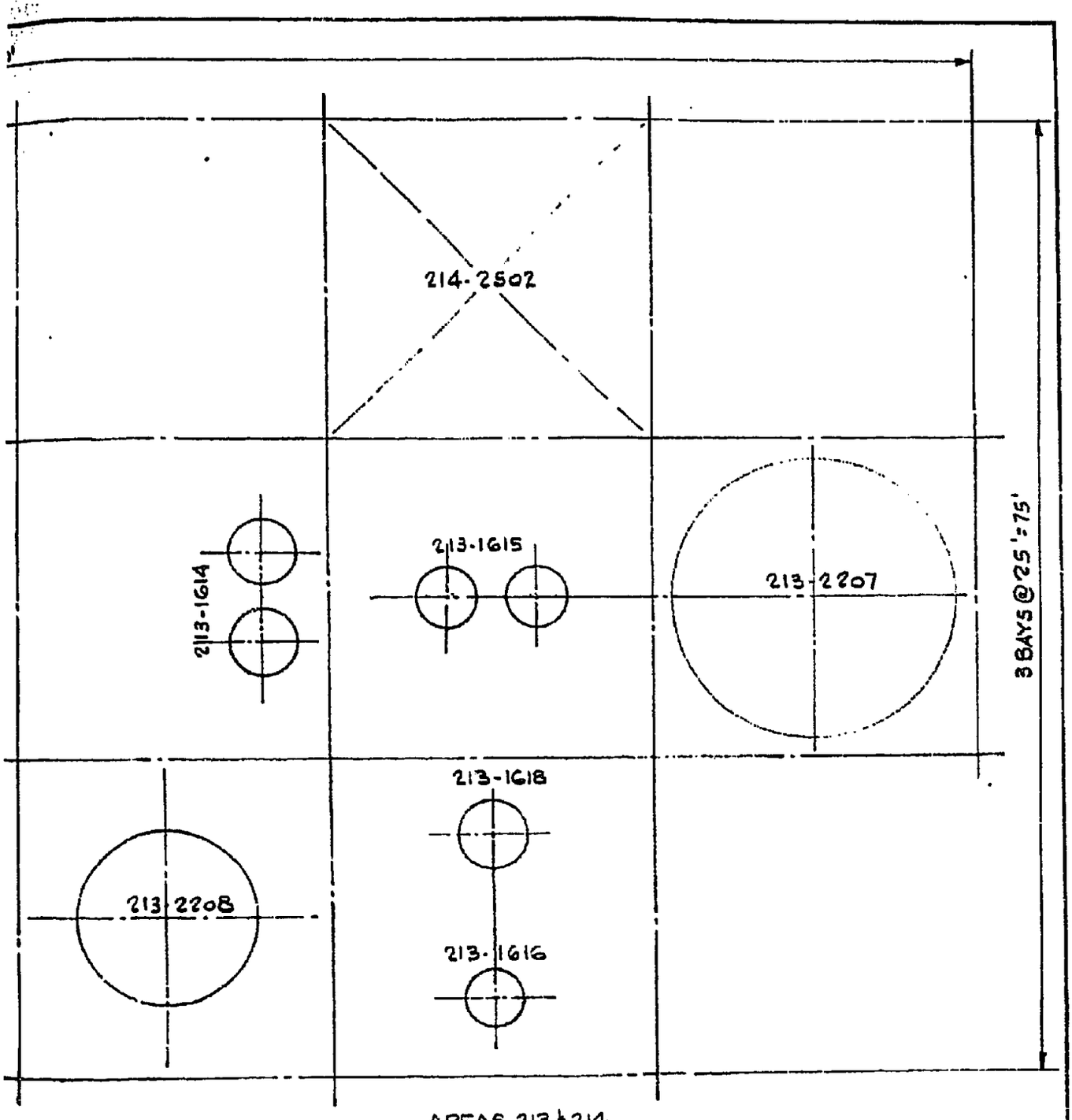
B	FINAL UPDATE	GW		6-5-81							
C	REVISED	GW		7-14-81							



AREAS 213 & 214
TYPICAL FOR MODULES 213A, B & C.

CLIENT
CIRI/PLACER

Davy McKee
ENGINEERS AND CONSTRUCTORS

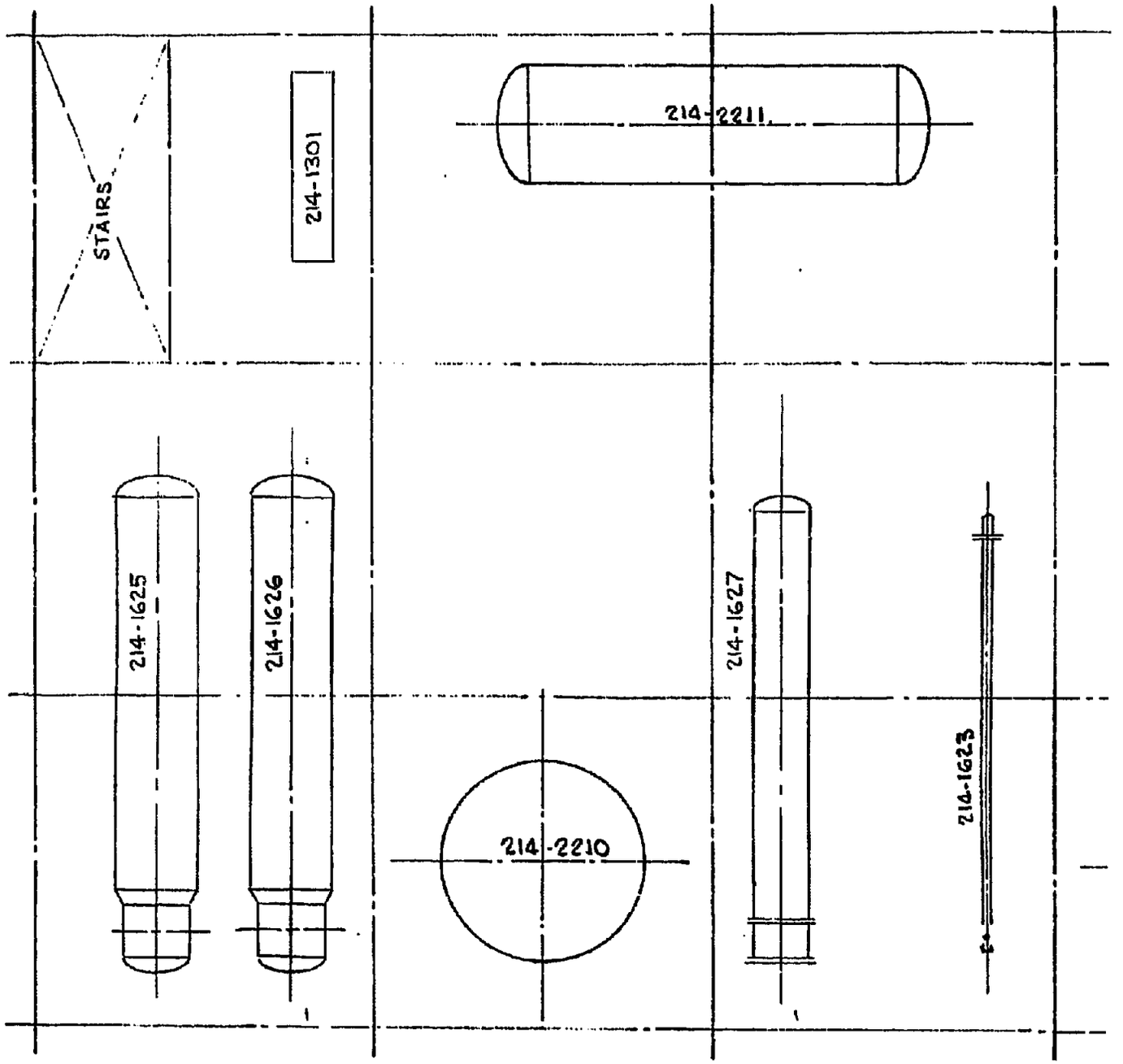
	BY	DATE
DES		
DRWN		
CK'D		
APP	[illegible]	7/20/81
APP		

TITLE
METHANOL UNIT
DISTILLATION & SYNTHESIS
PLAN @ BASE

SCALE 1"=10'

REV. A

DRAWING NO.
5530-213-P-002



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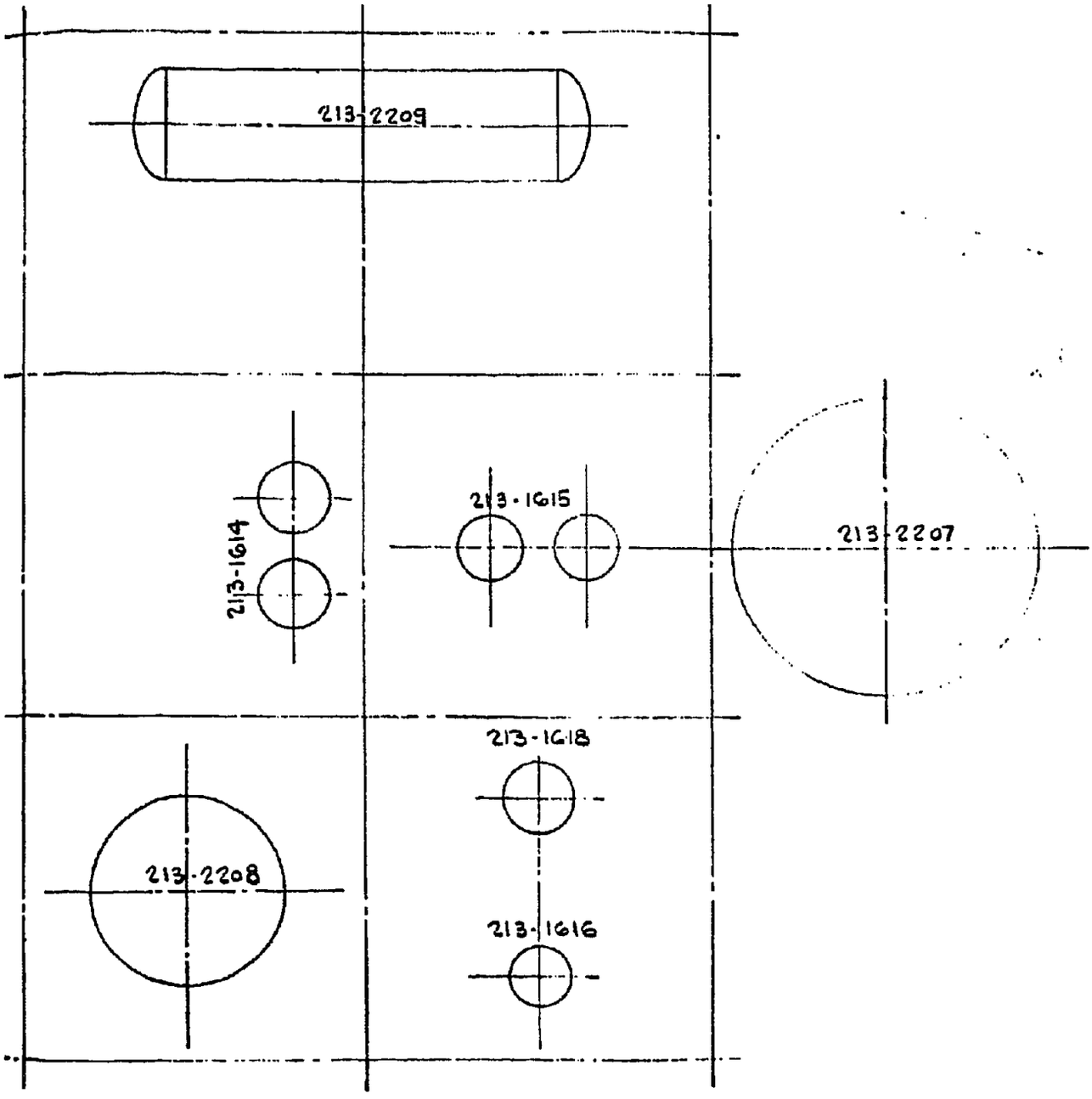
B	FINAL UPDATE	GW		4-5-81							
C	REVISED	GW		7-14-81							

DNM-1329-1 REV. 4/80



CLIENT

CIRI/PLACER

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DES		
DRWN		
CK'D		
APP	[signature]	7/20/81
APP		

TITLE

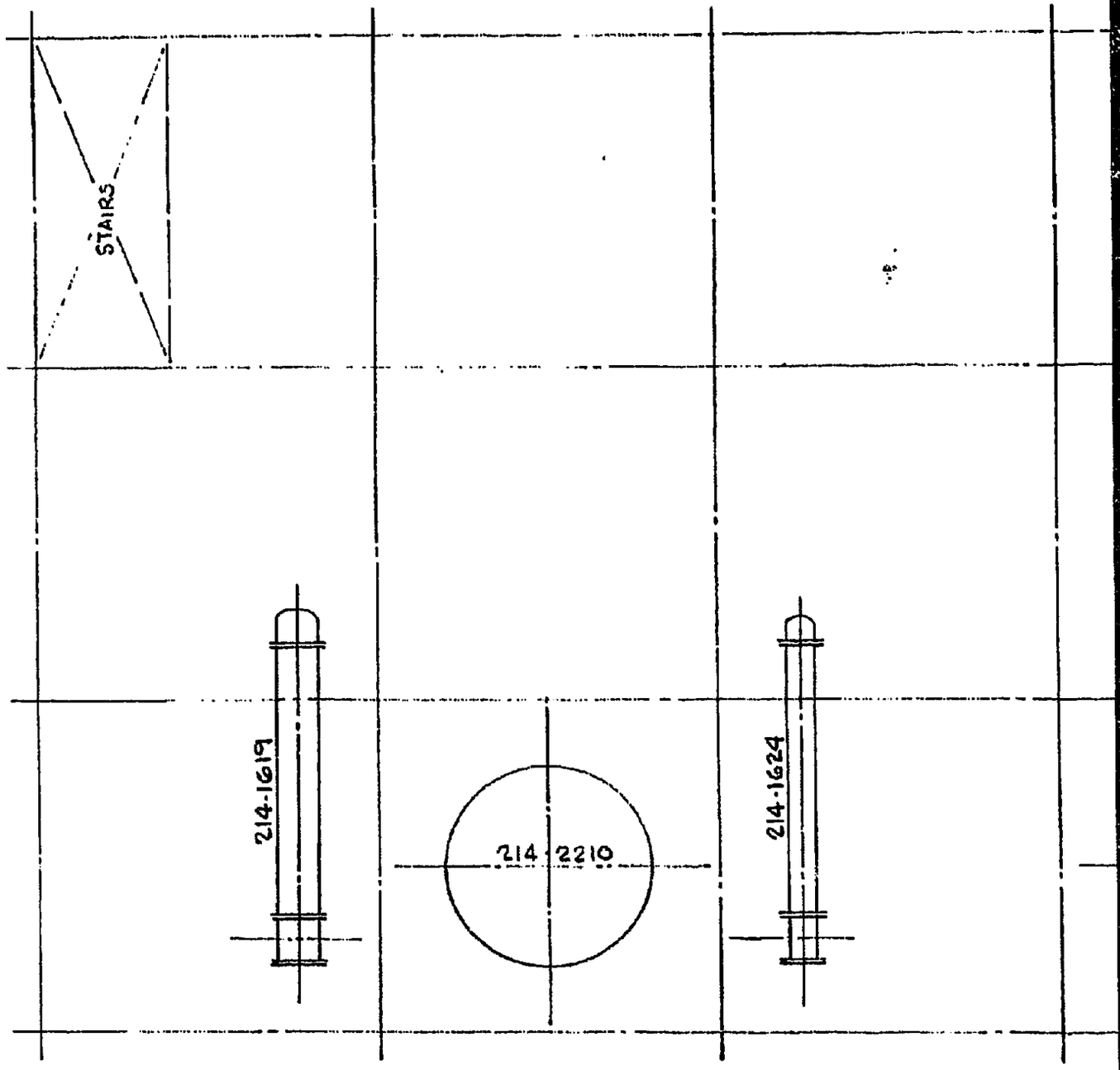
METHANOL UNIT
DISTILLATION & SYNTHESIS
PLAN ABOVE 22'-0"

SCALE 1" = 10'

DRAWING NO.

5530-213-P-003

REV. 0



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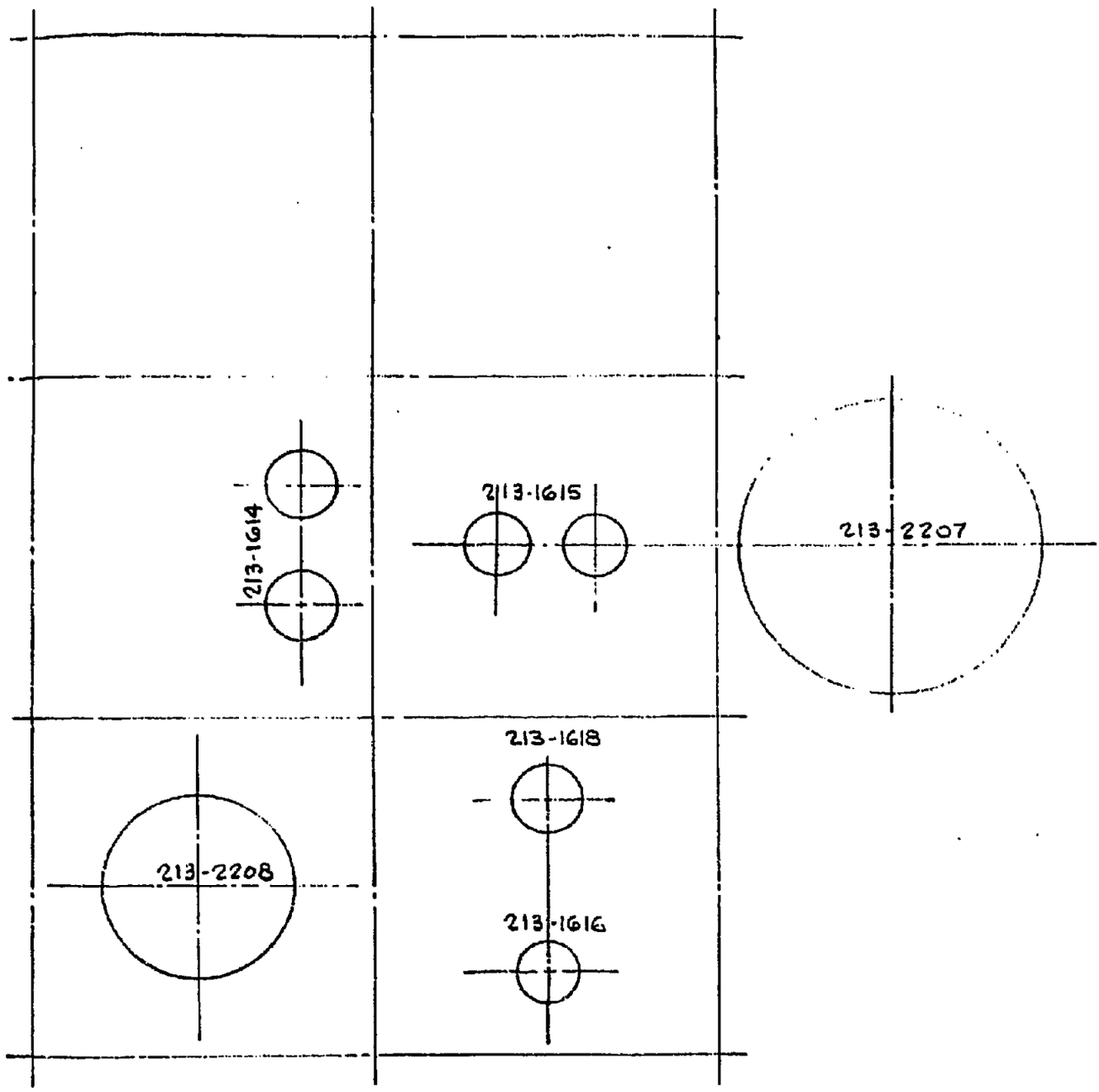
B	FINAL UPDATE	GW		6-5-81							
C	REVISED	GW		7-14-81							

EM-1320-1 REV. 4/80



CLIENT: CIRI/PLACER

Davy McKee
ENGINEERS AND CONSTRUCTORS

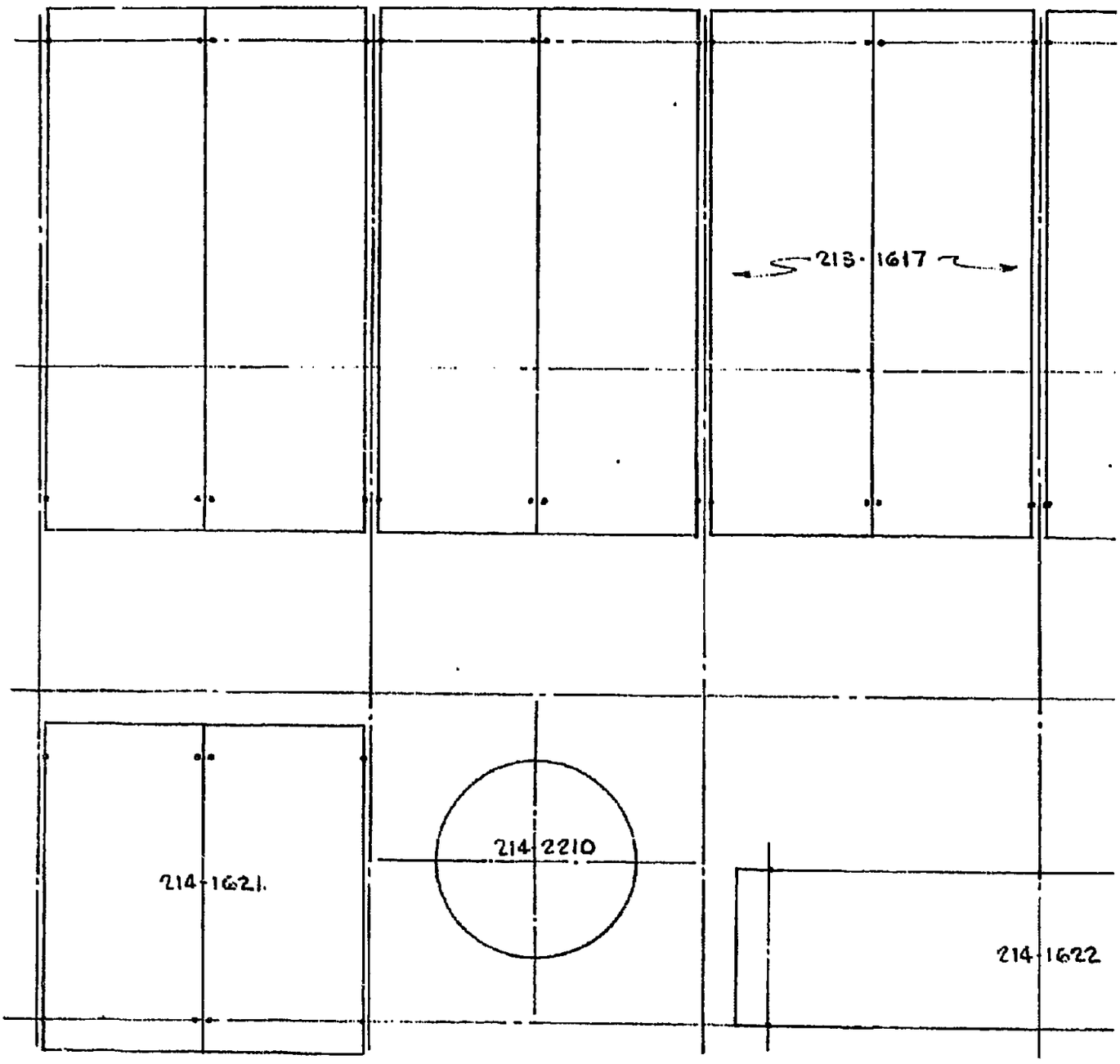
	BY	DATE
DES		
DRWN		
CK'D		
APP	JS.	7/20/81
APP		

TITLE: METHANOL UNIT
DISTILLATION & SYNTHESIS
PLAN ABOVE 38'-0"

SCALE 1" = 10'

DRAWING NO. 5530-213-P-004

REV. 0



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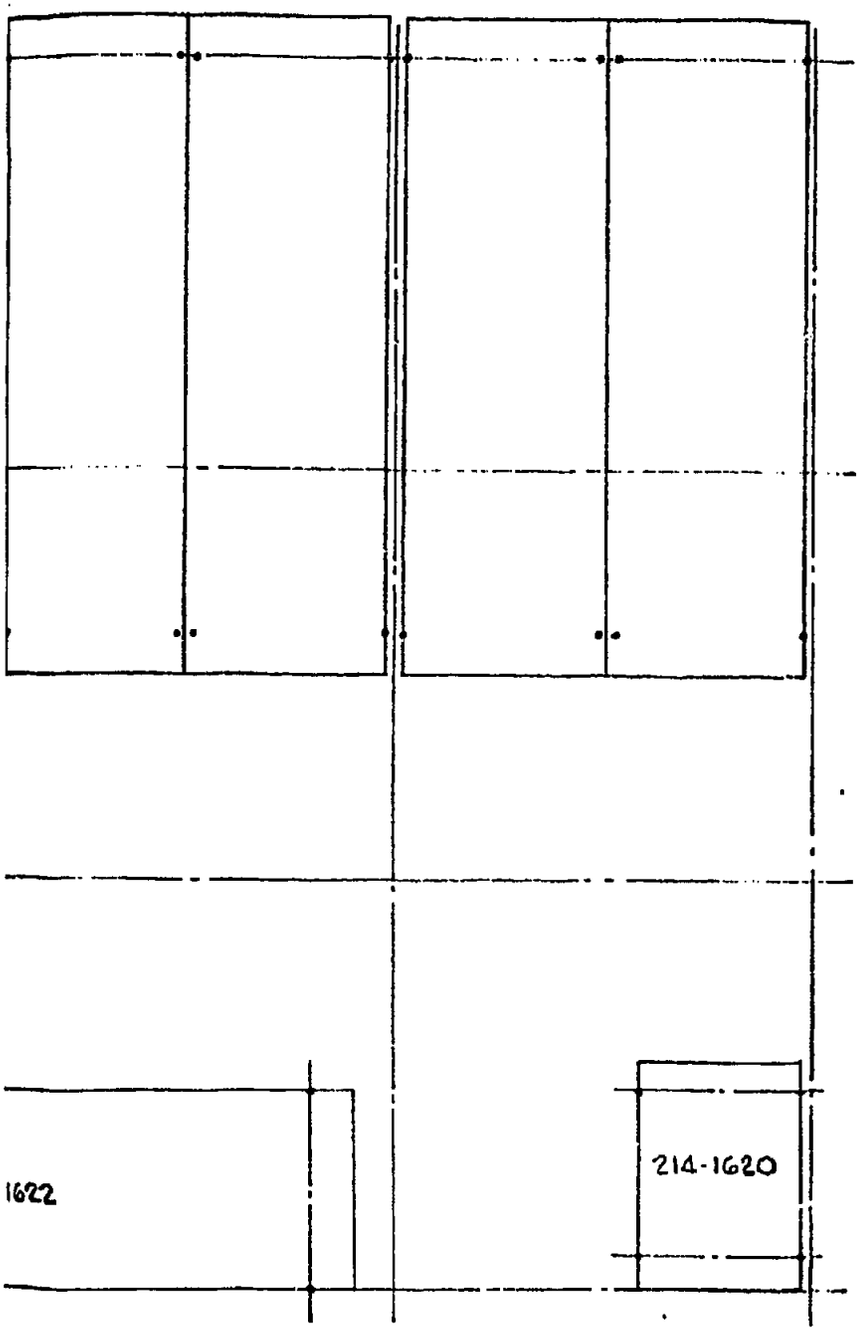
B	FINAL UPDATE	GW		6-5-81							
C	REVISED	GW		7-14-81							

DSH-1320-1 REV. 4/80



CLIENT

CIRI/PLACER

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DES		
DRWN		
CK'D		
APP	GJS.	7/20/81
APP		

TITLE

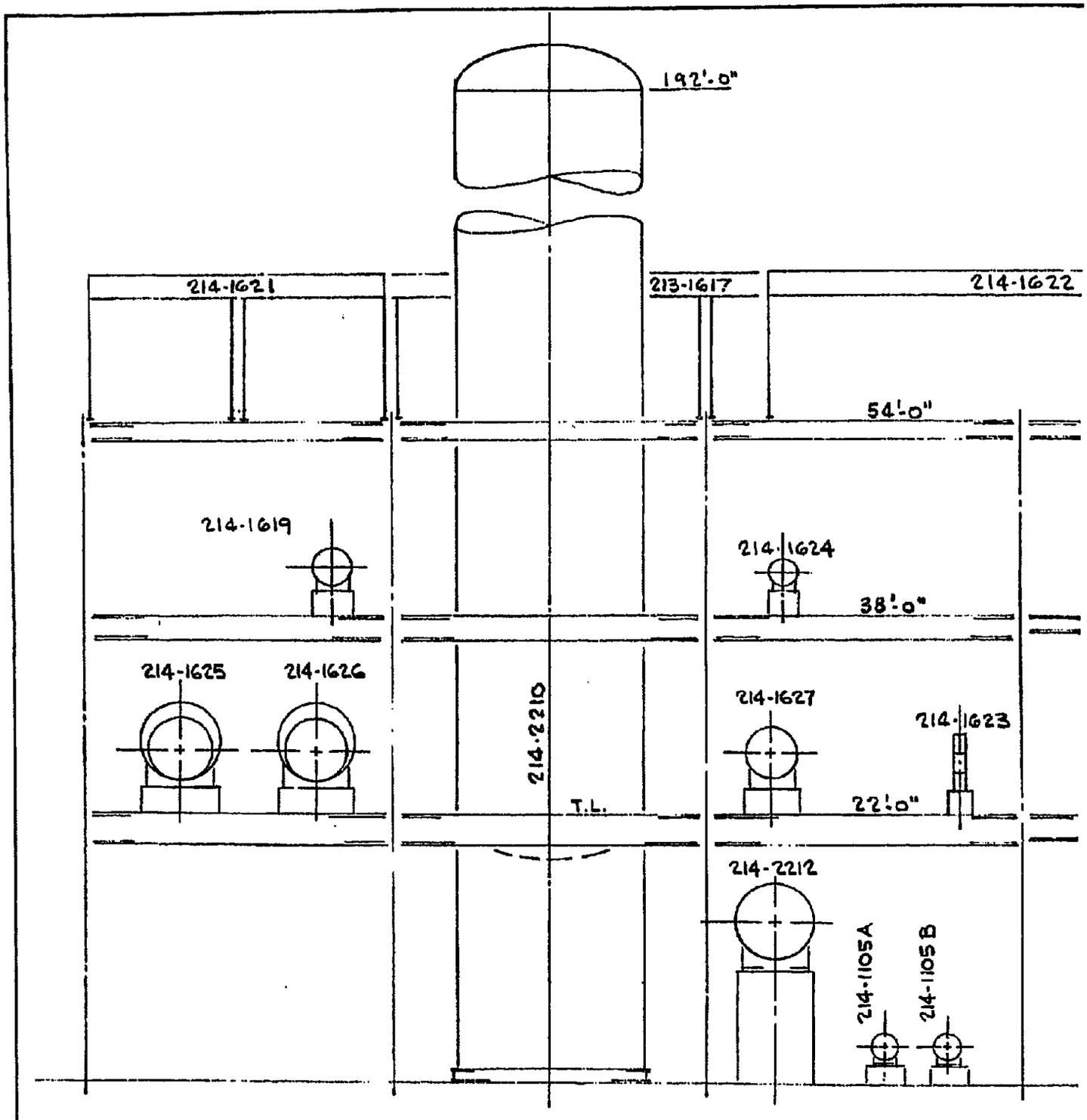
METHANOL UNIT
DISTILLATION & SYNTHESIS
PLAN ABOVE 54'0"

SCALE 1/8"=1'0"

REV. 0

DRAWING NO.

5530-213-P-005



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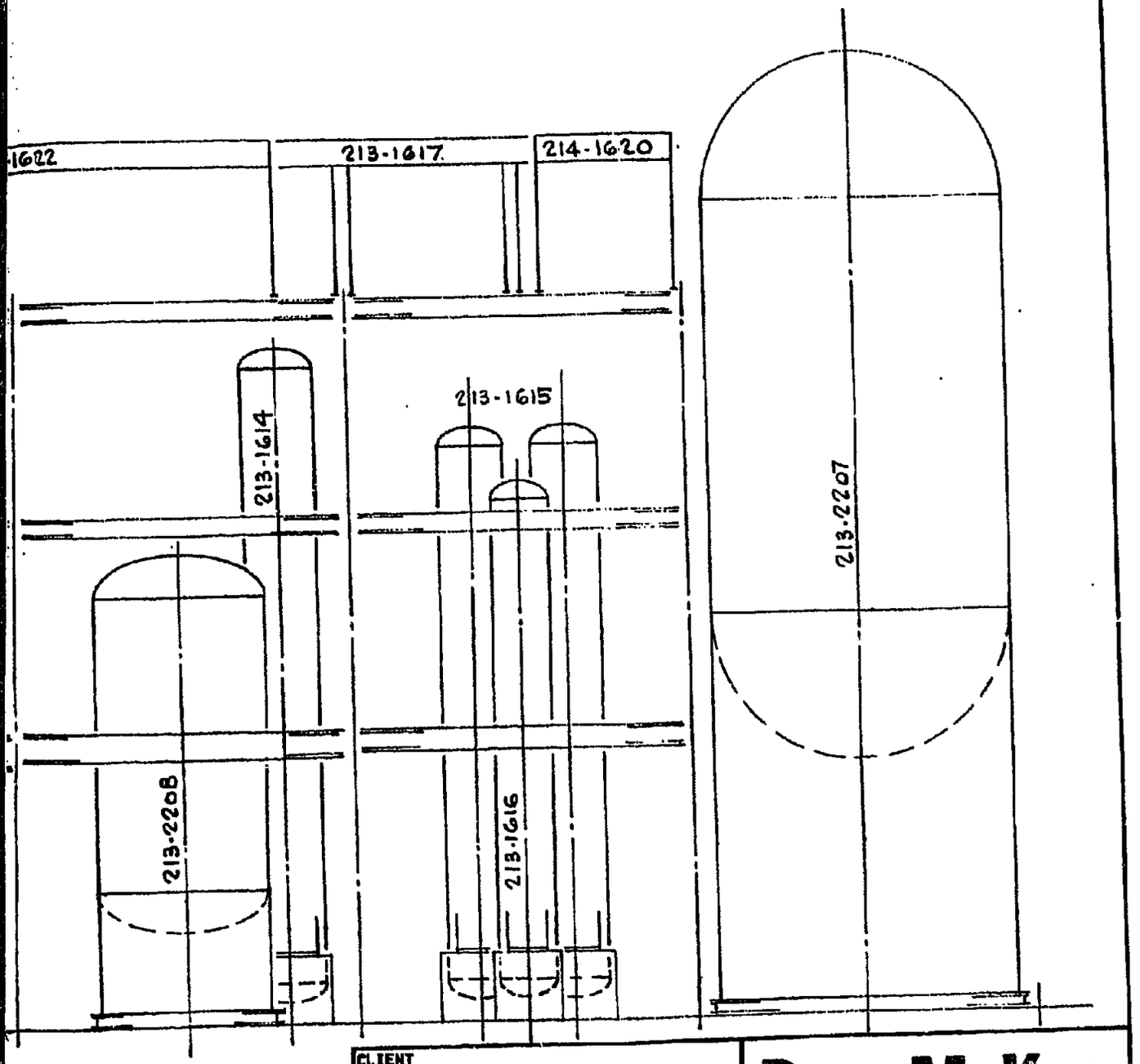
B	FINAL UPDATE	GW		6-5-81							
C	REVISED	GW		7-14-81							

DM-1123-1 REV. 4/80



CLIENT

CIRI/PLACER

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DES		
DRWN		
CK'D		
APP	gjs.	7/20/81
APP		

TITLE

METHANOL UNIT
DISTILLATION & SYNTHESIS
ELEVATION

SCALE 1"=10'

REV. 0

DRAWING NO.

5530-213-P-006

SECTION 7.0
OXYGEN, NITROGEN AND COMPRESSED AIR
(Areas 101, 102)

7.1 DESIGN BASIS

7.1.1 Three air separation plants will be provided. The capacity of each plant shall be 2500 STPD of 99.5% purity oxygen by volume.

7.1.2 Oxygen required for reaction with steam and coal will be supplied by the three air separation plants at 75 psig and 257°F.

7.2 PROCESS DESCRIPTION

7.2.1 Air Separation Plants (Area 101, Dwg. 5530-101-Y-001)

Oxygen will be supplied by three air separation plants. Nitrogen from the air separation plants will be used for blanketing, pressuring lock hoppers, pneumatic conveying and backup for instrument air.

Liquid oxygen and nitrogen storage tanks plus vaporizers are also provided in the air separation area. These are provided for emergency use during unscheduled shutdown of one or more of the three air separation plants.

7.2.2 Nitrogen and Plant Air System (Area 102, Dwg. 5530-102-Y-001)

Nitrogen from the air separation plants is compressed and cooled to 105 psia and 100°F in a two-stage compressor, and is then distributed for use in pressurizing coal feed and ash lockhoppers, conveying char and ash, and purging silos.

Instrument and utility air is supplied from a utility air package which compresses 180,000 scfh of air from atmospheric conditions to 105 psia. The compressed air is dried in a dessicant type drier to a -40°F dew point. The drier is a dual unit, one section of which can be regenerated while the other section is drying. Operation is completely automatic. A line from the compressed nitrogen system provides emergency backup for the instrument air system.

7.3 ENGINEERING DESIGN DATA

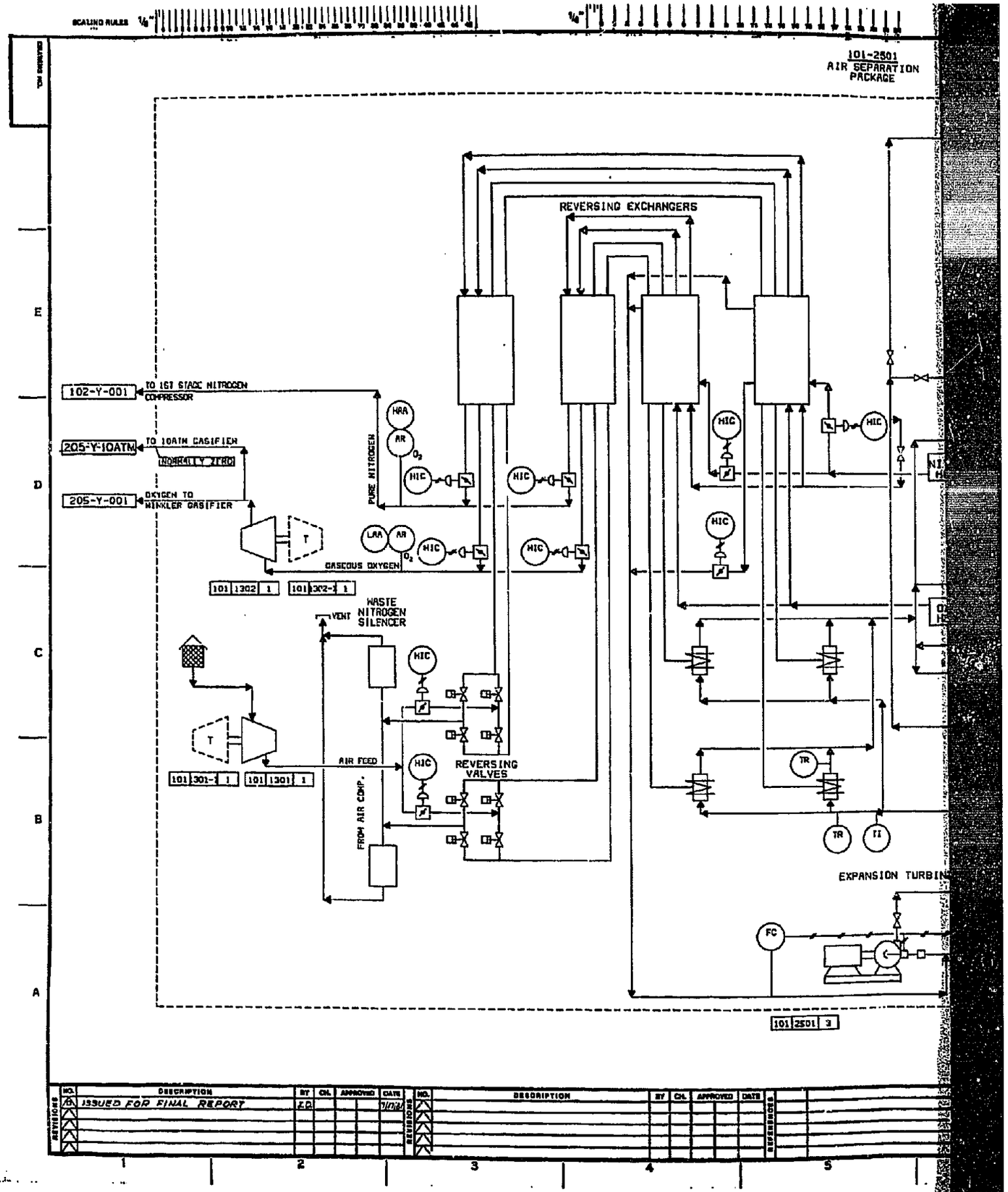
Design data pertinent to the air separation plants and nitrogen/plant air systems is detailed in the Process Flow Diagrams immediately following this page, in the Equipment List beginning on Page 7/4, and in the Drawings following Page 7/6.

DRAWINGS RELATING TO OXYGEN, NITROGEN, COMPRESSED AIR

Drawing No.	TITLE
5530-101-Y-001	Air Separation Plant
5530-102-Y-001	Nitrogen/Plant Air System

EQUIPMENT LIST

5530-102-P-001	Air Separation, Plant Air and Nitrogen Systems - General Arrangement
5530-102-P-002	Air and Separation, Plant Air and Nitrogen Systems - Plan
5530-102-P-003	Air and Separation, Plant Air and Nitrogen Systems - Plan


SCALING RULES
101-2501
AIR SEPARATION PACKAGE
REVERSING EXCHANGERS
102-Y-001
TO 1ST STAGE NITROGEN COMPRESSOR
205-Y-10ATM
TO 10ATM GASIFIER
NORMALLY ZERO
205-Y-001
OXYGEN TO WINKLER GASIFIER
PURE NITROGEN
GASEOUS OXYGEN
HIC
HAA
LAA
AR
101 1302 1
101 1302-1 1
WASTE NITROGEN SILENCER
VENT
AIR FEED
FROM AIR COMP.
REVERSING VALVES
101 1301-1 1
101 1301 1
TR
FI
FC
EXPANSION TURBIN
101 2501 3
REVISIONS
NO.
DESCRIPTION
BY
CHK.
APPROVED
DATE
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ISSUED FOR FINAL REPORT
E.D.
1/11/83
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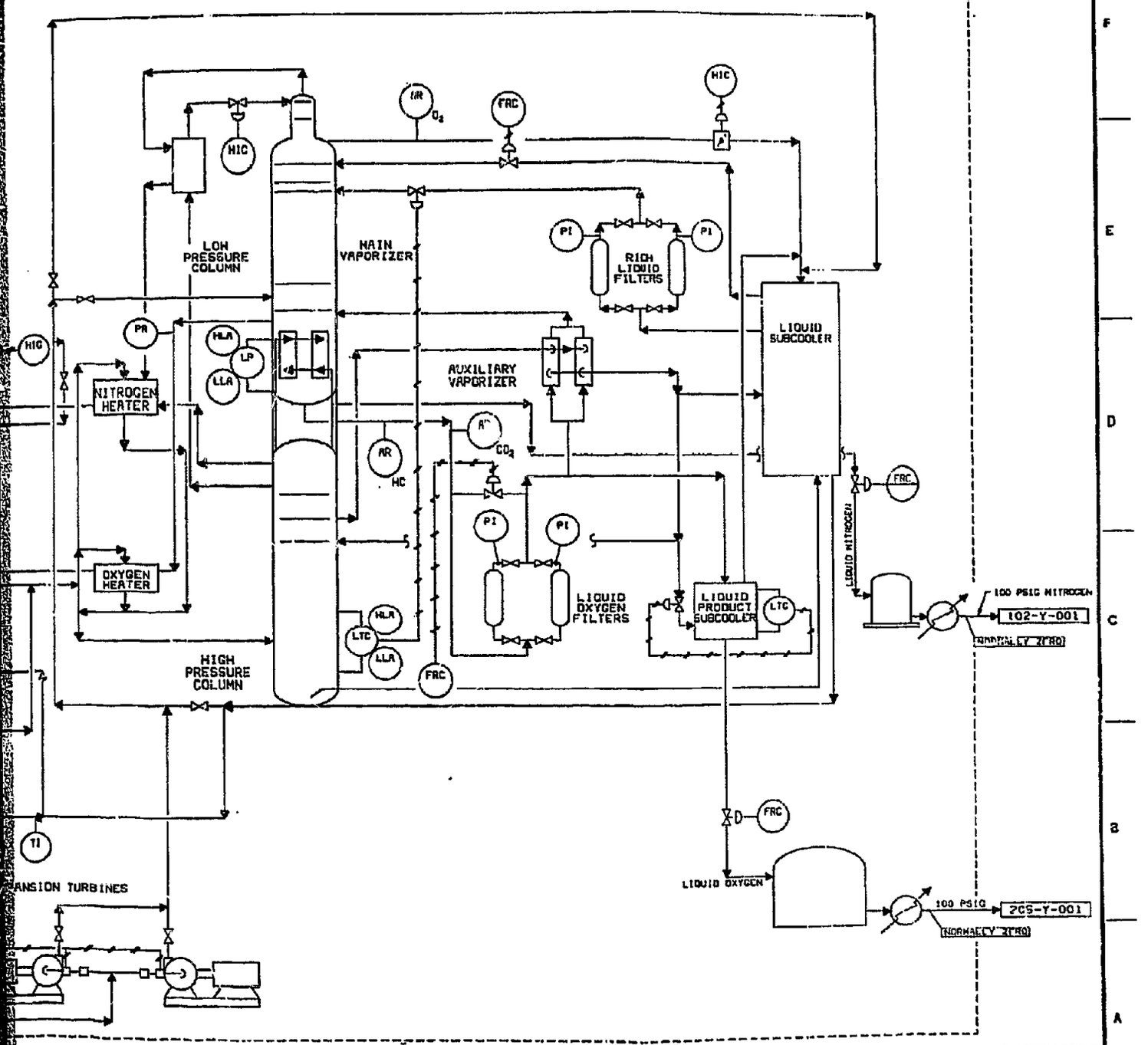
101-2501
SEPARATION
PACKAGE



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BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DESIGNED		
DRAWN	PRAS	6-88
CHECKED	GPL	7/11
APPROVED 1	TRS	7/88
APPROVED 2		
APPROVED 3		

DATE/TO: CLIENT / FIELD

TITLE: AIR SEPARATION PLANT

5530-101-Y-001

REVISION: 0

SCALE: ____ DWG NO. ____

AR1419

SCALING RULER 1/8" 1/4"

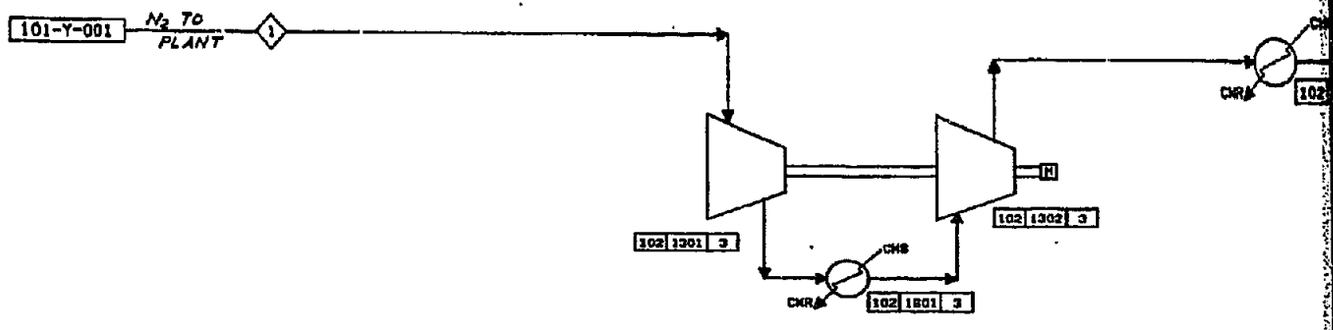
STREAM NO.		1		2		3		4		5	
STREAM DESCRIPTION		N_2 TO PLANT		N_2 TO COAL FEED LOCKHOPPER		N_2 TO CONVEYING		N_2 TO COAL DRYER		PLANT AIR	
PHASE		G		G		G		G		G	
COMPONENT	MOL. WT.	MOL %	LB MOL/HR	MOL %	LB MOL/HR	MOL %	LB MOL/HR	MOL %	LB MOL/HR	MOL %	LB MOL/HR
CARBON	12.011										
HYDROGEN	2.016										
NITROGEN	28.014	100.00	2330.56	100.00	1120.30	100.00	2079.11	100.00	91.15	78.00	574.71
SULFUR	32.080										
OXYGEN	32.000									21.00	98.61
CHLORINE	35.453										
ASH	-										
WATER	18.016										
CARBON MONOXIDE	28.011										
CARBON DIOXIDE	44.011										
METHANE	16.043										
HYDROGEN SULFIDE	34.076										
CARBONYL SULFIDE	60.071										
SULFUR DIOXIDE	64.066										
METHANOL	32.043										
DIMETHYL ETHER	46.068										
HIGHER ALCOHOL	74.120										
(SOLIDS CARRYOVER)	GR/SCF DRY										
(SOLIDS CARRYOVER)	LB/HR										
TOTAL (WET)		100.00	2330.56	100.00	1120.30	100.00	2079.11	100.00	91.15	100.00	674.32
FLOW (DRY)	SCFH	1,243,913		447,910		789,000		27,000		190,000	
TOTAL FLOW	LB/HR	93,302		23,065		58244		1943		13,685	
PRESSURE	PSIA	15		105		105		105		105	
TEMPERATURE	°F	60		100		100		100		100	
HHV	BTU/LB										
HHV (DRY)	BTU/SCF										

102-1301 1ST STAGE NITROGEN COMPRESSOR

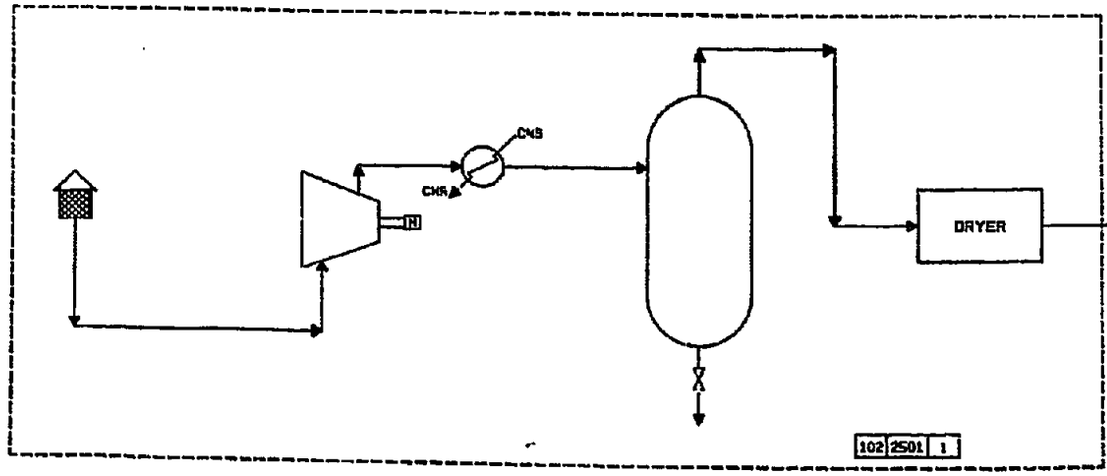
102-1601 1ST STAGE INTERCOOLER

102-1302 2ND STAGE NITROGEN COMPRESSOR

102-1602 2ND STAGE AFTERCOOLER



101-Y-001 VAPORIZED NITROGEN

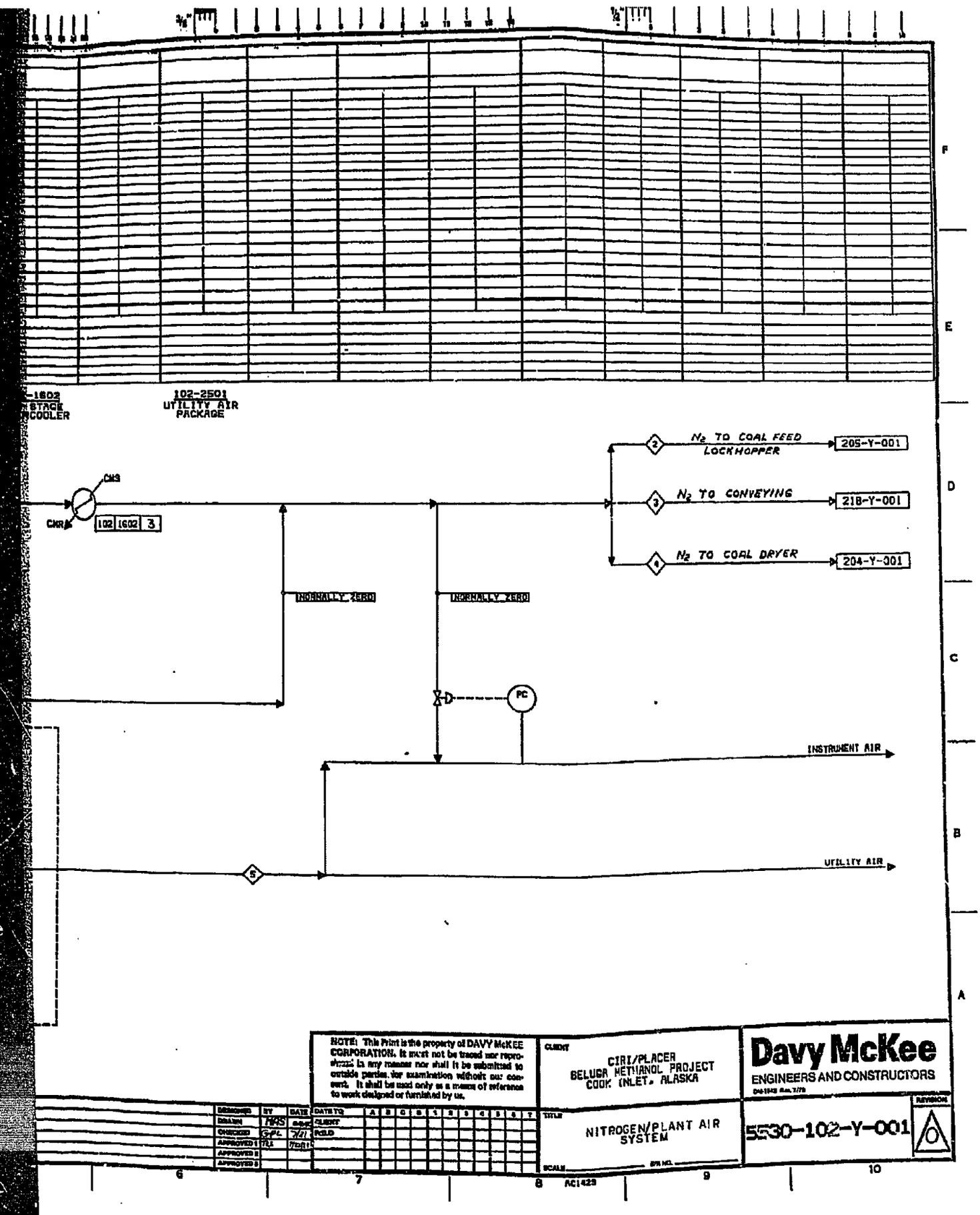


REVISIONS NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE
A	ISSUED FOR FINAL REPORT	T.D			1/1/78

REVISIONS NO.	DESCRIPTION	BY	CHK.	APPROVED	DATE

REFERENCES

1 2 3 4 5



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BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DESIGNED		
DRAWN	MRS	
CHECKED	GPL	
APPROVED 1	TRJ	
APPROVED 2		
APPROVED 3		

DATE TO: CLIENT / FIELD

TITLE: NITROGEN/PLANT AIR SYSTEM

SCALE: NONE

5530-102-Y-001

REVISION: 0

6 7 8 AC1429 9 10

NOMENCLATURE:
T - TYPE
C - CAPACITY
S - SIZE
P/T - OPERATING PRESSURE/TEMPERATURE
M - MATERIAL
CS - CARBON STEEL
SS - STAINLESS STEEL
CI - CAST IRON
D - DRIVE
W - WEIGHT
ACC - ACCESSORIES

AIR SEPARATION PLANT - AREA 101

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
101-2501	3	Air Separation and Oxygen Compression Package This system is to produce 2500 STPD of oxygen with a purity of 99.5% by volume. The oxygen is to be delivered at 75 psig.

NOMENCLATURE:
T - TYPE
C - CAPACITY
S - SIZE
P/T - OPERATING PRESSURE/TEMPERATURE
M - MATERIAL
CS - CARBON STEEL
SS - STAINLESS STEEL
CI - CAST IRON
D - DRIVE
W - WEIGHT
ACC - ACCESSORIES

NITROGEN/PLANT AIR SYSTEM - AREA 102

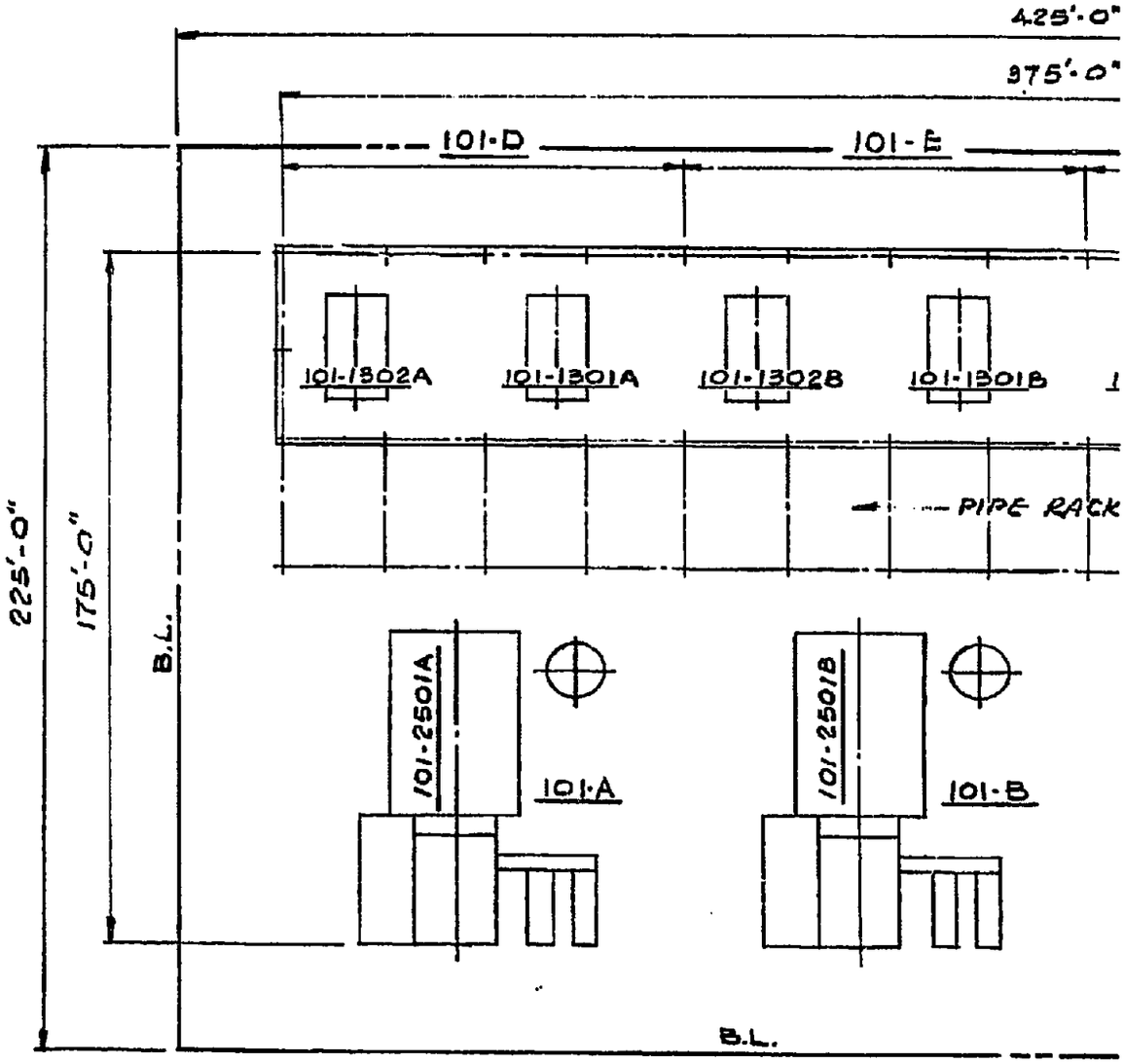
EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
102-1301	3	**First-Stage Nitrogen Compressor** T - Centrifugal S - 1025 hp C - 8,820 ICFM Pi/Ti - 0.5 psig/60°F Po/To - 30 psig/315°F D - Electric
102-1302	3	**Second-Stage Nitrogen Compressor** T - Centrifugal S - 1030 hp C - 3,560 ICFM Pi/Ti - 25 psig/100°F Po/To - 90 psig/355°F D - Electric
102-1601	3	**First-Stage Intercooler** T - Shell and Tube C - 6.52 MM Btu/hr S - 2,800 sq ft M - Shell - Carbon Steel Tubes - Carbon Steel Des P/T - Shell - 50 psig/350°F Tubes - 75 psig/150°F
102-1602	3	**Second-Stage Aftercooler** T - Shell and Tube C - 7.60 MM Btu/hr S - 3,000 sq. ft. M - Shell - Carbon Steel Tubes - Carbon Steel Des P/T - Shell - 75 psig/150°F Tubes - 200 psig/300°F

NITROGEN/PLANT AIR SYSTEM - AREA 102

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
102-2501	1	Utility Air Package This system is to produce 180,000 SCFH of dry air (-40°F dew pt.) at 90 psig.



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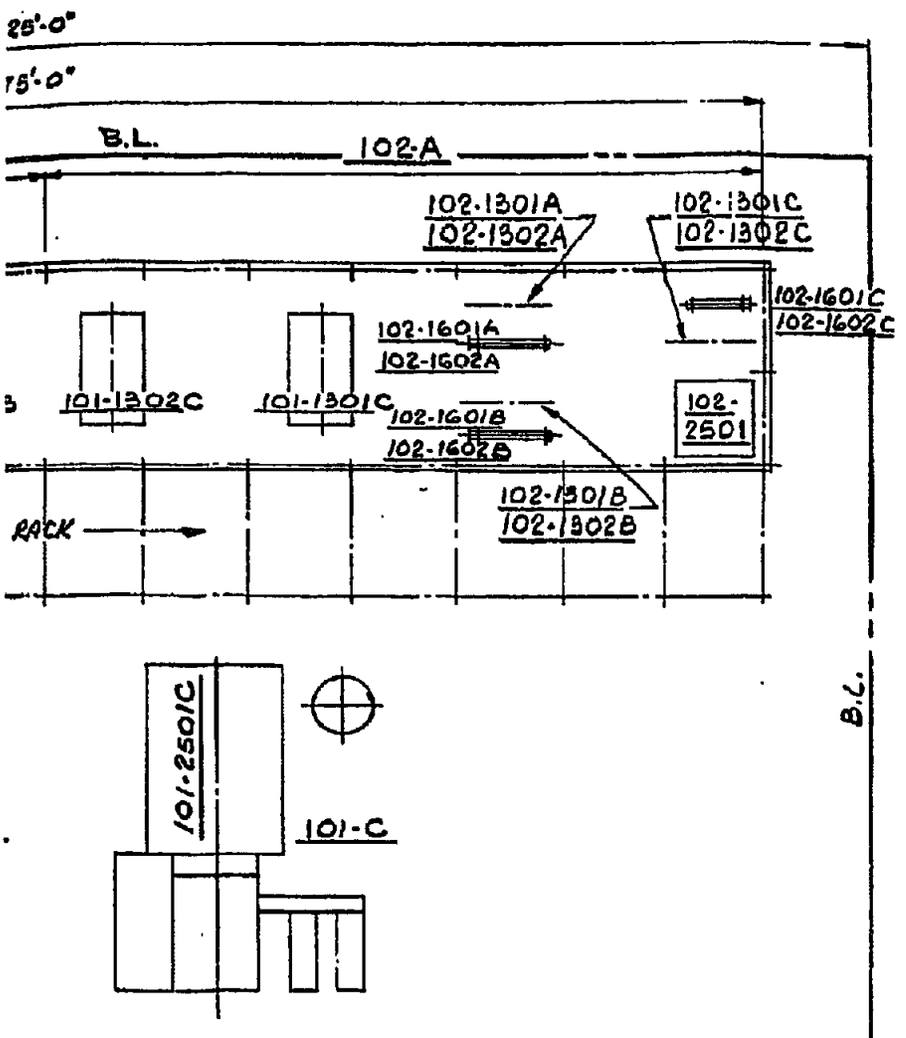
NO.	DESCRIPTION	BY	CHK.	DATE	NO.	DESCRIPTION	BY	CHK.	DATE	DWG. NO.	TITLE
A	PRELIM. REVIEW	ED. K		4/24/81	0	ISSUED FOR FINAL REPORT	GJ		7-20-81		



MODULES 101A, B, C, D, E & 102A (AREAS 101 & 102)

	BY	DATE
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APP	[illegible]	7/20/81
APP		

CLIENT
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BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
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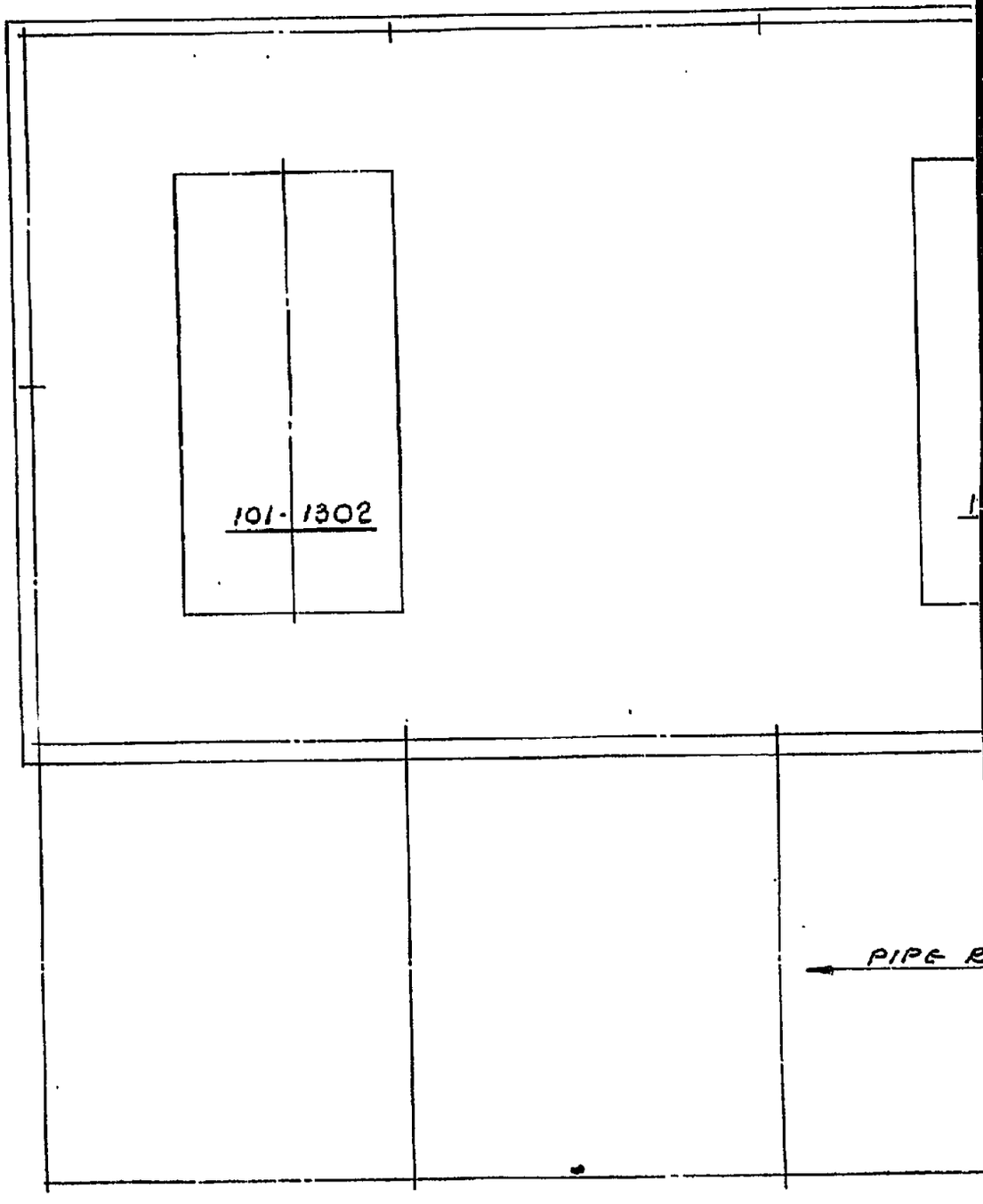
TITLE
AIR SEPARATION, PLANT AIR AND NITROGEN SYSTEMS GENERAL ARRANGEMENT

SCALE 1"=40'-0"

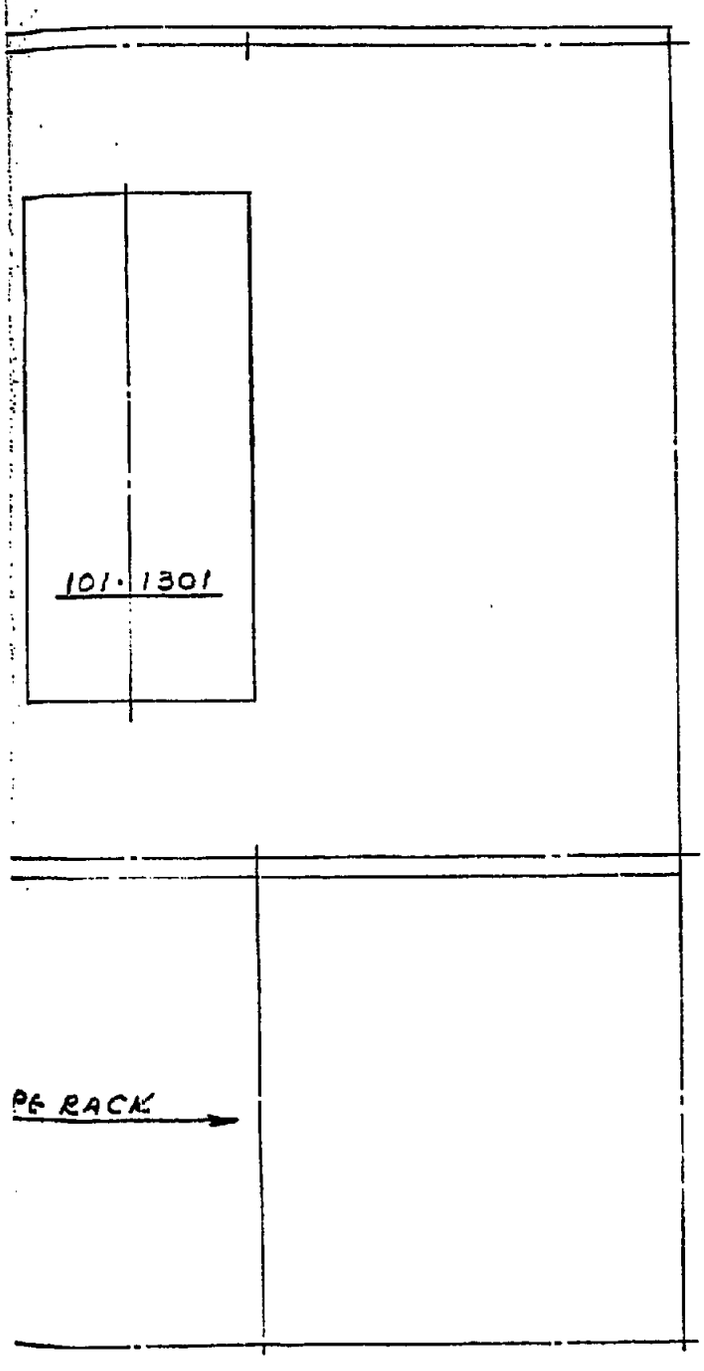
DRAWING NO.
5530-102-P-001

REV. 0



REVISIONS					REVISIONS					REFERENCES	
NO.	DESCRIPTION	BY	CHK.	DATE	NO.	DESCRIPTION	BY	CHK.	DATE	DWG. NO.	TITLE
A	PRELIM. REVIEW	Ed.K		6/24/81	0	ISSUED FOR FINAL REPORT	GLW		7-20-81		

CH-1320-4 REV. 4/80



TYPICAL - MODULES 101 D & E

CLIENT
CIRI / PLACER
BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
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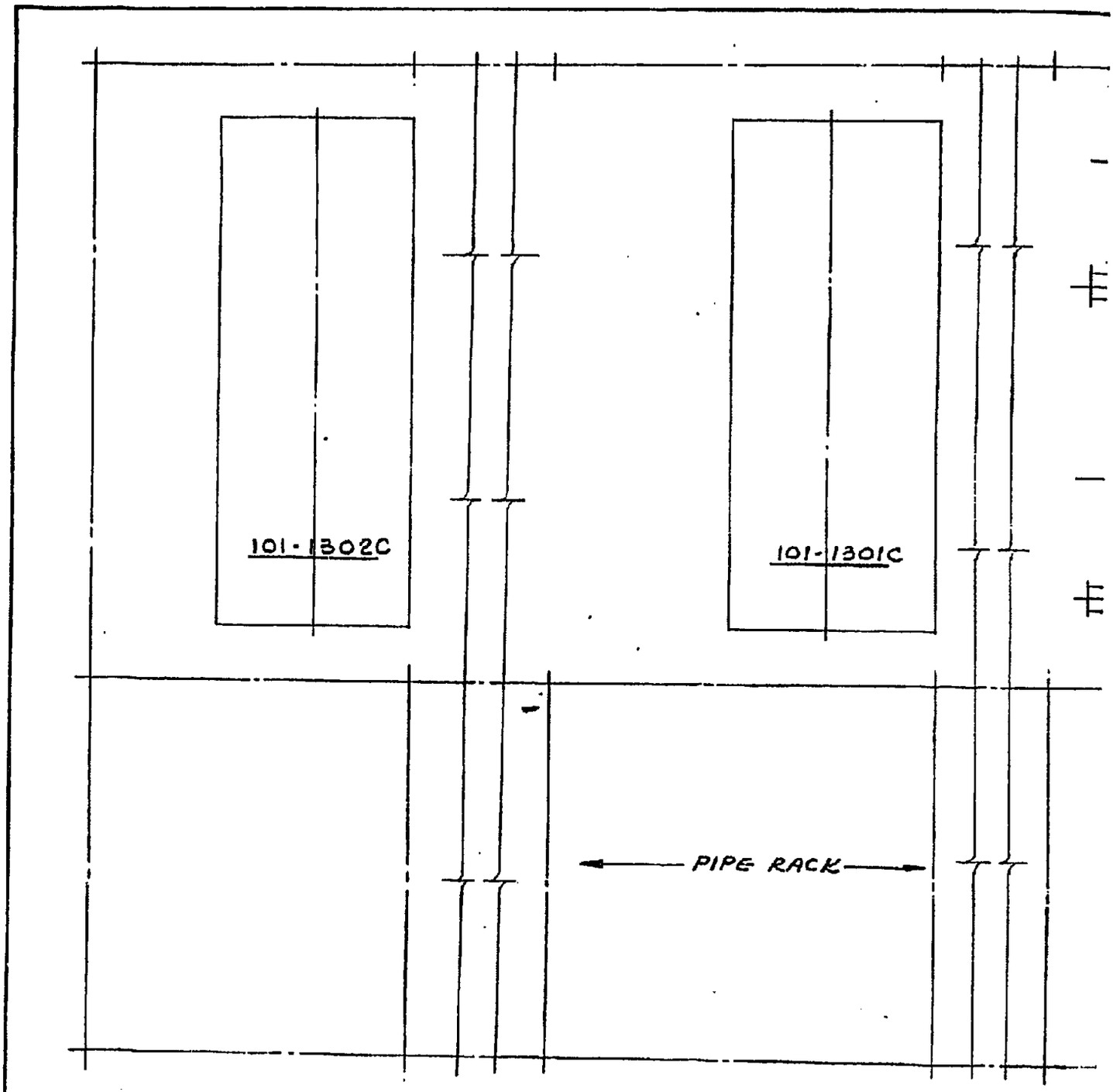
	BY	DATE
DES		
DRWN		
CK'D		
APP	mjh	7/20/81
APP		

TITLE: AIR SEPARATION, PLANT AIR AND NITROGEN SYSTEMS PLAN

SCALE 1"=10'-0"

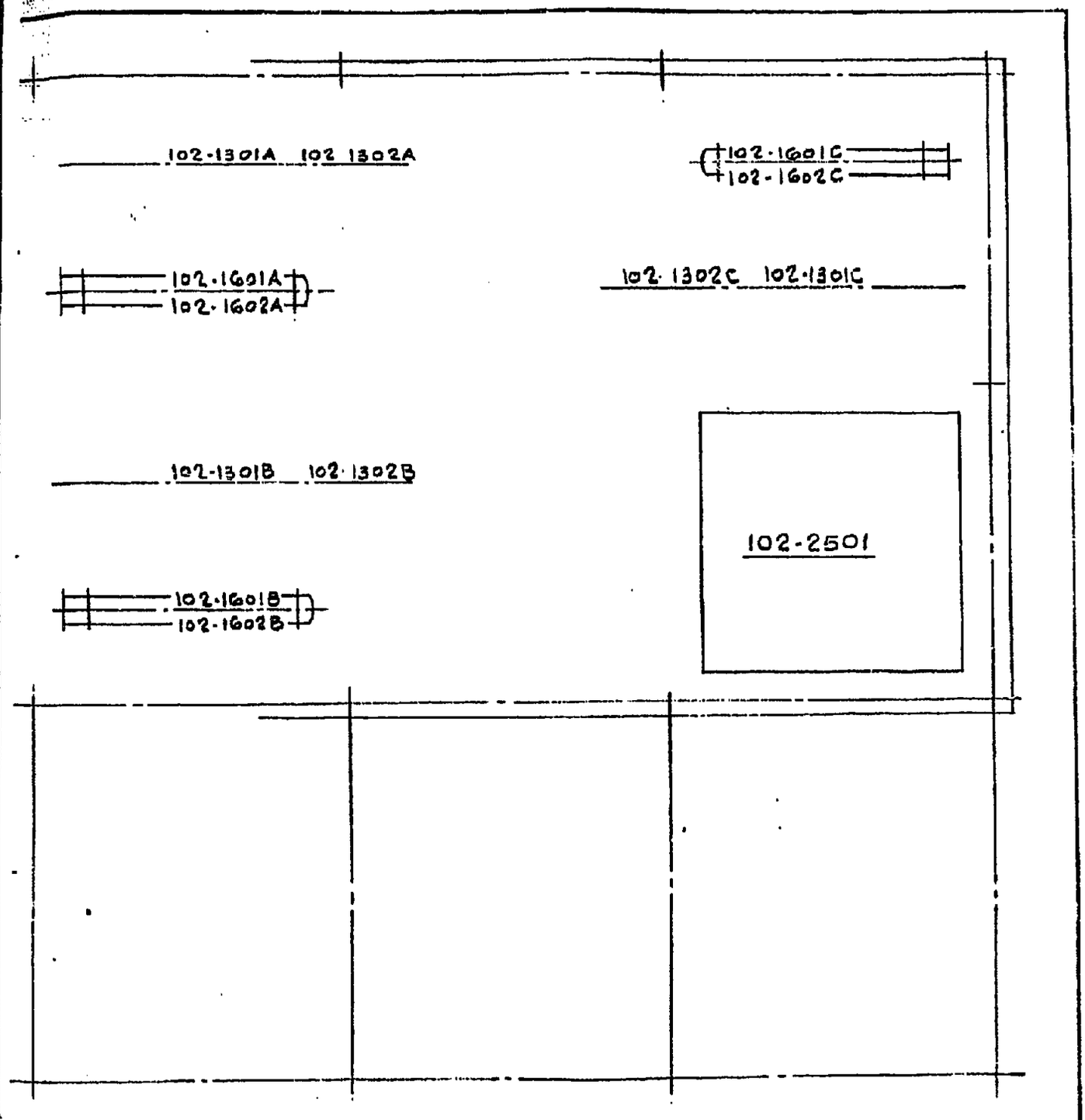
DRAWING NO. 5530-102-P-002

REV. 0



REVISIONS					REVISIONS					REFERENCES	
NO.	DESCRIPTION	BY	CHK.	DATE	NO.	DESCRIPTION	BY	CHK.	DATE	DWG. NO.	TITLE
A	PRELIM. REVIEW	E.D.K.		6/24/81	0	ISSUED FOR FINAL REPORT	GW		7-20-81		

DM-1224-1 REV. 4/80



CLIENT

CIRI / PLACER
BELUGA METHANOL PROJECT
COOK INLET, ALASKA

Davy McKee
ENGINEERS AND CONSTRUCTORS

	BY	DATE
DES		
DRWN		
CK'D		
APP	[signature]	7/20/81
APP		

TITLE: AIR SEPARATION, PLANT AIR AND NITROGEN SYSTEMS PLAN

SCALE 1" = 10'

DRAWING NO. 5530-102-P-003

REV. A

SECTION 8.0
UTILITIES
(Areas 103, 300, 301, 302, 305, 309)

8.1 PLANT STEAM SYSTEM (Dwg 5530-305-Y-001)

Steam for the entire plant is supplied from three different plant areas, and at several different pressure levels, as described below.

8.1.1 Power Plant (Area 300, Dwg 5530-300-Y-001)

- Design Basis:

  The primary power production facility for the process plant will be a conventional pulverized coal fired and steam turbine generator system with three boilers and three steam turbine generators. Its maximum design capacity will be 2,700,000 pounds per hour of high pressure steam at 1255 psig and 165 Mw of electrical power.

- Process Description - Steam Generation:

  A fuel supply consisting of a mixture of coal and char is received from the process plant, and is transferred by conveyor belt to the coal bunker. The coal bunker, is a silo type storage device which supplies fuel to the pulverizer for reduction of the particle size of the fuel mix to a fine powder. The powder is mixed with preheated combustion air and injected into the boiler where it is ignited. Boiler exhaust gases are circulated through heat recovery devices which preheat air for combustion and preheat boiler feedwater.

Part of the steam produced by the boilers is utilized by the steam turbines for production of electric power, and the remainder is sent to the process plant as high pressure steam.

The steam turbines selected for this operation are extraction type units which allow removal of part of the steam from the turbine after some energy has been utilized. The extraction steam is sent to the process plant as low pressure steam.

Ash from the combustion process is removed from the bottoms of the boilers, and from the baghouse exhaust gas cleaning unit, then pneumatically conveyed to a rail car loading station.

8.1.2 Reforming (Area 219)

- Design Basis:

The reformer is designed to recover heat from reformed gas to produce 236,700 pounds per hour of high pressure steam at 1500 psig and 900°F. In addition to the process requirements of the reforming reactor this steam is used for turbine drives in the methanol synthesis area. A common steam drum is utilized for the steam generation boiler and superheaters using natural boiler feedwater circulation.

- Process Description:

Steam is generated by recovering heat from the reformer flue gas using a radiant shield boiler. This unit forms a vertical waterwall screen across the entrance to the

main convection duct, and performs an important function in protecting the steam superheater from the cavity radiation of the reforming furnace rear wall. The radiant shield boiler comprises a vertical natural circulation system connected to lower and upper horizontal water headers. The steam generated in the boiler is then superheated in two sections, a high temperature section and a low temperature section. The superheater tube bundles are arranged horizontally to permit drainage of the coils.

Most of the exit steam at 1500 psig and 900°F goes to the steam turbine driver on the reformed gas compressor. A smaller portion is exported for other plant uses. Some steam is extracted from the compressor turbine at 350 psig for use on other drives in the methanol synthesis area and the remainder is condensed.

8.1.3 Gasifier Waste Heat Boilers (Area 206)

- Design Basis:

  Each gasification train includes a waste heat recovery section capable of producing 152,814 pounds per hour of high pressure steam at 855 psig and 840°F for use in steam turbines. Steam drum internals are designed to minimize entrainment losses. The output from each waste heat recovery unit is manifolded into a common steam header with suitable valves and controls.

- Process Description:

  Steam is generated by recovering heat from gasifier raw gas. The raw gas leaves the gasifier and enters the

waste heat recovery unit. This unit contains additional steam boiler tubes, high and low superheater sections, and a boiler feed water heater section.

The waste heat recovery unit on each gasifier acts as an individual steam generator, and is tied into a common 855 psig header. The steam is used for the steam turbine drivers on the process gas compressors.

8.1.4 Condensate

All condensate is returned for reuse.

Three deaerating/heaters are provided for the process area steam generators, and three are provided with the off-site boilers.

Demineralized water makeup is supplied from the raw water treatment area as shown on Drawing No. 5530-301-Y-002.

8.2 ELECTRICAL POWER SYSTEM (Area 309)

8.2.1 Design Basis

Electrical power for the plant and associated facilities is supplied by an in-plant generation station consisting of three equally rated steam turbine generators. The generator outputs are transformed from 13.8 KV to 69 KV. A single circuit, 161 KV, transmission line to the Beluga Power Company is provided for startup and standby purposes. The generators and utility power are paralleled in an outdoor 69 KV switchyard.

Power for the mines is transformed to 161 KV and transmitted on a single circuit overhead transmission line. One single tap type substation is supplied at each mine. The generation station load is normally fed from auxiliary transformers connected to the generators. Power for the remaining plant loads is distributed at 13.8 KV from double-winding secondary transformers.

The total power requirement for the proposed facility is estimated to be 165 megawatts, detailed as follows:

1.	Coal Area	16 MW
2.	Gasification & Gas Prep.	49 MW
3.	Water	15 MW
4.	Lights	5 MW
5.	Mine	50 MW
6.	Power House	15 MW
7.	Miscellaneous	15 MW

8.2.2 Electrical System Description

The electrical system consists of three major load centers:

1. Power Plant
2. Capps and Chuitna Mines
3. Process Plant

The total power requirements for these loads have been estimated to be 165 megawatts.

o Power Plant:

Three steam turbine generators supply prime power for the facility. A single circuit, 161 KV transmission line to the Beluga Power Company and 69KV to 161KV transformer is provided for start-up and standby power. The 13.8 KV output of the three generators is transformed to 69 KV and paralleled with the Beluga Power Company in an outdoor 69 KV switchyard.

Power for the power plant operating is normally provided from three 7500 KVA auxiliary transformers. A source of standby power is provided by one 10,000 KVA transformer.

o Transmission Line to Mines

The power to the Capps and Chuitna mines is transformed from 69 KV to 161 KV and transmitted by a single circuit transmission line. There is a tap type substation located at each mine. The step-up transformer feeding the transmission line is rated 70 MVA and is equipped with automatic load tap changing equipment to provide acceptable voltage regulation at the mines. The 161 KV transmission line runs alongside the railroad corridor.

o Process Plant:

The power requirements for the process plant are estimated to be 100 megawatts. Power for use within the process plant is transformed from 69 KV to 13.8 KV by three transformers rated 50 MVA each. In the event of a single transformer failure, the two remaining transformers have sufficient capacity for the entire plant load, when auxiliary transformer cooling is utilized.

The main 13.8 KV distribution substation for the methanol plant consists of three secondary selective switchgear lineups equipped with automatic transfer systems. Each switchgear lineup operates with the tie breakers normally open.

o Substations

The majority of the 480 volt and 4160 volt substations utilize a secondary selective distribution system with automatic transfer. Where reduced levels of reliability and longer outage times are permissible, a radial distribution system may be used. The present design includes twelve 480 volt radial substations, thirty-five 480 volt secondary selective substations, two 4160 volt radial substations and five 4160 volt secondary selective substations. Transformers for the 480 volt substations are rated 1000 KVA and transformers for the 4160 volt substations are rated 7500 KVA. Both are equipped with auxiliary fan cooling.

Equipment for the 480 volt and 4160 volt substations is installed in prefabricated buildings. The substation vendor supplies and installs all necessary accessories including ventilating equipment, lighting, annunciators and a DC control power system as required to operate the substation. The 480 volt prefabricated substation buildings are installed on modules at the point of module fabrication. Where an entire 480 volt substation is not required on a module, individual motor control centers are installed on the module. The 480 volt substation wiring is completed to the extent possible before the modules are shipped to Alaska. All 4160 volt substations will be shipped directly to Alaska where they will be mounted and wired.

All motors larger than 3500 hp are rated 13,200 volts, 3 phase. All motors in the size range of 200 hp to 3500 hp are 4000 volts, 3 phase. Motors smaller than 200 hp are 460 volts, 3 phase except for fractional horsepower motors which are rated 230/115 volts, single phase.

8.3 RAW WATER TREATMENT (Area 301)

All water used in the plant is drawn from wells. The water requirements fall into three categories of usage:

1. General Plant and Potable Use
2. Boiler Feed Water
3. Cooling Tower Water

A different type of treatment is required in each case to supply water of suitable quality for each use. The several requirements and treatments are described below.

8.3.1 General Plant and Potable Use

Raw water will be softened by the "Cold-Lime" process, neutralized, and chlorinated before distribution.

Estimated requirements for this use category are:

	GPM
Plant Processing Uses	500
Pump Seal Water	175
Make Up to Coal Dryer Scrubber	255
Loco Shop	50
Coal Handling & Storage Area	40
Drinking and Sanitary	15
Miscellaneous Uses	140
TOTAL	1175 GPM

Water treatment facilities using the "Cold-Lime" process will be designed to produce up to 1400 GPM of softened water to account for peak demands and to provide a nominal excess capacity.

8.3.2 Boiler Feed Water, (Dwg 5530-302-Y-001)

Water of boiler feed quality is required for producing high pressure steam, and for use in the gasifiers and reformer waste heat recovery boilers.

Due to the presence of high concentrations of silica in the well water, make-up water for boiler use is first softened using the "Warm-Lime" process for partial removal of silica, and then is demineralized using a combination of cation and anion exchange beds.

Water treatment facilities will be designed to supply up to 2600 GPM of make up water to the high pressure and process area boilers. This includes an allowance for nominal excess capacity.

8.3.3 Cooling Tower Make-Up Water

Cooling tower make-up water will require alkalinity control and chemical additions to prevent scaling and biological growth within the recirculating cooling system. These requirements are accomplished by adding appropriate chemicals directly to the cooling tower basins. Sulfuric acid is added for alkalinity control. Inhibitor and dispersant chemicals are added for scale control. Chlorine is added for control of biological growth.

The cooling tower blowdown will be discharged directly to the effluent storage pond for blending with the treated process wastewaters for final discharge to Cook Inlet.

8.4 COOLING WATER SYSTEM (Area 103)

Cooling water is supplied through a forced draft, open recirculation cooling tower system. There are five cooling towers. Each has its own set of recirculating cooling water pumps, and each represents 20% of the total plant cooling water capacity. Each tower has two speed reversible motor fan drives and adjustable louvres - a combination which provides maximum flexibility in adjusting to changing climatic conditions.

Each tower is designed to cool 66,000 gallons of water per minute from 95°F to 65°F with a 7° approach to the wet bulb temperature. Design summer time wet bulb temperaure is based on 69°F which will not be exceeded more than 5% of the time. (Date Source: The Fluor Co.).

Cooling tower water is distributed throughout the plant by means of distribution headers. To prevent fouling on heat exchanger surfaces, reduce scale formation and prevent the growth of algae, provision is made for the addition of certain chemicals such as chlorine, sulfuric acid, dispersant, etc.

Makeup water is supplied from wells, and controlled blow down will be sent to the wastewater treatment area prior to discharge from the plant.