

MISSISSIPPI POWER COMPANY KEMPER COUNTY IGCC PROJECT CONTRACT NO.: 17352 TAG NO.: CLCW HX, OPERATING UNIT 2 SPX MATERIAL NO.: G2010000817

APV PLATE HEAT EXCHANGERS

SPX/APV MODEL: S280 M-14

SPX FLOW TECHNOLOGY SYSTEMS, INC. 1200 W. ASH STREET GOLDSBORO, NC 27530 UNITED STATES TEL 888.278.4321 www.spxft.com



Qualit

Southern Company Generation Kemper County MM218131 0 Unit 1

APV NORTH AMERICA PO: MPC17352-0001 1000817 DATABOOK Rev: NA IGCC - MULTIPAGE - DOCUMENTATION PACKAGE FOR G2010000817 - TAG NO



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DESIGN	SPECIFICATIONS			
DESIGN CODE REF. CALC: 1000816-821 ASME	ASME SECTION VIII DIV 1 2007 EDITION, 2009 ADDENDA API 662			
MAX. ALLOWABLE WORKING PRESSURE	175 PSIG.			
MINIMUM DESIGN METAL TEMPERATURE	-20 °F. @ 175 PSIG.			
HYDROTEST PRESSURE	263 PSIG.	E		
	5F. 150/F	Э		
SERIAL NUMBER	G2010000817			
HEAT TRANSFER AREA	18294.4 SQ.FT.			
FRAME SIZE	No. 5			
MAXIMUM FRAME CAPACITY	808 PLATES MAX.			
DRY WEIGHT	37697 LBS.			
	2089 8 GALS			
FINISH	SPECIAL PAINT			
ACCESSORIES SUPPLIED	GROUNDING LUGS, TIE BAR SLEEVES			
	SS SHROUD			
OPERATING	CONDITIONS			
	FLOW RATE TEMP. °F. △P(PSIG)	4		
WATER (COLD) 89 WATER (HOT) 87	/∠/ɔɔ iɒ/nr 86.0 — 110.5 20.0 32706 lb/hr 119.0 — 94.0 18.9			
Plates (Total: 609)	, , , , , , , , , , , , , , , , , , , ,			
Qty Part Number ID Des	cription			
1 GSS24K4XTX6AMMXA A S28	305 (45) END 0.6 NIT PX HS (2 YEL)			
331 GSS23F4XTX6AMMXA C S28	305 (30) FLOW 0.6 NIT PX HS (2 YEL)			
U GSSZOPUXIXDAMMXA U S28	DUS (JU) FLUW U.B NII PX HS (Z YEL)			
Frame (Maximum: 813) Qty Part Number Des	scription			
1 GB510393G1G1G1G1	 nd			
1 GB510394AXAXAXAX Fol	ower – punch code 0000			
I GB010391 520	SU M-14/5 SPECIAL			
Fitting Qty Part Number Pos Des	cription	Q		
4 GB510395 H1 H2 NP	5 20 Flange (Studded) Titanium Class 150	J		
H3,H4 (Mo	ites With) ANSI B16.5			
Accessories				
Qty Part Number Des				
2 GB510560 Gro	IL Inspection and U Stamp unding Lugs			
1 GB510413 Shr 20 GB500636-M48 Tie	oud, \$280 FS5 304SS Bars Sleeves			
1 GSPEC-PAINT-3 3-Coat Paint procedure				
CENTER D	F GRAVITY			
WEIGHT	X Y	~		
FLOODED 7	7.11 76.69	2		
Mississippi Powe	r Company — Kemper			
County	IGCC Project			
De	kalb, MS			
Tag: CLCW H	K, Operating Unit 2			
G20	10000817			
Contract No.: 1/352	SDV Flow Toobseleer Conterned			
	1200 W. Ash Street			
	[®] Goldsboro, NC 27530			
	Tel: (919) 735-4570	1		
CONFIDENTIALITY NOTE: THE INFORMATION COTAINED HEREON IS OF A	rax: (919) 001-1134 Description:			
CONFIDENTIAL NATURE AND IS THE PROPERTY OF SPX FLOW TECHNOL SYSTEMS, INC. GOLDSBORO, NC, USA. IT SHALL NOT BE PHOTOGRAPH PHOTOSTATED, OR REPRODUCED IN ANY MANNER NOR USED FOR ANY PURPOSE WINJSOLVER FUTCH WITH WATTER BOTH STATUS	S280 M-14 SPECIAL			
TECHNOLOGY SYSTEMS, INC. GOLDSBORO, NC, USA Checked: Date: Supersedes:	Scale: Sheet:			
Annual Data D	N.T.S. 1 OF 1			
GJE 1F	EB11 1000817 101			
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Customer Contract No.: 17352

Document Title: Certificate of Conformance APV Order Number: G2010000816-821 Customer: Mississippi Power Company ISSUE: 00 DATE: 25Oct12 BY: GJE Page 1 of1

SPX Flow Technology Systems, Inc. PH: (919) 735-4570 FX: (919) 581-1134

Certificate Of Conformance

Customer: Mississippi Power Company **Customer Contract No: 17352** Location: Dekalb. MS **Project: Kemper County IGCC Project**

Material #	Model #	<u>Tag #</u>
G2010000816	S280 M-14	CLCW HX, Operating Unit 1
G2010000817	S280 M-14	CLCW HX, Operating Unit 2
G2010000818	S280 M-14	CLCW HX, Spare Unit
G2010000819	S280 M-14	CLCW HX, Operating Unit 3
G2010000820	S280 M-14	CLCW HX, Operating Unit 5
G2010000821	S280 M-14	CLCW HX, Operating Unit 4

This is to certify that the following Plate Heat Exchangers comply with the purchase order and were built to ASME Section VIII, Division 1 2007 Edition, 2009 Addenda using approved designs and materials.

Signed & Approved: <u>Gregory Eckard</u>



Project Manager / Mechanical Engineer



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PRESSURE VESSEL CALCULATIONS

FOR AN

APV PLATE HEAT EXCHANGER

IN ACCORDANCE WITH THE

ASME BOILER AND PRESSURE VESSEL CODE

SECTION VIII, DIVISION 1

2010 EDITION

HEAT EXCHANGER MODEL:	S280 MGS-14	
REFERENCE DRAWING NUMBER:	1000816-821	
DESIGN PRESSURE:	175.00	psi
TEST PRESSURE:	263.00	psi
MAXIMUM DESIGN TEMPERATURE:	150.00	F
MINIMUM DESIGN METAL TEMPERATURE:	-20.00	F

P.O. NO: 17352

TAG NO.:

CUSTOMER: Mississippi Power Company

LOCATION: Dekalb, MS

D Eckarl



THE FOLLOWING PARAMETERS APPLY TO THIS HEAT EXCHANGER DESIGN:

P =	175.000	psi	DESIGN PRESSURE (UG-21, Appendix 3)
A =	5104.755	sq in	PRESSURE AREA
d =	47.677	inches	SHORT SPAN (fig. UG-34 sketch j)
D =	107.070	inches	LONG SPAN (UG-34b)
G =	473.543	inches	GASKET PERIMETER (Appendix 2-3)
Hg =	2.264	inches	GASKET MOMENT ARM (Appendix 2-3, table 2.5.2)
L =	339.536	inches	TIE BAR PERIMETER (UG-34b, Appendix 2-10)
C =	0.300		UG-34 d sketch j
b =	0.188	inches	Appendix 2-3, Table 2-5.2, figure (1a) or (1b)
m =	1.000		ELASTOMER 75A SHORE (Table 2-5.1, Appendix 2-3)
y =	200.000	psi	ELASTOMER 75A SHORE (Table 2-5.1, Appendix 2-3)

BOLT (TIE BAR) DESIGN

REFERENCE: APPENDIX 2 - MANDATORY

MATERIAL:	SA-193 GR B7		
Sa =	25000	psi	@ ATMOSPHERIC TEMPERATURE
Sb =	25000	psi	@ DESIGN TEMPERATURE

BOLT LOAD:

DESIGN	CONDITIONS:	Wm1 = A*P+2b*G	*m*P	Appendix 2-5, formula 1
GASKET	SEATING:	Wm2 = b*G*y		Appendix 2-3 & 2-5 (formula 2)
	NOTE: THE FORMUL	AS HAVE BEEN M	10DIFIED FOR NONC	CIRCULAR GASKETS
	Wm1 =	924408.38	lbf	

Wm2 = 17757.86 lbf

TOTAL BOLT AREA REQUIRED IS THE GREATER OF THE FOLLOWING (Appendix 2-3 & 2-5d):

DESIGN CONDITIONS:	Am1 = Wm1/Sb =	36.976	sq in
GASKET SEATING:	Am2 = Wm2/Sa =	0.710	sq in

TOTAL BOLT AREA SUPPLIED:

SIZE 1	M48 x 5	QTY (n1)	20
SIZE 2		QTY (n2)	0

BOLT TENSILE AREA (As) = 0.7854 * (D - 0.9382 * P) ^ 2 Note: D is the bolt diameter, P is the bolt pitch

TOTAL AREA (Ab) = As1 * n1 + As2 * n2 45.668 sq in

TOTAL BOLT AREA SUPPLIED (45.668 sq in) IS GREATER THAN REQUIRED (36.976 sq in)





Greg Eckard 03-Feb-11 1000816-821 ASME

REV NO.:

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UNPORTED SLAB THICKNESS

The head and follower covers are designed as noncircular flat plates attached with bolts causing an edge moment. The thickness of the covers without openings is determined in accordance with UG-34 - UNSTAYED FLAT HEADS AND COVERS.

SLAB MATERIAL:	SA-516 GR 70		
Sop = 20 CA = 0 E =	0000 psi 0000 inches 1	@ 1: Corrosion Allowance Joint Efficiency (no w	50 F relded joints)
THICKNESS "T1" REQUIRED	AT OPERATING CONDITIONS		
T1 = d*SQR[((Z*C*P/(Sop*E Z = MINIMUM OF: 3.4-(2.4* W = Wm1 = A*P+2*b*G*m*	E))+((6*W*Hg)/(Sop*E*L*d*d))] d/D) OR 2.5 P	UG-34 Fo UG-34 Fo Appendix	ormula 5 ormula 4 ‹ 2-5 Formula 3
Z = 2 W = 924408	.331 .384 lbf		
MINIMUM REQUIRED UNP	PORTED THICKNESS, INCLUDI	NG CA T1 =	3.970 inches
THICKNESS "T2" REQUIRED I	DUE TO GASKET SEATING		
T2 = d*SQR[((Z*C*P/(Sgs*E P = 0 psig at gasket seating Wgs = ((Am+Ab)*Sa)/2 Am = GREATER OF: Am1 =	E))+((6*Wgs*Hg)/(Sgs*E*L*d*d))) conditions = Wm1/Sb OR Am2 = Wm2/Sa (Appendix From page 2)	c 2 - 5 Formula 4
Am = 36 Sgs = 20 Wgs = 1033051	.976 sq in 0000 psi .250 lbf		
MINIMUM REQUIRED UNP	PORTED THICKNESS, INCLUDI	NG CA T2 =	1.438 inches

MINIMUM REQUIRED UNPORTED THICKNESS, INCLUDING CA, @ OPERATING OR GASKET SEATING CONDITIONS

T = GREATER OF: T1 OR T2

T = 3.970 inches





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REINFORCEMENT REQUIRED FOR PORTED SLABS

A finite element analysis calculation (using ALGOR's Linear Stress Analysis package, version 9.20) in accordance with U-2(g) has been performed to calculate the required port reinforcement thickness. This analysis is summarized in APV Publication 3392. The following equation has been derived from the results of this analysis.

TBPA =	6398.097	sq in	AREA ENCLOSED BY ALL TIE BARS
ATMIN =	3812.589	sq in	MAXIMUM AREA ENCLOSED BY SIDE TIE BARS
			LOCATED INSIDE VERTICAL PORT CENTERS
VTC =	10.433	inches	MAXIMUM VERTICAL SPAN OF SIDE TIE BARS
			LOCATED INSIDE VERTICAL PORT CENTERS
TBMD =	31.646	inches	MAXIMUM VERTICAL SPAN FROM TOP / BOTTOM END
			TIE BARS TO TOP / BOTTOM SIDE TIE BAR LOCATED
			INSIDE VERTICAL PORT CENTERS
A =	0.9348		CONSTANT VALUE FOR US UNITS

THICKNESS "T3" REQUIRED FOR PORT REINFORCEMENT

T3 = A*(P/Sop)^0.5*d^1.0066*[(TBPA/ATMIN)*(VTC/TBMD)]^0.0201

MINIMUM REQUIRED REINFORCED THICKNESS, INCLUDING CA T3 = 4.226 inches

MINIMUM THICKNESS "Tport" REQUIRED FOR PORTED SLABS

Tport = GREATER OF: T OR T3

Tport = 4.226 inches

LOADINGS

The slab thickness for this heat exchanger is based on the loadings is section UG-22(a), taking into consideration both the internal and external (full vacuum) pressures. UG-21 states that the pressure vessel shall be designed for at least the most severe condition of coincident pressure and temperature expected in normal operation. The internal pressure is used in this calculation since it creates the maximum differential pressure between the inside and outside of the vessel. Loadings in sections UG-22 (b) through (i) have been considered with no additional thickness required.



HYDROSTATIC TEST PRESSURE

REFERENCE: UG-99 STANDARD HYDROSTATIC TESTLOWEST STRESS RATIO (LSR):1UG-99(b)MINIMUM TEST PRESSURE = 1.5*MAWP*LSR =263.00psi(PER NOTE 33, MAWP MAY BE ASSUMED TO BE THE SAME AS THE DESIGN PRESSURE)

IMPACT TESTING

The slab material, at 5.0 inches nominal thickness, is supplied in the normalized condition. The slab material is thus classified by curve D in section UCS-66. The governing thickness for determining whether impact testing is required is 5.0 / 4 = 1.25 inches [UCS-66(a)(3)]. Using 1.25 inches as the minimum thickness, table UCS-66 indicates that impact testing is required for minimum temperatures less than -21.0 F. The tie bar material impact test exemption temperature is -55.0 F. Therefore, no impact testing is required for this frame since the minimum temperature is -20.0 F. (reference: UG-20, UG-84 & UCS-66)

DESIGN SUMMARY

DESIGN TEMPERATURE:	150.00	F
MINIMUM METAL DESIGN TEMPERATURE:	-20.00	F
MAXIMUM DESIGN PRESSURE:	175.00	psi
MINIMUM TEST PRESSURE:	263.00	psi
HEAD AND PORTED FOLLOWER:		
MINIMUM REQUIRED THICKNESS:	4.226	inches
UNPORTED FOLLOWER:		
MINIMUM REQUIRED THICKNESS:	3.970	inches
TIE BARS:		
REQUIRED TOTAL ROOT AREA:	36.976	sq in
SUPPLIED TOTAL ROOT AREA:	45.668	sq in



5 of 5

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AGI by: Har R nne

Paul Hommer, Quality Manager

VENDOR	261	1
PART #	CB50292	Revie
P.O./DATE	4501217000	ASM
HEAT #	456090.4.0701	Edition
THICKNESS	55"N/516	Ву&а.[
INSPECTOR APP:	2Jacth 10.	10.17
A.I. APPROVAL:	15 10 17.12	·
DESCRIPTION	SARD	

4.98 /5.15

Reviewed and Accepted to

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ASME Sect. II 10-10-12 Edition: By & Date



Material Test Report 9/12/2012 Cert Number Test Reference 11722 A(SPX Flow Technology Systems Inc 1200 West Ash Street Goldsboro, NC 27530 Issued from AQL fric. - Steel Processing Divisi AQ2/22 State Roads 7 Hammas, OH 43831 SPX Flow Technology Systems Inc, 1200 West Ash Street, Goldsboro, NC 27530 SPX Flow Technology Systems Inc, 1200 West Ash Street, Goldsboro, NC 27530 Sold To: Ship To: Product Information Heat 457734-4-0201 HR Steel Plate AS16 Gr70 Tag 406323AAA Normalized 5.5" x Custom Shape Conform To ASME-SA516 Gr70 r05 12/1/2005 ASTM-A516GR70N >4 r10 10/1/2010 ASTM-A20 r10 10/1/2010 Chemical Composition S Si 0.014 0.19 NI <0.005 Cr 0.021 AI 0.03 0.21 0.014 0.013 1.1 Cu 0.019 Nb <0.002 <0.002 <0.002 **Physical Tests** Elongation in 2 (T) 30.2 % Tensile (T) 75,400 PSI Yield (T) 47,300 PSI Impact Tests Impc UM Temp D Rstt 1 Rsit 2 Rsit 3 Heat Treatment Time 1:15 HRS Cool Mthd Air 70 F Heat Trmt Temp 1675 F Normalize SO 2016748 / PO 4501217000 / PN GB510394 REV 0 tommer AGI by: 0 Paul Hornmer, Quality Manager VENDOR Reviewed and Accepted to PART # ASME Sect. II P.O./DATE \sim Edition:20 HEAT # By & Date: 9.17 THICKNESS INSPECTOR APP 2 A.I. APPROVAL: 1.600 7.12 DESCRIPTION olla 9/12/2012 04:05 PM 🗋 🕘 1

4.98 5.15



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KEYS Threaded Pro	STONE* -	* * MATE	RIAL CER	TIFICATION	* * *	7621 C Cleve)ld Rockside Rd and,10hio 44131
Sold To:	SPX FLOW TEC SPX SHARED S 2200 EAST DE DES PLAINES,	CHNOLOGY SY SERVICES CVON AVE ILLINOIS	STEMS 60018	Order Order Shipp Invoi	Date No. ed Date ce No.	4/19/12 4501213 8/31/12 67990-0	2 107 2
<u> </u>	METRIC A 1	193 - B-7 A	LLOY FULL	THREAD STU	DS - PLAI	IN .	
	13 Pcs. M4	18 X 5.0 X	5600 MM				
	PART NO. C	GN510549		ID# 2B46	ZM = HEAT	:# 110446	
 ASTM ELEMEN AMOUNT	Heat No. 110446 A193, GRADE E TS: C S 0.410	Order No. 0018698 37 As CH P 00 0.0110	Rec. 2/24 SPECIFICA ME SA193, IEMICALS MN 0.8900	Date 4/12 GRADE B7 S 0.0300	Code SI 0.2700	 CR 0.8270	MO 0.1580
ELEMEN AMOUNT	TS: NI S 0.077	CU 70 0.2200	AL 0.0030	NB 0.0270	SN 0.0070	TI 0.0012	V 0.0060
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Reviewed and Accepted to

ASME Sect. II Edition 2010/2011 By & Date: Stx 9/17/17 07.17.12

State of Ohio County of Cuyahoga We certify the foregoing a true and accurate report as represented by our suppliers.

Lisa Jarosz Sales & Q.A. Coordinator



KEY	STO	NE * *	* MAT	ERIAL C	CERTIFICA	TION	* * *	7621 Old	Rockside Rd
Sold To:	Froducts D SPX F SPX S 2200 DES F	IVISION FLOW TECH SHARED SH EAST DEV PLAINES,	HNOLOGY S ERVICES /ON AVE ILLINOIS	YSTEMS 60018		Order Da Order No Shipped Invoice	te Date No.	4/19/12 450121310 8/31/12 67990-02)7
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	11	Pcs. M48	3 x 5.0 x	5600 MM	1				
	PAF	RT NO. GI	3510549		ID#	2B20ZM	= HEAT#	11922820	
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Eleme: Amoun	nts: ts	V 0.027	CU 0.220	AL 0.003	NB 0.220	SN 0.013			
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Reviewed and Accepted to

ASME Sect. II Edition: 2010 12 By & Date:

State of Ohio County of Cuyahoga

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We certify the foregoing a true and accurate report as represented by our suppliers.

Lisa Járosz Sales & Q.A. Coordinator

Sworn to and subscribed before me This _____ Day of ______ 20____



KPF (FACTORY : 601 YONGTAN-DONG, CHUNGJU-CITY, CHUNGCHEONGBUK-00, KOREA 380-250 TEL : (043) 849 - 1114 FAX : (043) 849 - 1234 FAX : (043) 849 - 1234 FIELO OF TESTING : MECHANICAL, CHEMICAL LAB, IO. : 111963 CERT. NO. : 0682-01, 0682-02	STANDARD 0F CERTIFIED : 1S0 9001, 1S0 14001, 0S9000 CERT. NO. : AC-01899, EAC-03556, MC-01899 PAGE 1/2 PAGE 1/2	Condition Random Condition Center Segregation Spec. of Test Method 2 R2 C2 ASTM E381 -	K.R. LEE	Impact Test Bending Bolt Tap Mrench Zation	Individual Average Tost By Hardness Fit Test Tast By Hardness								the above results are true and correct in every details	IN-SUB CHOE Chief of Quality Management Oept.	
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N CERTIFIC	COMPANY PURCHASING 10 NUTS, ZP F LOGO 1NG (WHITE)	D PCS	00 × 1000		Proof Load	Load Elongation								ARE ON FILE This		KPF
INSPECTI 0	Customer : FASTENAL Description : GR.2H HE) Grade : GR.2H Size : M48x5.0P Marking : 2H.M48,Ki rface Condition : ZINC PLA	Lot No. : F2H05974 Q'ty Shipped : 839	Ni B Cu T1 x100 x10000 x100 x100 x1	1	nen Tensile	ngth Elongation Reduction of Area				-				QA) AND RECORDS OF COMPLIANCE		
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Product Group	Mercha	ant Bar Qua	lity					Part Number	53375250	2403730	
Product Group Grado	Mercha ASTM	Ant Bar Qua	lity 29-05, A709-0	9a GR36, AS	ME SA36-0"	7 Ed 11 Ad		Part Number Lot #	53375250 DL121025	02403730 55901	
Product Group Grado Size	Mercha ASTM 3/8x2-1	ant Bar Qua A36-08, A5 I/2" Flat	lity 29-05, A709-0	99a GR36, AS	ME SA36-0	7 Ed 11 Ad		Part Number Lot # Heat #	53375250 DL121025 DL121025	02403730 55901 559	
Product Group Grado Size	Mercha ASTM 3/8x2- 3/8x2-	Ant Bar Qua A36-08, A5 1/2" Flat 1/2" Flat 20	lity 29-05, A709-0 A36/A529GR	99a GR36, AS	ME SA36-0	7 Ed 11 Ad		Part Number Lot # Heat # B.L. Number	53375250 DL121025 DL121025 C1-57943	02403730 55901 559	
Product Group Grado Size Product Description	Mercha ASTM 3/8x2- 3/8x2- A36/A	Ant Bar Qua A36-08, A5 1/2" Flat 1/2" Flat 20 529GR50	lity 29-05, A709-0 A36/A529GR	1999 GR36, AS	ME SA36-0	7 Ed 11 Ad		Part Number Lot # B.L. Number Load Number	53375250 DL12102f DL12102f C1-57943 C1 26229	02403730 55901 559 155 155 133	
Product Group Grado Size Product Description Customer Spec	Mercha ASTM 3/8x2- 3/8x2- A36/A	Ant Bar Qua A36-08, A5 1/2" Flat 1/2" Flat 20 529GR50	lity 29-05, A709-0 A36/A529GR	99a GR36, AS	ME SA36-0	7 Ed 11 Ad	C	Part Number Lot # B.L. Number Load Number ustomer Part #	53375250 DL121025 DL121025 C1-57943 C1 26229	02403730 55901 559 55 53 33	
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Product Group Grado Size Product Description Customer Spee hereby certify that in C	Mercha ASTM 3/8x2 3/8x2 3/8x2 A36/A3 cmeterial des Mn	Ant Bar Qua A36-08, A5 I/2" Flat I/2" Flat I/2" Flat 20 529GR50 cribed herein fr	lity 29-05, A709-0 A36/A529GR as linen manu/action S	1999 GR36, AS 150 ured in accordance Si	ME SA36-0" with the space	7 Ed 11 Ad eations and stand Ni	Ends licted abov Cr	Part Number Lot # B.L. Number Load Number ustomer Part # a anu Ital it satisfias Mo	53375250 DL12102f DL12102f C1-57943 C1 26229 Incee requireme V	02403730 55901 559 559 55 33 55 33 55 50 55 50 55 50 55 50 55 50 55 50 55 50 55 50 55 50 55 55	

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL 2. MELTED AND MANUFACTURED IN THE USA 3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

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VENDOR	HJerson
PART #	GB510555
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NBMG-10 January 1, 2012	Quality Record	James H. Blew Division Metallurgist	Page 2	of 6







Perviewed and Accepted to ASME Sect. II ASME Sect. II Coltion: 20/1 Asme Sect. II Aster III Aster III <	ONE THORN RUN CENTER 59 DSO QUALITY PACKAGING INC SUITE 325 RUN CENTER 59 DSO QUALITY PACKAGING INC SUITE 325 RUN CENTER 59 DSO QUALITY PACKAGING INC SUITE 325 MD 21060 MOON TOWNSHIP PA 15108 ATI GRADE AND SPECIFICATIONS ATI GRADE 1 TITANIUM SHEET C R PLATE FRAME HEAT EXCHANGER-COILS ANNEALED IBA FIN 3 EDGE (APV 0041-1 REVIS & SMS 29 REV 11) (ASTM-E-8-11) (ASTM-A-480-11B) (DIN EN 10204:2005 3.1 CERTIFICATE) (ASTM-E-384-11) (ASME-SB-265 ED 2010) (07/21/10 EXCPTS TO 0041-1/SMS29) (ISO 20482:2007) (ASTM-E-384-11)	ITEM PCS DIMENSIONS W/G/L HEAT # LIFT # TEST # GROSS TARE NET THEO TAG #/ CD SKID # (MM) (MM) (KGS) (KGS) (KGS) (KGS) (KGS) (KGS) (KGS) (KGS) (FGS) (FGS) (FGS) (FGS) (FGS) 1 2740 2721 866900 CDS TARE NET THEO TAG #/ CD SKID # 001A 1 1254./.6/824484. N49XEM 11441T227B L252519 2758 18 2740 2721 866900 CDS TARE NET THEO TAG #/ CD SKID # 001A 1 1254./.6/824484. N49XEM 11441T227B L252519 2758 18 2740 2721 866900 CDS TARE NET THEO TAG #/ CD SKID # 1 SKID 1 274. SMID 1 2721 866900 CDS TARE NET THEO TAG #/ CD SKID # 1 SKID 2721 866900 CDS TARE NET THEO TAG #/ CD SYID # 2758 18 2740 2721 866900 CDS TARE NET THEO TAG #/ CD SYID # 1 SKID 1 2720 CDS TARE NET THEO TAG #/ CD SYID # 1 SKID 1 2720 CDS TARE NET THEO TAG #/ CD SYID # 1 SKID 1 2720 CDS TARE NET THEO TAG #/ CD SYID # 1 SKID 1 2720 CDS TARE NET TAG TAG #/ CD SYID # 1 SKID 1 SKID 1 2720 CDS TARE NET THEO TAG #/ CD SYID # 1 SKID 1 SKID 1 2720 CDS TARE NET TAG TAG TAG TAG TAG #/ CD SYID # 1 SKID 1 SKID 1 2720 CDS TARE NET TAG TAG TAG TAG TAG TAG TAG TAG TAG TA	6080 40 6040 5999 ORDER REMARKS: "THE ABSENCE OF INTERLEAVE PAPER CAN LEAD TO SURFACE DAMAGE. ALLEGHENY LUDLUM WILL ASSUME NO RESPONSIBILITY FOR SUCH DAMAGE ON ORDERS WHICH PROHIBIT PAPER INTERLEAVE." DIST: EMAIL AND MAIL ACKNOWLEDGEMENTS TO MCGINNIS@UNITI-TITANIUM.COM & KUNKLE@UNITI-TITANIUM.COM SEND ONLY ENGLISH INVOICES, NO METRIC ORDERS NO CERTS TO THE SOLD-TO, UNITI RECEIVES THRU ON-DEMAND FINAL DEST: APV PRODUCTS DAMAGE NO CERTS TO THE SOLD-TO, UNITI RECEIVES THRU	TYPE HEAT/TESTCTINFEO R-EACH R-TOTL HEAT N49XEM .005 BAL .001 .03 .03 <.1000 <.4000 TEST LOCATION RW RW RW XX	ITEM TEST NOYIELD TENSILE YLD/TEN % ELONG001A L252519L 196.292.6748.NR106.HV5KGNR787106.HV5KG787107.HV5KG787107.HV5KG786107.HV5KG786107.HV5KG796107.HV5KG708107.HV5KG7087C708 </th <th>er fram fragt som offen singer orden for an entropy of the source and the source of th</th>	er fram fragt som offen singer orden for an entropy of the source and the source of th
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CERTIFICATE OF TEST AL 6188-4 1211	*** METRIC *** *** METRIC *** *** METRIC *** *** D000 32-052-097 D6/04/12 SHPPHAGICANTON NAUCOCCANON SHPPHAGICANTON 241482 MD 21060	D,INC. IN 3 EDGE (APV 0041-1 REV15 & TE) (ASTM-E-384-11)	BEND BOTTOM BEND TT PASS TT PASS TT PASS TT PASS TT PASS TT PASS TT PASS TC PA
	ACCEPTING MILL ACCEPTING MILL ACCEPTING MILL SVILLE, OH [541346 13200116060 00 PHL 29 PHL 20	AT EXCHANGER-CARRIER - GROSS, RONALI AT EXCHANGER-COILS ANNEALED 1BA F (DIN EN 10204:2005 3.1 CERTIFICA 1-1/SMS29) (ISO 20482:2003)	TRAN TRAN ELONG BEND IN 50.8 MM BOTTOM BEND 36. L PASS TC TC TC TC TC TC TC TC TC TC TC TC TC
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AL BIGB64 CERTIFICATE OF TEST REPOUCT CODE *** ENGLISH PRODUCT CODE *** ENGLISH *** ENGLISH *** ENGLISH *** ENGLISH *** ENGLISH *** *** ENGLISH *** *** ENGLISH *** *** *** *** ENGLISH *****	ROSS, RONALD, INC. ALED 1BA FIN 3 EDGE (APV 0041-1 REV15 CERTIFICATE) (ASTM-E-384-11) 003) HNIQUES:	L5065 CEST >>>>>>>>>>>	0 FOLLOW 06/04/12 12:52:14 and the fourther a voite grant of the fourther of the fourther and the fourther and the fourther of the four
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NOTICE OF SHIPMENT/ CUSTORD. NO & DATE 7450/4501221502 7450/4501221502 7450/4501221502 7450/4501221502 7450/4501221502 7450/4501221502 7450/4501221502 105/23/12 105/2	GRADE AND SPECIFICATIONS ATI GRADE 1 TITANIUM SHEET C R PI SMS 29 REV 11) (ASTM-E-8-11) (AST (ASME-SB-265 ED 2010) (07/21/10 E	YIELD ITEM TEST NO FSI * 001A L252519 T 29200. T 29200.	TEST LOCATION TC	ITEM TEST NO H2 CHECK 001A L252519 .0027	TEST LOCATION TC TC	NR = DATA NOT REQUIRED METALLOGRAPHIC MAGNIFICATION: 100	GRADE VERIFICATION WAS CARRIED OU	DIN EN 10204:2005 - 3.1 ATI ALLEG PRESSURE EQUIPMENT DIRECTIVE PED	THIS CERTIFICATE OF TEST SHALL NO WERE PERFORMED BY AN OUTSIDE ATI	QUALITY SYSTEM CERTIFIED ACCORDIN INDUSTRIE SERVICE GMBH, (NOTIFIED	PAGE 02 - CONTINUED ON PAGE 03	CONSIGNEE. Please hole—This contigrment was turned over to the first infinition containing and any short to the please of the please porterior please activity and any operation pleased. For your accessing the protection please activity and any at a structure if any shorting of the please of the please of the please of the contention please activity and any at a structure if any shorting a discover 242-2428-98 or operation agent on varyal twing at a structure of the please o
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SUMITOMO METAL INDUSTRIES, LTD. ADDRESS : No. 2-12-1, MINATOCHO, JOETSU CITY. NIIGATA PREF, JAPAN T: Top M: Middle % 5 Direction B: Bottom T: Transverse H: Hard S: Soft L: Longitudinal Manager of Quality System Section SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS; GOOD X.3 Element
 Le CC: Ch+Ta+Ti
 CG: Other Element Each
 Element Total
 Remainder
 Bal : Balance cera A : Annealing Q : Quenching T : Tempering S : Solution Treatment Certified According to PED 97/23/EC Annex 1. Section 4.3 by TUV ANLAGENTECHNIK GmbH Efichsen(10.5mm Min); T:11.7 ,B:11.6 : 165Min-248Max, 240Min-410Max, 34Min : 165Min-230Max, 240Min-390Max, 45Min EL(%) 34 NAOETSU WORKS (1) MECHANICAL PROPERTIES, YT; Y.S/T.S *5 0.2%Y.S(MPa) T.S(MPa) EL Notes %1 Shape A ; COII X 2 L. C X L : Ladle C : Check % 6 Test Item **% 4 Position** 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination GOOD Date AER. D185115 Heat No. **INSPECTION CERTIFICATE** ₩3 Inspection No. 1,360 12CS545 nspection Agency 28 NAR STAINLESS STEEL ST TITANIUM Witnessed by 티너 Remarks Condition & Finish BAL. BAL. T;Total $\langle \circ \rangle$ Mass ····I E-I 0.66 0.72 0.53 0.56 0.67 44 ъ Х % 9<u>%</u> Chemical Composition in Quantity 4.5 6.0 ASTM NO 6.0 0 ¥ფ ე_¥ 0.10 0.03 Bend Test Чe U ; up 0.030 0.04 0.002 Hardness Test Customer SPX FLOW TECHNOLOGY DANMARK A/S 0.600X 1254.0 X COIL. z Shape & Size Inch; feet; _ nm; space 107 107 107 106 130 0.06 ASTM B265 GRADE HV Reviewed and Accepted to By & Date: 54 10/5/12 S Join Si Reduction 0 of Area S 0.0500.0050 0.0020.0020 Elongation (1)YXNC0796 11-AGNS-1244 52 Ħ 51 Edition: 2011 Test ASME Sect. II 298 314 300 309 Tensile Strength Unit υ $(1)^{-1}$ Tensile MPa Specification & Type P.O.No. 4501134464 Min Max --+ Yield Strength 0.2 % offset Certificate No. ₩ A.(1.)... 199 166 199 172 Case No. БЭ Heat Treatment & 7 --4 --4 <u>∗</u> 4 5 TI BT BL MID Max Ň Qualit 3.4 LAND 8 2 8 8 8 2 8 8 新口语 1412 Recor



SUMITOMO METAL INDUSTRIES,LTD NAOETSU WORKS ADDRESS : N.2-12-1, MINATOCHO, JOETSU CITY, NIIGATA PREF, JAPAN
 # 4 Position
 T: Top
 M: Middle % 5 Direction

 B: Bottom
 T: Transverse
 H: Hard
 S: Soft
 L: Longitudinate
 SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS;GOOD
(1) MECHANICAL PROPERTIES, YT, Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) Manager of Quality System Section CC : Cb+ Ta + Ti GG : Other Element Each HH : Other Element Total Remain : Remainder Bal : Balance (egg) A : Annealing Q : Quenching T : Tempering S : Solution Treatment T : 165Min-248Max, 240Min-410Max, 34Min L : 165Min-230Max, 240Min-390Max, 45Min Certified According to PED 97/23/EC Annex 1 34 1 Y: 1.0%07bet Yield Strength 2 Y: 0.2%07bet Yield Strength 3 Y: 0.1%07faet Yield Strength 4 Y: 0.01%07faet Yield Strength ER : Erichaen FC : Ferrite Content MP: Magnetic Permeability NM: Non-Metallic Inclusion Test Section 4.3 by TUV ANLAGENTECHNIK GmbH Erichsen(10.5mm Min); T:11.7 ,B:11.6 × 3 Element **%7 Heat Treatment** A ; Coil Notes #1 Shape GS : Grain Size X 2 L. C X L : Ladie C : Check % 6 Test Item 2012. We hereby certify that the above results are true and correct in every details. Dimensional { Visual Examination m GOOD Date APR. D185115 Heat No. **INSPECTION CERTIFICATE** ¥3 Inspection No. 2B2,660 12CS545 nspection Agency NAR STAINLESS STEEL ST TITANIUM Witnessed by Condition & Finish Remarks BAL. BAL. T;Total ्रे Mass Ч 0.53 0.56 0.72 0.67 0.66 Quantity k g ΥT х Chemical Composition in 9**%** 4.5 ASTM NO 6.0 6.0 ¥ 0 ₩ 0 0.10 0.03 Bend Test ڻه بيتا U; up 0.030 0.002 Hardness Test Customer SPX FLOW TECHNOLOGY DANMARK A/S Shape & Size 0.600X 1254.0 X COIL N ASTM B265 GRADE 1 105 106 107 130 Unit inch; feet; _ mm ; space 0.06 0.04 Н٧ Reduction of Area 0 R 0.0500.0050 0.0020.0020 Elongation YXNC0796 11-AGNS-1244 (1)Ξ, 37 51 Test 298 314 309 309 Tensile Strength υ Tensile MPa 4501134464 Specification & Type Min ¥1 A LELI T2U75 Certificate No. Yield Strength 0.2 % offset (1)---166 199 199 172 Case No. 01 MP a Heat Treatment *7 P.O.No. * Min Max Ż *** Qualit **t** [] [] **g** Rant ង ា ព ា ព H H H H Recor
















SUMITOMO METAL INDUSTRIES,LTD NAOETSU WORKS ADDRESS : N. 2-12-1, MINATOCHO, JOETSU CITY NIIGATA PREF, JAPAN % 4 Position T : Top M : Middle % 5 Direction B : Botton H : Hard S : Soft L : Longlucdinal SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS;GOOD
(1) MECHANICAL PROPERTIES, YT; Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) Manager of Quality System Section CC: Cb+ Ta+ Ti GG: Other Element Each HH: Other Element Tatal Remain: Remainder Ball : Balance je ya A : Annealing Q : Quenching T : Tempering S : Solution Treatment *5 0.2%Y.S(MPa) T.S(MPa) EL(%) T : 165Min-248Max, 240Min-410Max, 34Min L : 165Min-230Max, 240Min-390Max, 45Min Certified According to PED 97/23/EC Annex 1. ф С % 6 Test Item
1Y: 10% officet Yield Strength
2Y: 0.02% officet Yield Strength
3Y: 0.1% officet Yield Strength
4Y: 0.01% officet Yield Strength FC : Ferrite Content MP : Magnetic Permeability NM : Non-Metallic Inclusion Test Section 4.3 by TUV ANLAGENTECHNIK GmbH % 3 Element CC : Cb+ Erichsen(10.5mm Min); T:11.0 , B:10.9 **%7 Heat Treatment** A ; Coi. **GS**:Grain Size Notes #1 Shape ER : Erichsen %2 L.C % L:Ladie C:Check 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination GOOD Date APR. V155018 Heat No. **INSPECTION CERTIFICATE** ۲¥ Inspection No. 2B 12CS550 nspection Agency NAR STAINLESS STEEL ST TITANIUM Witnessed by Remarks Condition & Finish BAL. BAL. Quantity kg T:Total \diamond 3,000 Mass Ē 0.72 0.68 0.56 0.68 0.56 ΥT % Chemical Composition in 9 ※ 4.5 5 . 5 5.5 ASTM NO ¥წ თ აც -1 0.10 0.04 GRADE Bend Test Ч dn : N 0.030 0.04 0.002 Hardness Test ASME SB-265 2010ED. Customer SPX FLOW TECHNOLOGY DANMARK A/S 0.600X 1254.0 X COIL z Shape & Size 106 130 108 108 inch; feet; _ no ; space 0.06 НΥ Reduction AA 0 of Area 0.0500.0050 0.0020.0018 Elongation YXNC0796 11-AGNS-1244 (1)Ħ 34 35 2 Test 296 301 300 300 Chi Tensile Strength (17 Tensile MPa Specification & Type P.O.No. 4501134464 utw Max æ × Yield Strength 0.2 % offset (1)-201 204 T2473 169 Certificate No. Case No. MPa TL BH Min Max Ż Quality *** 1012 grnu 11 17 17 12 11.11 Recor





Ŧ SUMITOMO METAL INDUSTRIES,LTD. NAOETSU WORKS ADDRESS : M2-12-1, MINATOCHO, JOETSU CITY. NIIGATA PREF, JAPAN Manager of Quality System Section

 %4 Position

 T: Top
 M: Middle % 5 Direction

 B: Bottom
 T: Transverse

 H: Hard
 S: Soft
 L: Longitudinal

 * 6 Test Item

 1Y: 10% offset Yield Strength

 1Y: 0.02% offset Yield Strength

 3Y: 0.1% offset Yield Strength

 4Y: 0.01% offset Yield Strength

 FC: Ferthen

 S: Grain Size

 A: Annealing Q: Crain Size

 A: Annealing Q: S: Solution Treatment

 T: Tempering S: Solution Treatment
 SPEC.NO.0041~I REV.15, SURFACE ROUGHNESS;GOOD
(1) MECHANICAL PROPERTIES, YT; Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) X.3 Element
 Le CC: Cb+Ta+Ti
 CG: Other Element Each
 HH: Other Element Total
 Remain: Remainder
 Bal : Balance je y j Certified According to PED 97/23/EC Annex 1 0.2%Y.S(MPa) T.S(MPa) EL(%) : 165Min-248Max, 240Min-410Max, 34Min : 165Min-230Max, 240Min-390Max, 45Min 34 Section 4.3 by TUV ANLAGENTECHNIK GmbH Erichsen(10.5mm Min); T:12.4 ,B:12.2 Notes **1 Shape A ; Coll X 2 L. C X L : Ladle C : Check 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination Date MAR. 12. GOOD D144940 Heat No. INSPECTION CERTIFICATE ¥33 Inspection No. nspection Agency 2B 1285503 NAR STAINLESS STEEL ST TITANIUM Witnessed by Ļ, ٤-1 Remarks Condition & Finish BAL. BAL. T;Total ᢅ᠅ 3,365 Mass TL 0.68 0.58 0.58 0.72 ΥŢ σ х **9**₩ Chemical Composition in Quantity ASTM NO. 4.5 5.5 ທ ທ ₩ 03 0.10 Bend e) Fu U; up 0.030 Hardness Test Customer SFX FLOW TECHNOLOGY DANMARK A/S N Shape & Size 0.600X 1254.0 X COIL 113 130 113 107 0.06 ASTM B265 GRADE Unit inch; feet; ma; space 0.04 21.000.01 < 2/12/01 Reviewed and Accepted to Reduction 0 of Area 0.0500.0050 Elongation UNIN T2462 XXNC0795 (1)Edition: 201 III: By & Date: She Test ASME Sect. H 311 311 298 Tensile Strength 307 (1) \cup Tensile MPa Specification & Type 後3し・ 4501134464 Min Max Yield Strength 0.2 % offset K, ž 210 208 208 (1) 178 Case No. τu Heat Treatment #7 Ę * 5 HUH P.O.No. Min Max No. 3858 alit ានក្ន 4 80 A H anna Recor

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ADDRESS : M. 2-12-1, MINATOCHO, JOETSU CITY, NIGATA PREF, JAPAN SUMITOMO METAL INDUSTRIES,LTD. Manager of Quality System Section %4 Position T: Top M: Middle %5 Direction B: Bottom T: Transverse H: Hard S: Soft L: Longludinal SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS;GOOD
(1) MECHANICAL PROFERTIES, YT; Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) jera, CGC : Cb+ Ta+ Ti GG : Other Element Each HH : Other Element Total Remain : Remainder Bal : Balance A : Annealing Q : Quenching T : Tempering S : Solution Treatment Certified According to PED 97/23/EC Annex 1 : 165Min-248Max, 240Min-410Max, 34Min : 165Min-230Max, 240Min-390Max, 45Min 340 A start with a fire and a strength
 1 Y: 1.0% offset Yield Strength
 2 Y: 0.0% offset Yield Strength
 4 Y: 0.1% offset Yield Strength
 4 Y: 0.1% offset Yield Strength
 5 Firethean
 F Fir NAOETSU WORKS Section 4.3 by TUV ANLAGENTECHNIK GmbH × 3 Element Erichsen(10.5mm Min); T:12.4 ,B:12.2 **%7 Heat Treatment** Notes #1 Shape A ; Coil ×2 L.C × L:Ladle C:Check % 6 Test Item 2012. We hereby certify that the above results are true and correct in every details. Dimensional de Visual Examination ୍ଲ ମ GOOD 0.2%Y.S(MPa) Date MAR D144940 Heat No. INSPECTION CERTIFICATE ₩3 Inspection No. nspection Agency 1285503 2B NAR STAINLESS STEEL ST TITANIUM با Witnessed by E⊶ Remarks Condition & Finish T1 BAL BAL. 3, 365 ᠕᠕ ᡃᡞᡐᠶ Mass 0.58 0.68 0.58 0.72 Quantity kg ΨY Ж 9<u>%</u> Chemical Composition in 4.5 ນ ເມ ນ ເ **ASTM NO** ₩ 03 0.10 0.03 Bend Test е Н U; up 0.030 0.002 Hardness Test Customer SPX FLOW TECHNOLOGY DANMARK A/S Shape & Size X COIL. z 113 113 107 130 107 0.06 Unit inch; feet; nn ; space ASTM B265 GRADE 0.04 2 Reduction of Area 0 × 0.600X 1254.0 0.0500.0050 0.0040.0026 Elongation unce T2462 xxnc0795 2 þ: Test 311 298 Tensile Strength 307 Tensile (T)мРа Specification & Type ** 4501134464 Min Max ₩ R Yield Strength 0.2 % offset 210 181 208 178 1) Case No. MPa Heat Treatment & 7 P.O.No. * E FIFICO Min Max **8** Quality 6193 0.450 11111 01110 មួយមន្ត Recor







7 SUMITOMO METAL INDUSTRIES,LTD. NAOETSU WORKS ADDRESS : ML2-12-1, MINATOCHO, JOETSU CITY, NIIGATA PREF, JAPAN
 X
 4 Position

 T:
 TOP
 M: Middle % 5 Direction

 B:
 Bottom
 T:
 Transverse

 H:
 Hard
 S:
 Soft
 L:
 Longitudinal
 ** 3 Element e CC : Cb+ Ta+ Ti ek GG : Other Element Each HH : Other Element Total Remain: Remainder Bal : Balance SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS,GOOD
(1) MECHANICAL PROFERTIES, YT, Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) Manager of Quality System Section je sta A : Annealing Q : Quenching T : Tempering S : Solution Treatment Certified According to PED 97/23/EC Annex 1 **9** T : 165Min-248Max, 240Min-410Max, 34Min L : 165Min-230Max, 240Min-390Max, 45Min ER: Ericheen FC: Ferrite Content MP: Magnetic Permeability MM: Non-Metallic Inclusion Test MM: Their Theilment *7 Hierd Theilment 1 Y. 1.0%ooffset Yield Strength 2 Y: 0.02%offset Yield Strength 3 Y: 0.1%offset Yield Strength 4 Y: 0.01%offset Yield Strength Section 4.3 by TUV ANLAGENTECHNIK GmbH Erichsen(10.5mm Min), T:12.4 ,B:12.2 A Col Notes %1 Shape X2 L.C L: Ladle C: Check % 6 Test Item 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination 12. GOOD Date MAR. D144940 Heat No. INSPECTION CERTIFICATE ¥3 Inspection No. 28 1285503 inspection Agency NAR STAINLESS STEEL ST TITANIUM Witnessed by Condition & Finish Remarks BAL. 3, 365 BAL. $\langle \diamond \rangle$ Mass E 0.68 0.58 0.70 0.58 0.72 Quantity k g E. % Chemical Composition in 9× 4.5 ა. ა 5.5 ASTM NO ₩ th -4 0.10 0.03 ASME SB-265 2010ED. GRADE Bend e) Fri **dn** : U 0.030 0.002 Hardness Test A/S 0.600X 1254.0 X COIL. Shape & Size z 113 130 Unit inch; "feet; ' am; space 101 0.06 0.04 Customer SPX FLOW TECHNOLOGY DANMARK Reduction 0 of Area C 0.0500.0050 HAUE T 162 XXNC0795 Elongation (1)H 35 34 Test Tensile Strength 311 298 298 307 (1)Tensile P.O.No. 4501134464 Specification & Type 来るし、 MFa Min МөХ ₩ R Yield Strength 0.2 % offset (1)210 181 208 178 Case No. МРа Heat Treatment & 7 * Min Max No -1 Qualt a li la la 8.6.2 8 0.6.00 율흡캵횖 Recor

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ŧ SUMITOMO METAL INDUSTRIES,LTD. ADDRESS : Nu. 2-12-1, MINATOCHO, JOETSU CITY, NIIGATA PREF, JAPAN X 4 Position T: Top M: Middle X 5 Direction B: Bottom H: Hard S: Soft L: Longluddhal SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS;GOOD
(1) MECHANICAL PROPERTIES, YT, Y.S/T.S
*5 0.2%Y.S(MPa) T.S(MPa) EL(%) Manager of Quality System Section CC: Cb+ Ta+ Tl GC: Other Element Each HH: Other Element Total Remain: Remainder Bal : Balance cera A : Annealing Q : Quenching T : Tempering S : Solution Treatment Certified According to PED 97/23/EC Annex 1 T : 165Min-248Max, 240Min-410Max, 34Min L : 165Min-230Max, 240Min-410Max, 34Min : 165Min-230Max, 240Min-390Max, 45Min 34 NAOETSU WORKS I Y: 1.0% offset Yield Strength 2Y: 0.02% offset Yield Strength 3Y: 0.1% offset Yield Strength 4Y: 0.01% offset Yield Strength ER : Erichsen FC : Ferrite Coutent MP: Magetic Permeability NM: Non-Matalile Inclusion Test GS : Grain Size Section 4.3 by TUV ANLAGENTECHNIK GmbH Erichsen(10.5mm Min); T:12.4, B:12.2 ※ 3 Element Notes *1 Shape A ; Coil **%7 Heat Treatment** X 2 L. C X L : Ladle C : Check % 6 Test Item Date MAR. 12, 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination G00D D144940 Heat No. **INSPECTION CERTIFICATE** ₩3 Inspection No. а С 1285503 inspection Agency ณ * ~ NAR STAINLESS STEEL ST TITANIUM Witnessed by Remarks Condition & Finish BAL. BAL. (ి T;Total 3,375 ---4 E-4 Mass 0.58 0.68 0.58 0.72 Quantity kg ΕŻ % 9<u>%</u> Chemical Composition in 4.5 5. G ON MIST 5 [.] 2 ₩ 00 01.0 0.03 Bend е, 0 : m 0.030 0.002 Hardness Test Customer SPX FLOW TECHNOLOGY DANMARK A/S 0.600X 1254.0 X COIL. z Shape & Size 130 113 107 101 0.06 inch; feet; nm; space ASTM B265 GRADE 0.04 Reduction of Area 0 5 .0050 0.0040.0026 Elongation $(1)_{-}$ 11-AGNS-1244 Ħ Test 0.0500 YXNC0795 Crit 311 311 307 Tensile Strength U Tensile (7) 4Fa Specification & Type 4501134464 塗るし・ Мах Min ľ∦ A Yield Strength 0.2 % offeet 210 181 208 178 Case No. Certificate No. БЧ Heat Treatment P.O.No. EI EI â Min Max Ŋ, RILUE. 際に減増 4220 22122 agaa 2144 Recor

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Kemper County MM218131





Ŧ SUMITOMO METAL INDUSTRIES,LTD. ADDRESS : M. 2-12-1, MINATOCHO, JOETSU CITY, NIIGATA PREF. JAPAN X.4 Position T: Top M: Middle X.5 Direction B: Bottom T: Transverse H: Hard S: Soft L: Longitudinal * 3 Element e CC: Cb+ Ta+ Ti GG: Other Element Each HH: Other Element Total Rennin: Renniader Bal : Balance A transaction of the strength Manager of Quality System Section SPEC.NO.0041-1 REV.15, SURFACE ROUGHNDSS;GOOD
(1) MECHANICAL FROPERTIES, YT, Y.S/T.S
*5 0.2%Y.S(MFa) T.S(MPa) EL(%) kena Certified According to FED 97/23/EC Annex 1 **7**0 : 165Min-248Max, 240Min-410Max, 34Min
: 165Min-230Max, 240Min-390Max, 45Min NAOETSU WORKS Section 4.3 by TUV ANLAGENTECHNIK GmbH Erichsen(10.5mm Min); T:12.4 , E:12.2 Notes ※1 Shape A ; こう11 X 2 L. C X L : Ladle C : Check % 6 Test Item 2012. We hereby certify that the above results are true and correct in every details. Dimensional & Visual Examination 12. GOOD Date MAR. D144940 Heat No. **INSPECTION CERTIFICATE 8**楽 Inspection No. න ූ 1285503 nspection Agency NAR STAINLESS STEEL Witnessed by Ľ, ٤ Condition & Finish Remarks ST TITANIUM BAL. BAL. T;Total ᢅ᠅ 3,375 Mass اير. 11 0.58 0.58 0.72 0.68 0.70 Y ç % Chemical Composition in Quantity ₩8 4.5 с. Ю STM NO มา -มา 9<u>%</u> 02 0.03 Bend e G 0 U ; up 0.020 Hardness Test Customer SPX FLOW TECHNOLOGY DANMARK A/S Shape & Size \mathbb{Z} X COIL 130 113 011 107 107 inch; feet; m; space ASTN B265 GRADE 0.06 0.04 Reduction of Area -0.606X 1254.0 0.0500.0050 .0026 Elongation YXNC0795 11-AGNS-1244 10 20 34 ឆា កា 10 10 Test 0.0040 Unit Tensile Strength 311 314 -(1)Tensile Specification & Type MPa P.O.No. 4501134464 がるし Mi n Max ₩1 К, Yield Strength 0.2 % offset 230 208 0 7 7 0 181 Case No. Certificate No. S Heat T reatment *7 a) Lu * 54 Min 2 йц. (п. RIVER 3144 9888C BERG 后期日本 Recor





























INSPECTION CERTIFIES STELLER IN A STAINLESS STELLER IS TATANULUM STAINLESS STELLER IS TATANULUM STAINLESS STELLER IS TATANULUM IS TATAN	INSPECTION CERTIFI INSPECTION CERTIFI
NSPI Size Size <th>INSERTING TO A REAL AND A REAL AN</th>	INSERTING TO A REAL AND A REAL AN
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	INSPECTION CERTIFICATE SUMITOMO METAL INDUSTR NAOETSU WORKS ADDRESS : M. 2-12-1, MINATOCHO, JOE	NAR STAINLESS STEEL ST TITANIUM Date FEB. 29, 2012. 34	Condition & Finish 25 Notes #1 Shape A : Coil	Quantity Mass Inspection No. Heat No. Dressenate Vania	1 2,055 12BS502 D144938 G00D #2.L.C #3Ement L: Ladie CC: Ch+Th+Ti C: Check Filement Remain Remainder Remain Remainder	Composition in % *3 *1 T: Top M: Middle % 5 Direct	T1 Hard S : Soft L : Long	1V:10%offlet Yield Strength 21:00%offset Yield Strength 21:00%offset Yield Strength 31:01%offlet Yield Strength	4Y: 0.01% offset Yield Strength ER: Erichsen	Magnetic Permeability MM:Magnetic Permeability MM:Non-Metallic Inclusion Tet	Cos Curino Size 2. Cos Curino Size 2. A nata Size A Annealing Q : Quenching T : Prenpering S : Solution Treature	d *6 %6 Remarks	VI SPEC.NO.0041-1 REV.15, SURFACE ROUGHNESS, G (1) MECHANICAL PROPERTIES, YT, Y.S/T.S	ASTM ND *5 0.2%Y.S(MPa) T.S(MPa) EL(%)	4-5	E Certified According to PED 97/23/EC Annex	0.60 Erichsen(10.5mm Min), Tur 2 Build AmbH	5.5 0.72 TELEVILLE MAIN MAIN 11.11 1.12.3 , D: 12.4	0.60 Witnessed by	Inspection Agency	I Kent
۰. م	JUBU YXNC0795 Certificate No. 11-AGNS-1244 C Customer SDV F100 mBC11000000 D	P.O.No. 4501134464	Specification & Type ASTM B265 GRADE 1	No. Case No. #1 Unit inch ; feet ; an : space U; up		2 L Chemica	Min C C H O N	Max 0.0500.0050 0.06 0.030				*** Tensile Test Hardness B	4 5 Yatd Strength Tensile Bongation Reduction 0.2 % offset Strength of Area	MPa MPa % % HV	Min (1) (1) (1)	110 1 TT 220 308 34 110	TL 185 310 49 112	TARD BT 217 301 34 109	BL 184 305 49 109	Reviewed and Accepted to	Harri Transminer



SURFACE PREPARATION & PAINT REPORT

Customer:	Mississippi Power Company
PO #:	17352
Tag No.:	See Table
Project:	Kemper County IGCC Project
Project No.:	
APV Material number:	See Table
Paint System:	3 - Coat
Primer Coat:	Carbozinc 8071
Intermediate Coat:	Carboguard 8922
Finish Coat:	Carbothane 8815
Paint Procedure	1000816-821 PAINT

	Customer Tag No	SPX Material No
	CLCW HX, Unit 1	G2010000816
C	CLCW HX, Unit 2	G2010000817
4	CLCW HX, Unit 3	G2010000819
	CLCW HX, Unit 4	G2010000821
	CLCW HX, Unit 5	G2010000820
	CLCW HX, Spare Unit	G2010000818

Condition	Start of Blasting	Start of Primer	Start of Intermediate Coat	Start of Top Coat
Time	6.9~	90-	6 04	90
Ambient Temperature (°F)	76.7	77 6	73/2-	701
Relative Humidity (%)	151	623	68.9	et 2
Dew point Temperature (°F)	(4.3	63 8	62.7	67.4
Substrate Temperature (°F)	76.1	763	21.3	2618

BLAST	HE	AD	FOL	LOWER
	SIDE A	SIDE B	SIDE A	SIDE B
READING 1	2.7	2.0	2.1	2.6
SIDE A Tes SIDI	Testex PRESS-O-FILM T www.testextape.com tex PRESS-O-FILM T tex PRESS-O-FILM T 0.8 to 20	M TM HT Carse	Testex PRESS as (C+XC)/2 Testex PRESS-0 Testex PRESS-0 www.testextape.com	S-O-FILM TM HT Coarse 0.8 to 2.5 mil 20 to 64 µm 20 to 64 µm 4.5 mil 5 µm 5 µm 5 µm 6 bo 2.5 mil 20 to 64 µm 20
PRIMER	HEAD	FOLLOWER	25	115 μm 4.5 ml
allowable: 3.0-4.0	SIDE A / SIDE B	SIDE A / SIDE B		- 110
READING 1	3.21 3.5	3+136		
READING 2	2.31 2.2	2513,4		
READING 3	30120	24124		

INTERMEDIATE COAT	HEAD	FOLLOWER			
allowable: 5.0-6.0	SIDE A / SIDE B	SIDE A / SIDE B			
READING 1	6.01 5.8	5.41 5.4			
READING 2	5.81 5.6	5.41 5.5			
READING 3	59151	5.61 55			

TOP COAT	HEAD	FOLLOWER
allowable: 2.0-3.0	SIDE A / SIDE B	SIDE A / SIDE B
READING 1	2.2124	2.2/23
READING 2	20122	21/22
READING 3	2.2/2.4	24/ 8.2
Greg Eckard Mechanical Engineer / Contra Ll. II. G. C. C. C.	ct Administrator	Jo Tehl

Quality

Record

State State

lia Idan APV Coatings Technician

CONTFOLLED COPY COPY SEP 14 M2 NUMBER

CERTIFICATE OF TEST

Liquid Penetrant Examination Date: <u>9 24 2012</u>	1200 W. Ash Street P.O. Box 2046 Goldsboro, NC 27533-2046 Tel: 919-735-4570 Fax: 919-731-5443					
Customer Order Number (s)	Router Number(s) <u>417</u>					
Penetrant Method: Visible / Florescent	Penetrant Mfg. & Type: <u>P&R 9D/B</u>					
Light Meter ID : Calibration	Due Date: Foot Candles:75					
Procedure Number: 7 DOC 4004	Sensitivity Level:					
	Dwell Time: <u>S/10</u> (mins.)					
Plate Type:	Visual Booth Inspector:					
Material: <u> </u>	Employee Number: BOG					
Thickness:	Production Order Qty:					
Cast No(s):	Sample Size:					
Examination Results (sketch map defects i	f needed):					
Number of Good Plates:/ 2	_Number of Defective Plates:					
Comments:						

APV:TDOC 0910 Issue 3 01/04/2012



Quality Manager or Designee APPX 4005, A Rev. 03

APV Products Heat Transfer-Goldsborc

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SPX Flow Technology - APV Heat Transfer INSPECTION and MATERIAL CERTIFICATION

CUSTOMER	Mississippi Power	Order Number	27278535	DRWG NO.:	1000817 Rev 01
NB No.:	13879	Serial Number	G2010000817	CRN No.:	
Model:	S280 M-14	Quality Plan	YES	CE Stamp	

	MATERIAL SPECIFICATION AND HEAT CODES									
Component	Specification	Heat Number	Assembler							
Head	SA516 Gr70	415609640701	RO							
Follower	SA516 Gr70	457734-4-0201	10							
Tie Bars	SA193 Gr B7	2B202m, 21:452.00	10							
Tie Bar Nuts	SA194 Gr 2H	26200 2HB - FNL	KO							
Flanges										
Stubends										
Pipe										
Liners										
Tri-Clamp										
Grid										
Grounding	·	$\int \partial i d \partial \partial \rho d \sigma \sigma$								
Lug	SA36	<u>DLJ102559</u>								
Plates	SB265 Gr1	T2485, T2474, T2450, T2475, T2461, T2462, T2466	Rp.							
Plates		T2449, T2460, T2472, T2473								

Hydrostatic Test

Chamber	Pressure	Temp	Time (Min)	Gage #	Chart Rec #	APV	A.I.	3rd Party
H1 & H4	263	Ambient	BURNE TUTA	isty FACT	60163	10	Ν	
H3 & H2	263	Ambient	BU 1015-5	FAOSH	G0163	LP	MG10	15112
HISHY	(X S S	Ambient	Remainder	FAUSH	60163	10	Bio	15.12
43542	205	Ambient	Remanderise	FAJ	00163	LO	112	
		Ambient						
		Ambient						
		Ambient						
		Ambient			in the second			
		Ambient						
		Ambient					L	

APV

Quality

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APV: TDOC 0902 ISSUE 06

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	Manufactured and certified by SPX Flow Technology - APV Heat Transfer, 1200 W. Ash Street, Goldsboro, NC 27530 (Name and address of Manufacturer)														
2.	Manufactured 1	or _Mississi j	opi Power	Compa	ny, 2992 V	lest Bea	ach Boulevar	d, Gu	lfport	<u>, Ms. 3</u>	9501				
3.	Location of Ins	allation Miss	issippi Po	wer Co	mpany, 58	35 High	way 493, Del	(alb, l	<u>Ms. 39</u>	9328					
4.	Type: Vert. Heat Exchanger										(G2010	00081	7	
	(H	oriz. or vert., or sph	ere)	(Tank, separator, jkt. vessel, heat exh., etc.)						(Mfg.'s serial No.)					
	(CI	(Drawing	REV 01	(Nat'l. Bd. No	(Nat'l. Bd. No.)			2012							
5.	ASME Code, S	ection VIII, Div	.1	20	07/2009		N/	Α				·			
Itoms	6-11 incl to b	completed fo	l r single wall ve	dition and A	ddenda (date)	ted vessel	Code Case	No.	ore or	S	pecial Servi	ce per L	JG 120(d)		
6. S	Shell (a) No	of course(s):	no s	nell	(b) (b)	Dverall len	gth (ft & in.):	kchang	ers, or	champer	of multi-t	Jnamu	ber vess	eis.	
r															
No	Course(s)		Material		Thickness	Long. Joint (Cat. A)		Eff Type		Circum: Joint (Cat. A, B, & C))	Heat Tr	Time
	pianotor, in:	Longar (it a int)		1,00		1,000		E.I.	Type					remp.	Talle
L															
7.	Heads: (a) S	A516-70 He	ad, Fixed				(b) SA51	6-70	Head.	Movea	able				
r	·····	(Mat'l	Spec. No., Grade	ог Туре) Н.Т	- Time & Temp.		_ (*)		(Mat'l Sp	bec. No., Gr	ade or Type) H.T. ~ `	Time & Ter	np	
	Location (1 Bottom En	op Thickne	ess Corr Crow	Radius Knuc	Elliptical kle Ratio	Coni Agex A	cal Hemispherical ngle Radius	F Dia	lat meter	Side to	Pressure	Туре	Categ	ory A	Fff
(a	a) END	4.226"	0.0"		inter i tranto		rigio ritualas	57")	(148"		Concure	1,700	T dil, Op		
(t	D) END	3.97"	0.0"					57")	(142"						
If rem	novable, bolts u	sed (describe	other fastening	s) Bolts	<u>s 20 SA 19</u>	3-B7 M4	18, Nuts 40 S	<u>A 194</u>	-2H N	148					
9.	MAWP 175/	475						(gee a weia,		If bol	ted des	cribe or	sketch
10.	Impact test BC	lting, Impac	psi at max	. temp. r fig. U(150 (internal) CS-66(e)	(external)	°F ۸	1in. des	sign me at	tal temp.	-20	If boli ire of	ted, des °F at	cribe or 175/1	sketch. 75 psi °F
10. 11	Impact test BC	iting, Impac	psi at max	. temp.	150 (internal) CS-66(e) (Indicate yes of	(external) or <i>n</i> o and the	°F N	fin. des	sign me at	test ter	-20	If boli ire of	ted, des °F at	cribe or 175/1	sketch. <u>75</u> psi °F
10. 11. Items	Impact test <u>Bc</u> Hydro., pneu.,	iting, Impac	psi at max	. temp. r fig. U(263 ps	150 (internal) CS-66(e) (Indicate yes o	(external) or <i>n</i> o and the oof test	°F M	fin. des	sign me at	test ter	-20	If boli ire of	ted, des °F at	cribe or 175/1	sketch. 75 psi °F
10. 11. Items 12.	Impact test <u>BC</u> Hydro., pneu., s 12 and 13 to t Tubesheet:	iting, Impac or comb. test j e completed fo	psi at max	. temp. r fig. U(263 ps s.	150 (internal) CS-66(e) (Indicate yes of 51 Pr	(external) or no and the oof test	°F M	fin. des	sign me at	test ter	-20	If boli ire of	ted, des °F at	cribe or 175/1	sketch. 75 psi °F
10. 11. Items 12.	Impact test <u>BC</u> Hydro., pneu., s 12 and 13 to t Tubesheet:	(external) (external) (iting, Impac or comb. test (e completed for Stationary (Mat ¹)	psi at max	. temp. Ir fig. U(263 ps s. S.	150 (internal) CS-66(e) (Indicate yes o 5 Pr ect to press.)	(external) or no and the oof test Nor	°F M	Ain. des tested)	sign me at	test ter	0	If boli	ted, des °F at	d or bolted	sketch. 75 psi _ °F
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(Mat'l Spec. No., Grade, size, No.)



						FORM U	-1 (Back)					
16. MAV	VP		p	osi at max. ten	np.	°F Min. design metal				np.	psi	
	(interna	al) -	(external)		(internal)	(external)					·····	
17. Impa	ict test								at test	temperatu	ire of	•F
					(Indicate	e yes or no and t	he components(s) impact tested	d)			
18. Hydr	o., pneu., o	or com	b. test press			Proof test						
19. Nozz	les, inspec	ction, a	ind safety va	lve openings:								
Purpos	se (Inlet		Diameter	Flange	Mate	rial	Nozzie T	hickness	Reinforcement	How A	tached	Location
Outlet, D	rain, etc.)	No.	or Size	Туре	Nozzle	Flange	Nom.	Corr.	Material	Nozzle	Flange	(Insp. Open.)
INI	ET	2	20"	MACH'D		v			NONE			HEAD
OUT		2	20"	MACH'D					NONE			HEAD
				1								
												+
				++								
			···	<u>+</u> +		·						
				1ł	L			L	- I		L	J
20. Supp	orts: Skirt	r	io Lug	gs O	Legs	0	Others	1	Feet	Attached	Head	, Bolted
		(yes o	no)	(No.)		(No.)		(Des	cribe)	-	(Where	and how)
22. Rem	narks: He	ads,	Impact ex	cempt per	UCS 66 (3)	(a), Fixed	Head to	Movable	head distan	ce 107-7/8	"	
He	eat trans	iter p	lates, Mat	1 SB265 G	ir1, .024" t	nick, qty (609, Impa	ct exem	pt per UNF 6	5		
						0711500						
	RESSUR	ERE	LIEF DEV	ICES SUP	PLIED BY	OTHERS	PER UG-	125 (A)				
We certif Code for U Certific Date _/	ty that the si Pressure V cate Authori D / / C /	tateme /essels ization /2_	nts made in t , Section VIII, No. <u>27,8</u> Name <u>SPX</u>	his report are c Division 1. <u>69</u> Expire: Flow Tect	CERTIFIC correct and that s July 15, 20 hnology - A	CATE OF t all details of 015. NPV Heat	SHOP CO design, mate Transfer	Signed	CE ction, and workma	nship of this v	vessel confor	n to the ASME
				(N	Manufacturer)					(Representativ	e)	
					CERTIF	ICATE OF	SHOP IN	SPECTIO	N			
I, the un	dersigned,	holding	g a valid com	nmission issue	d by the Natio	onal Board o	f Boiler and	Pressure V	essel Inspectors	and/or the St	tate or Provi	nce of <u>North</u>
Carolir vessel d construct warranty, liable in a Date	and en escribed ir ed this pres expressed ny manner	nployed ssure v or imp for any	d by <u>HSE</u> Manufacturer vessel in acco lied, concernin personal inici signed	r's Data Repo ordance with A ng the pressure ry or property.	ort on/ SME Code, Si e vessel descri damage or a b	i C / i ection VIII, Di bed in this Ma ss of any kind	, and state vision 1. By anufacturer's arising from Commissions (N	of e that, to ti signing this Data Report or connector	Hartford Cor he best of my l certificate neither Furthermore, ne d with this Inspect	necticut nowledge an the Inspector on.	have inspect d belief, the f nor his emp ector nor his e	cted the pressure Manufacturer has loyer makes any employer shall be
			, <u>,</u>	CEF	RTIFICATE	OF FIELD	ASSEMB	LY COM	PLIANCE			********
We certify Section	y that the s /III, Division	tateme	nts on this re	port are correct	t and that the fi	eld assembly	construction	of all parts o	f this vessel confo	rms with the n	equirements o	of ASME Code,
Det:		zation	NO		Expires	<u></u>						
Date	//_		INdi 118	(Assembler)		Sigr	ieu	/Do				
							ACCENT					
I, the unc	lersigned, h 1 by	olding	a valid comm	ission issued b	by the National	Board of Boik	er and Pressu of	ure Vessel Ir	ISPECTOR and/or the sectors and/or the sectors and sec	ne State or Pr	ovince of	and
compare	d the sta	tement	s in this N	Manufacturer's	Data Report not included i	t with the in the certifica	described p te of shop ins	ressure ve pection, hav	essel and state ve been inspected	that parts by me and to	referred to the best of m	as data items y knowledge and
and subj	- manufacti	nei nas	s constructed	anu assembled	u mispressure nsi Ru	vessei in acci	broance with	ASME Code	e, section VIII, Div	ision 1. The d	escribed vess	horbordan actual
for any p	ected to a concerning ersonal inju	the pre iry or p	roperty damag	described in t ge or a loss of a	his Manufactur any kind arising	y signing this rer's Data Re g from or conr	certificate ne port. Further lected with th	either the Ins more, neithe is inspection	spector nor his er er the Inspector no 1.	nployer make or his employe	es any warrar er shall be liab	ity, expressed or ble in any manner
for any p	ected to a concerning ersonal inju	the pre iry or p Sic	roperty damag	described in t ge or a loss of a	his Manufactur any kind arising	y signing this rer's Data Re g from or conn Cor	certificate ne port. Further lected with th	either the Ins more, neithe is inspection	spector nor his er er the Inspector no 1.	nployer make or his employe	s any warrar er shall be liat	ity, expressed or le in any manner




ASA Sector Mill Dv. 1:2007 Editor 2009 Add Contract No. - (7352 Furthesen Equipment No. Cripty Weight : 57697 LBS Tegt : CLOW HX: Operating Unit 2





PROJECT: Kemper County IGCC Project Project Location: Dekalb, MS CLIENT: Mississippi Power Company TAG No: Below P.O. No: 17352

DESCRIPTION: S280 M-14 Plate and Frame Heat Exchanger

SUPPLIER: SPX Flow Technology Systems, Inc. WORKS ORDER No: SEE BELOW

Quality

Recoi

00 5/19/2011 GJE REVISION No: DATE: Щ. Н

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REQUIREMENT	CHARACTERISTICS	CONTROL PROCEDURES	VERIFICATION	AF	~	CUSTO	MER	
	TO BE VERIFIED	& ACCEPTANCE CRITERIA	DOCUMENTATION	CODE	SIGN	CODE S	NGN	
Approved Inspection & Test Plan	Purchase Order- Adherence	Inspection & Test Plan	Signed ITP	3	100%	N/A		
Receive material & inspect against	Visual & dimensional	APV Documentation	Test Certification	3	172	N/A		
material test certificates	& Chemical	TDOC 0012 lssue 12		₩	Ş			
	Composition							
	Against Specification				·			
Material dimensions & markings	Visual & dimensional	APV Drawings	ISO Manual	3	NA	N/A	Γ	
Prefabrication meeting - 10 day notice	Purchase Order	Inspection & Test Plan	Signed ITP	3	IN :	N/A		
	Adherence				VE			
Cut coil to length	Visual & dimensional	APV Documentation	Quality control &	×	1	N/A		
	against specification	APV 3456	Material Certification		- VIN			
Press & dimensional check first	Visual & dimensional	APV Documentation	Quality control log book	3		N/A		
off plate	against specification	TDOC 0018 Issue 06	& SAP transaction		Sile I			_
Press plates	Visual & dimensional	Routing	SAP transaction	3		A/N	240	f
	& Chemical				MA			2
	Composition Against						0	3
	Specification						-	
Apply gaskets to plates	Visual & dimensional	APV Documentation	SAP transaction	3	7/"	N/A		
	against specification	APV 3181			() L			12010
Fabricate frame components	Visual & dimensional	APV Detail Drawings	Routings &	3	67	R		1 . 11
	against specification		SAP transaction		1 M			
Dye pen test liner welds	Visual against	Per specification 1000816-821 NDE	Routings &	3		X		
	specification		SAP transaction		RU			
	Approved Inspection & Test Plan Receive material & inspect against material test certificates Material dimensions & markings Prefabrication meeting - 10 day notice Cut coil to length Cut coil to length Press & dimensional check first Of plate Press plates Press plates Apply gaskets to plates Fabricate frame components Dye pen test liner welds	Tobal Section & Test Plan TO BE VERIFIED Approved Inspection & Test Plan Purchase Order Receive material & inspect against Visual & dimensional material test certificates & Chemical material dimensions & markings Visual & dimensional Material dimensions & markings Visual & dimensional Prefabrication Against Composition Against Material dimensions & markings Visual & dimensional Prefabrication Nisual & dimensional Prefabrication Visual & dimensional Press & dimensional check first Visual & dimensional off plate Visual & dimensional Press plates Visual & dimensional Apply gaskets to plates Visual & dimensional Apply gaskets to plates Visual & dimensional Press plates Visual & dimensional Boricate frame components Visual & dimensional Press plates Visual & dimensional Boricate frame components Visual & dimensional Boricate frame components Visual & dimensional Boricate frame components Visual against specification Dye pen test	Approved Inspection & Test Plan CONTROCT CRUTERIA Approved Inspection & Test Plan Adherence Inspection & Test Plan Receive material & inspect against Visual & dimensional APV Documentation Receive material & inspect against Visual & dimensional APV Documentation material test certificates Composition A Chemical TDOC 0012 Issue 12 Material dimensions & markings Visual & dimensional APV Drawings Inspection & Test Plan Material dimensions & markings Visual & dimensional APV Drawings Inspection & Test Plan Prefabrication meeting - 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REVISION No: DATE: BY:

> PROJECT: Kemper County IGCC Project Project Location: Dekalb, MS

CLIENT: Mississippi Power Company P.O. No: 17352 TAG No: Below

DESCRIPTION: **S280 M-14 Plate and Frame Heat Exchanger** SUPPLIER: **SPX Flow Technology Systems, Inc.** WORKS ORDER No: **SEE BELOW** SUPPLIER CONTACT: INSPECTION AUTHORITY: **Hartford Steamboiler**

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Customer

Record

H- Hold Point, W - Witness Point, R - Review Documentation, N - Notification V - Verification

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Doc. No.:100816-821 ITP

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Approved

DESCRIPTION: S280 M-14 Plate and Frame Heat Exchanger SUPPLIER CONTACT: INSPECTION AUTHORITY: Hartford Steamboiler SUPPLIER: SPX Flow Technology Systems, Inc. WORKS ORDER No: SEE BELOW Customer

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5/19/2011 GJE

REVISION No: DATE: BY:

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Assemble heat exchangers &	Visual & dimensional	APV Documentation APV3181	SAP transaction	3	¢	N/A	
dimensional checks	against specification				≽		
Hydrostatic pressure test	Integrity of assembled	ASME VIII Div 1, 2007 Edition,	Test certification	≥	(N	1
W/ Chart recorder	unit	2009 Addenda	ASME U-1 data report	<u> </u>	2		
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code stamp					Ĺ		
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Review final documentation package:	All documents	Purchase order required	Final Documentation	≥		Т	
ASME U-1 data report, material test	complete	documentation		_			
certificates, Shop traveler, nameplate				<u> </u>	S.		

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Inspection & Test Plan

Inspection Release

Release by Inspector required

facsimile

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prior to shipment

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Instruction Manual Paraflow Plate Heat Exchanger







Read and understand this manual prior to operating or servicing this productuality

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1.0 INTRODUCTION

1.1 General

The purpose of this manual is to provide you with the information necessary for the safe and proper installation, operation and maintenance of your APV Paraflow Plate Heat Exchanger. This will ensure many years of satisfactory performance. The manual is specific to the tie bar tightened frames. Separate publications deal with Paraflow Plate Heat Exchangers tightened by other means.

1.2 Safety

Safe installation, operation and maintenance of the APV Paraflow Plate Heat Exchanger requires proper procedures and training of all personnel. Section 2.0 Safety Instructions should be read and understood before proceeding. This section discusses general safety practices. In addition, specific hazards are indicated throughout this manual by the appropriate hazard label in bold type.

Warning:

Read and understand the entire manual before unpacking the equipment and installing it.

It is the objective of APV to clearly identify each area of potential hazard and guide workers in safe operation, service and maintenance procedures.

1.3 Design

The Paraflow is the original plate type heat exchanger designed by APV to provide maximum efficiency and cost effectiveness in handling heat transfer duties. The basic concept is two liquids flowing on either side of a thin corrugated metal plate so heat may be easily transferred between the two. The plate heat exchanger also minimizes maintenance downtime and requires little floor space compared to other types of heat transfer equipment. This equipment has many applications in a wide range of industries. Typical industries include:

Chemical	Dairy
Industrial	Beverage
Petroleum	Liquid Food
HVAC	Pharmaceutical
Refrigeration	Health Care

1.4 Receiving and Inspection

APV Paraflow Plate Heat Exchangers are assembled and inspected before shipment and properly prepared for transportation. APV cannot, however, guarantee safe arrival. Therefore, upon receipt of this equipment, check all received items against the packing list for damage or missing parts. Damage or loss should be reported immediately to the carrier.



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2.0 SAFETY INSTRUCTIONS

2.1 General Statement

APV Paraflow Plate Heat Exchangers are designed and manufactured with due consideration and care for generally accepted safety standards. However, like any mechanical device, the proper and safe performance of this equipment depends upon using sound and prudent operating, maintenance and servicing procedures under properly trained supervision.

For your protection, and the protection of others, learn and always follow the safety rules outlined in this section. Observe warning signs on machines and act accordingly. Form safe working habits by reading the rules and abiding by them. Keep this booklet handy and review it from time to time to refresh your understanding of the rules.

2.2 Hazard Level Identification

Definitions for identifying the various hazard levels shown on warning labels or to indicate proper safety procedures in the instruction manual are provided in the following labels.

Danger:

The use of the word "Danger" always signifies an immediate hazard with a high likelihood of severe personal injury or death if instructions, including recommended precautions, are not followed.

Warning:

The use of the word "Warning" signifies the presence of hazards or unsafe practices that could result in severe personal injury or death if instructions, including recommended precautions, are not followed.

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Caution:

The use of the word "Caution" always signifies possible hazards that could result in minor injury or damage to product or property if instructions, including recommended precautions, are not followed.

2.3 Operating Zone

An operating zone should be established around all heat exchangers. A brightly painted guard rail or warning stripe should define the zone. Only the operator or other authorized personnel should be within the operating zone when machine control circuits are energized or the heat exchanger is operating. No tools or other equipment should be kept within the operating zone.

2.4 Installation

Utilities, such as water, steam, electric, air and hydraulic, should be installed by trained and authorized personnel only. Installations must comply with all applicable codes and standards, including those established by OSHA.

2.5 Safety Instructions

Before Starting a Machine

Be absolutely positive all necessary guards and safety devices are installed and operating properly. This includes spray screen or pressure relief devices.

Be sure all personnel are clear of the machine.

Remove (from the operating zone) any materials, tools or other foreign objects that could cause injury to personnel or damage the machine.

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Make certain all alarms, indicating lights, pressure gauges and other safety devices or indicators are in working order.

After Shutdown

Make certain all water, steam, air, hydraulic and electric utilities are turned off. Make certain all pressure in the heat exchanger is released.

2.6 General Operating Safety

Do not operate this heat exchanger until you read and understand the operating instructions and become thoroughly familiar with the heat exchanger and its operation.

Never operate a heat exchanger while a safety device or guard is removed or disconnected.

Always wear safety glasses, hats, shoes, ear protection or any other required safety equipment.

Never remove "Warning" tags that are displayed on the heat exchanger. Torn or worn labels should be replaced.

Do not start the heat exchanger until all other personnel in the area have been warned and have moved outside the operating zone.

Remove any tools or other foreign objects from the operating zone before starting.

Absolutely do not have loose clothing, neckties, necklaces or unrestrained long hair near an operating heat exchanger.

Do not wear gloves, rings, watches, bracelets or other jewelry near an operating heat exchanger.

Keep the operating zone free of obstacles that could cause a person to trip or fall towards an operating heat exchanger.

Never sit or stand on anything that might cause you to fall against the heat exchanger.

"Horseplay" around a heat exchanger at any time is dangerous and prohibited.

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Know the EMERGENCY STOP procedure for the machine.

Never operate the machine above specified capacity, pressures or temperatures.

Keep alert and observe indicator lights and warnings that are displayed on the heat exchanger.

Do not operate faulty or damaged equipment. Make certain proper service and maintenance procedures have been performed.

A safe work surface should be provided around the heat exchanger, including proper guarding of elevated platforms and the design and use of ladders.

2.7 Service and Maintenance Safety

Do not service a heat exchanger until you are thoroughly qualified and familiar with the tasks to be performed.

Never operate any valves, pumps or controls while persons are performing maintenance on the heat exchanger.

Do not bypass a safety device.

Always use the proper tool for the job.

Do not enter a confined space without first checking for toxic fumes and providing standby personnel on the site.

2.8 Safe Cleaning Procedures

Manual Cleaning Procedures

Do not use toxic or flammable solvents to clean a heat exchanger.

Always clean up spills around heat exchanger as soon as possible.

Never attempt to clean a heat exchanger while it is operating.

Cleaning In Place Procedures

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Make certain all connections in the cleaning circuit are tight to avoid contact with hot water or cleaning solutions.

When the cleaning cycle is controlled from a remote or automated control center, establish fail safe procedures to avoid automatic start up while servicing equipment in the circuit.

On equipment that includes heat shields, make certain the shields are properly installed prior to starting the cleaning cycle (see Paragraph 4.8 and 9.3).

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3.0 **CONSTRUCTION** 3.1 Frame A typical Paraflow Plate Heat Exchanger is shown in Figure 1. Figure 2 is an exploded view showing the individual components. The main components include a stationary cover (head), Item 1, an end support, Item 2, connected by a top carrying bar, Item 3, and bottom guide rail, Item 4. These components are bolted together to form a rigid frame that supports the thin metal heat transfer plates, Item 5, and moveable cover (or follower), Item 6. Each plate is separated and sealed by a gasket. The plates are compressed between the head and follower by means of tie bars, Item 7 on either side Figure 1 of the exchanger. Liquids are introduced to the heat exchanger through connections located in the head, follower or intermediate connector grids, when supplied (as shown in Figure 3 on page 10). **Top Carrying Bar** (3 **End Support** 2 **Heat Transfer** Plates Head 6 Follower 6⁹⁸ **Tie Bars** Bottom Bar s∰ Figure 2 Issue 5 Section 3.0 Qualit June 13, 2008 Page 9 of 36 lecoi

When Paraflow Plate Heat Exchangers are opened for service, the follower moves back along the top bar to allow full access to each individual plate. Divider plates and intermediate connector grids also move freely on the top carrying bar to provide easy access to individual plates.

Paraflow frames used in industrial duties are fabricated in carbon steel and are finished in a heavy duty chemical resistant paint. Industrial frame connections may be studded with various lining materials or nozzles. The nozzles are fabricated in carbon steel, stainless steel or alternate metals. Connection types may be lap-joint, weld neck or specialty flanges. Sanitary tube connections may also be supplied on carbon steel frames. The connection materials and types may be mixed on an individual frame. Frames used for sanitary duties are usually fabricated in solid stainless steel or carbon steel that is entirely clad with stainless steel. The finish is either a #4 polish or glass bead blast depending on the model. Standard connections are sanitary tube fittings at all locations. Industrial fittings may be supplied when required.

Divider plates may be used to divide a heat exchanger into separate operating sections. Divider plates have no connections but may allow flow from one section to the next.

Intermediate connector grids as shown in **Figure 3** may be used to divide a heat exchanger into separate sections to accommodate multiple duties within a single frame. Connector grids may have up to two connections at any corner.



3.2 Plates

APV heat exchanger plates come in over 60 different sizes and 34 different corrugation patterns. This allows the heat exchanger to be matched closely to a specific duty. The corrugations cause turbulence in the liquids as they flow in a thin stream in the passage between each plate (Figure 4). The plates have ports in each corner that, when stacked in a plate pack, form a manifold for even fluid distribution to the individual plate passages (Figure 5). The ports are gasketed so only two ports on each plate allow flow across the plate (flow ports). The other two ports are through ports and do not allow the liquid flowing in them across the plate. This flow pattern is alternated from plate to plate to form right hand plates and left hand plates.





Figure 5

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Plate Construction

All plates are designated as either diagonal flow or vertical flow (Figure 6) based on their flow pattern. Plates are pressed in thicknesses between 0.4 - 1.2 mm (0.016 and 0.047 inches) in a variety of materials (see Plate Materials below). The plate corrugation pattern alternates from plate to plate to provide support at the points of contact. One type of corrugation pattern looks like a washboard. It provides a wide gap between plates with contact points about every 1 to 3 square inch of heat transfer surface area.



Another design is the chevron pattern of relatively shallow corrugations with support provided at peak/peak contact. Alternate plates are arranged so that corrugations cross to provide contact points for every 0.2 to 1 square inch of surface. This greater density of contact points in the chevron pattern allows a higher differential operating pressure for a given plate thickness than the washboard pattern.

Mixing Plates

To obtain optimum thermal and pressure drop performance while using a minimum number of heat exchanger plates, plates of two or more corrugation angles may be mixed within the same frame. This is

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available for many APV Paraflow Plate Heat Exchanger models.

Mixing plate angles results in flow passages that differ significantly in their flow characteristics. This allows the Paraflow design to be fine tuned in a single or even multiple pass arrangement to closely match to the thermal and pressure drop requirements of the application.

Plate Material

Paraflow plates may be pressed from 304 or 316 stainless steel, Avesta 254SMO or 254SLX, Nickel 200, Hastelloy B-2, C-276 or G-3, Incoloy 825, Inconel 625, Monel 400, Titanium, Titanium-Palladium or other specialty alloys as required to provide suitable corrosion resistance to the liquids being handled.

Duo-Safety Plate

The APV Duo-Safety heat exchanger plate is a double wall plate manufactured from two loose plates pressed together at the same time to form a pair. Each APV Duo-Safety plate pair is equipped with a non-glue Paraclip gasket, which seals and holds the pair together.

The space between the two plates of the APV Duo-Safety plate pair serves as a safety zone in case of through-plate leaks from corrosion or wear. Should this occur, the liquids will not be mixed, but will be discharged between the two walls into the atmosphere. This provides a high level of certainty that liquids will not be cross contaminated. The APV Duo-Safety plate pair also can be dismantled for cleaning between the two plate walls.

Paraweld Plate

The APV Paraweld plate is a right and left hand plate laser welded together to form a plate pair. This welded plate is particularly suited for use with refrigerants such as ammonia and Freon, or aggressive liquids that would otherwise attack the gaskets in a conventional heat exchanger plate.

When the welded pairs are installed in a frame, each pair is separated by elastomeric seals.

3.3 Gaskets

The seal between the plates is achieved by a single gasket around the perimeter of the plate and a double gasket around the two through ports. This double gasket separates the port from the heat transfer area with a double barrier. The space between the double gasket is vented to atmosphere to prevent cross contamination. (Figure 7).



Figure 7

Interlocking Gaskets

APV Paraflow Plate Heat Exchanger plates have interlocking gaskets with upstanding lugs and scallops evenly spaced around the outside edges. These scallops ensure that there are no unsupported portions of the gaskets and, in combination with the patented form of the pressed groove, provide mechanical plate-to-plate support for the sealing systems. The upstanding lugs (Figure 8) maintain plate alignment in the Paraflow during plate pack closure and operation. The groove form provides 100% peripheral support of the gasket, leaving none of the material exposed to the outside. In addition, the gasket exposure to the process liquid is minimized by the full depth plate gasket groove.



Figure 8

Gasket Materials

As detailed in Figure 9, various gasket materials are available as standard which provide chemical and temperature resistance coupled with excellent sealing properties. Other gasket materials are available for special applications. Gasket material selection must take into consideration the chemical composition of the fluids involved as well as the operating conditions.

Materials	Application	
Paracil	General Purpose material for aqueous	
	and fatty duties	
EPDM	High temperature general purpose	
	material for chemical and steam	
	applications	
Paraflor	Mineral oils, acids, steam and hot water	
	at high temperatures	
Paradur	Organic solvents, chemicals and sulfuric	
	acid	
Paraprene	Refrigeration duties with ammonia and	
(Neoprene)	freon.	
Figure 0		

Figure 9

Gasket Attachment

APV Paraflow Plate Heat Exchanger gaskets are attached to individual plates by one of two methods, glued or clip in. The glued in gaskets are attached by a thermoplastic adhesive which is heat cured for maximum strength.

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The clip in gaskets (Paraclip) are attached to the plates by small nubs around the perimeter of the gasket which snap into matching holes.

3.4 Intermediate Connector Grids

These intermediate connector grids divide the plate heat exchanger into separate sections that may operate independently. The connector grids are equipped with removable connector bosses (Figure 10) that provide connections for the liquids handled.



Figure 10

The connector grid bosses form the connecting link between sections of the plate heat exchanger and provide connections to and from these sections. On some models, two connections can be provided in the same connector grid boss with connections to the adjoining sections.

3.5 General Arrangement Drawing

A General Arrangement Drawing is supplied with each APV Paraflow Plate Heat Exchanger. This drawing provides detailed information concerning design specifications, operating conditions, dimensions, connections, plates and gaskets, plate arrangement diagram and key, bill of material and special notes.

Design Specifications

The data list on the design specifications provides the key mechanical information used to design the plate heat exchanger. This includes the design code, maximum allowable working pressure and temperature, maximum and minimum platage

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dimensions, heat transfer area, frame size, maximum plate capacity, weights and volume.

Operating Conditions

This table on the drawing contains the duty or operating conditions for which the heat exchanger was designed. It specifies each fluid, the flow rates, the temperatures and the pressure drops.

Connection Schedule

The connection schedule identifies the size, material and type of each connection supplied.

Plate and Gasket List

Each general arrangement drawing contains a summary of all the plates and gaskets used for the plate arrangement. This summary includes plate types, angles and material, and also gasket type, material and attachment (glued or clip in).

3.6 Plate Arrangement Diagram

Configuration of the Diagram

The plate heat exchanger is designed to perform a duty (or duties) by arranging the number and type of plates required in a specific sequence. This arrangement is represented schematically by the plate diagram shown on the general arrangement drawing. The schematic represents the fluid flows by heavy lines with arrows and the plates by thin vertical lines. Plate ports that block flow (not open) are represented by small black rectangles.

Each connection on the plate diagram is identified and labeled. The connections are also identified on the dimensioned view or the isometric view of the plate heat exchanger and the Connection Schedule.

Along the top of this diagram is a listing of each plate required, showing the hand of each plate (Right or Left), the direction the gaskets face (Head or Follower) and the punch code (blanking designation). The punch code indicates which ports are open and allow flow. Additional codes may be listed indicating plates with drains (D) and vents (V) or plates with end gaskets (K). Other symbols may be used to indicate special support pads or gaskets. The general arrangement drawing includes a key which illustrates the punch codes. The punch codes are also illustrated on the following pages in Figure 11 for vertical flow plates and Figure 12 for diagonal flow plates.



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IMPORTANT NOTICE:

The standard conventions for identifying plates and showing the plate arrangement diagram have changed effective August 11, 1997.

The plate punch code will use The five character code as shown In Figure 11 or 12. The equivalent three character code is shown for reference. The position are numbered as shown in the sketch on the right. The complete plate identification number is constructed as follows:





- R = RIGHT HAND PLATE, L = LEFT HAND PLATE

The plate arrangement and all general arrangement drawing will now show the head or fixed cover on the left. Frame connections are labeled with an H (head) of F (follower) and a number corresponding to the position.



Connection grids are labeled with a G plus a number with 1 being the first grid from the head. Grid connections are labeled as follows:



These labels are shown in the picture below and examples of the plate arrangements are shown on the following page.



Examples

Figure 13 shows a typical single pass arrangement using diagonal flow plates with all the connections on the head.

Note:

PLATES MUST BE ARRANGED ALTERNATELY LEFT AND RIGHT. FOR CONVENIENCE ON THE DRAWING, WHERE BLOCKS OF R1234 AND L1234 PLATES OCCURS, THE TOTAL NUMBER OF EACH IS GIVEN

Figure 14 shows a two-section arrangement with connections on the head, follower and connector grid. It also shows the use of the special codes to indicate drain plates (D), support pads (P) and seal plates (S) typical for an SR6 plate.





4.0 INSTALLATION

4.1 Location

The heat exchanger should be installed in an area with adequate clearance around the unit to install or remove plates and perform maintenance.

The unit should also be located with consideration for the required piping connections. Product and service lines should be designed to minimize pressure drops and be adequately supported to minimize the loads on the heat exchanger.

4.2 Foundations

The foundation pad for the heat exchanger should be level and sized properly for the outline of the frame. It must also be of adequate strength to support the full operating weight of the unit. The overall dimensions and operating weight are listed on the general arrangement drawing.

4.3 Space Requirements

On at least one side of the plate heat exchanger there must be sufficient clearance to remove a plate from the top bar. Also, there must be adequate room to tighten or remove the tie bars and inspect the plate heat exchanger (Figure 15). The follower must be free to move along the full length of the top bar as shown in (Figure 16). The general arrangement drawing provides overall dimensions and plate removal distance.



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4.4 Connections and Piping

The plate heat exchanger must be connected in accordance with the arrangement shown on the general arrangement drawing provided with the heat exchanger.

Pipe lines to the follower and connector grid(s) must be located to allow the unit to be easily opened for inspection and maintenance. These lines must also be flexible to allow for small variations in the tightening dimensions and possible thermal expansion.

4.5 Pressure Pulsation and Vibration

Piston pumps, gear pumps, valves etc. must not be able to transfer pressure pulsations or vibrations to the plate heat exchanger as this may cause fatigue fracture in the plates. The use of pressure dampers in the pipeline is recommended to minimize this effect.

4.6 Pressure / Temperature Ratings

The pressure and temperature ratings for a specific heat exchanger are listed on the general arrangement drawing provided with the unit. These ratings must not be exceeded at any time during startup or operation.

Over pressure protection must be provided if it is possible the system may develop a higher pressure than the maximum allowable working pressure of the heat exchanger.

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Warning:

Do not exceed the maximum operating pressure or temperature listed on the General Arrangement Drawing or damage to the heat exchanger will result.

4.7 Hydraulic Shock

The plate heat exchanger will be damaged by any hydraulic shock that occurs during start up or operating changes. To avoid damage, throttling valves and soft pump starts are recommended.

4.8 Spray Screen

A spray screen may be provided for new or existing heat exchangers. They are recommended whenever corrosive liquids or high temperatures are present. See Section 9.0 Accessories for more information.

4.9 Short Term Storage

All heat exchangers and components must be stored in a cool environment away from sunlight. They must also be covered loosely by a tarp or plastic sheet that allows air circulation and provides protection from water, debris and sunlight. This procedure is suitable when the storage period is less than six months.

4.10 Long Term Storage

Long term storage of APV Plate Heat Exchangers requires following Procedure SP5002 to avoid damage or deterioration. This procedure should be used when a heat exchanger will not be placed in service within six months after shipment from the factory. This procedure should also be used when an installed heat exchanger will be out of service for more than six months. Contact the Customer Service Department listed in Section 8.0 of this manual for copies of the procedure and assistance.

Caution:

A heat exchanger which has been in storage for more than five (5) years should be inspected by an APV representative prior to preparing it for operation.

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5.0 ASSEMBLY

5.1 Handling

APV Paraflow Plate Heat Exchangers are shipped fully assembled and skid mounted, or when required, they are shipped unassembled in boxes. In either case, proper handling practices must be followed. The weight of an assembled heat exchanger is listed on the general arrangement drawing. Weights of components are listed on the shipping box. The skids and boxes are designed to be moved by standard lift trucks of proper capacity.

5.2 Lifting

All APV heat exchangers are provided with lifting holes, lugs or eyebolts to simplify lifting. The general arrangement drawing shows their size and location. When lifting an assembled heat exchanger frame, ensure that the lifting point is approximately above the center of the plate pack. A spreader beam is recommended for large or long frames.

Warning:

All lifting equipment must have the proper capacity and be in good condition. Personnel must follow safe rigging practices at all times.

5.3 Assembling the Frame

Caution:

All components must be properly supported during all phases of assembly.

The following steps are recommended to safely assemble an APV heat exchanger. These instructions refer to the components illustrated in Figure 2 in Section 3.0.

When assembling a heat exchanger frame, start by erecting and securing the head. Fasten the bottom guide bar to the head by the bolts supplied and block it up. Bolt the end support to the bottom guide bar with the bolts supplied. See **Figure 17**. Note that shorter bolts are used at the end support.



Figure 17

Position the follower in the frame next to the head and brace it securely. See Figure 18.



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Position the top carrying bar between the head and end support and using the bolts provided, fasten it securely. See **Figure 19**.



Lift the follower into place and install the roller and axle assembly. See **Figure 20**. Roll the follower back to the end support to allow plate installation.



5.4 Installation of Plates

Wipe the top carrying strip clean between the head and the end support and apply a petroleum based rease to allow the plates to slide freely.

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Install all the plates of the type and quantity specified on the plate arrangement drawing, starting at the head end of the frame. Check to make sure all plates are oriented properly, that gaskets are properly seated in their grooves, and there is no debris anywhere on the plates or gaskets. Clean the sealing surface with a lint free cloth. Push each plate firmly against the previous one. Use special care with plates having Paraclip gaskets (gaskets clipped to the plates) to avoid dislodging them. See Figure 21.



Note: The plate arrangement on the general arrangement drawing indicates if the gasket side of the plate faces the head or follower.

CAUTION:

During installation, always alternate left and right hand plates. For simplification only, whole blocks of identical left or right hand plates are shown on the plate arrangement drawing. The total number of each is given.



5.5 Installation of the Tie Bars

When all plates have been correctly installed, roll the follower up to the end of the plate pack. Install the tie bars into the frame holes or key hole slots as specified by the tightening instructions below.

Clean the tie bar threads and liberally apply an antiseize compound along the area where the nuts will travel during tightening. Also apply the compound to both sides of the plain washer under the tie bar nut. APV recommends **Never-Seez® Regular Grade Lubricant** for carbon steel tie bars and **Never Seez® Black Moly Lubricant** for stainless steel tie bars. Do not use standard grease as it may result in galling. **Figure 22** shows an assembled frame with tie bars installed.

CAUTION:

Never-Seez® Regular Grade is not suitable for stainless steel tie bars.



5.6 Closing Tie Bar Frames

The intent of these instructions is to provide a method to evenly and safely tighten a Paraflow Plate Heat Exchanger with tie bars. Proper tightening is essential for satisfactory operation and maximum gasket life. These instructions should be followed closely for both initial assembly and whenever the exchanger is closed after service.

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 Confirm that plates are all installed correctly to the general arrangement drawing. Check the quantity and orientation (alternating left and right). Move the follower toward the fixed head as far as it can go. Install four tie bars as shown in Figure 23.



2. Starting with the top tie bar pair and alternating with the bottom, tighten the tie bars evenly about 1/2" to 1" at time until the platage dimension (thickness of the plate pack) measured at the installed tie bars is equal and the follower is parallel to the head. This measurement should be about 10% over the final plate dimension specified on the Paraflow plate arrangement drawing. Throughout this step, keep the dimension from one side to the other at each pair of tie bars within 1/4". Also, always tighten the top pair of tie bars first to keep the plates from riding up.



3. Install the rest of the tie bars on the sides of the heat exchanger between the ports (if applicable) and tighten them evenly until the plate dimension is the same at all installed tie bars.

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- 4. Starting with the top pair of tie bars, continue tightening equally about 1/4" at time until the platage dimension measures about 5% above the final dimension.
- 5. Install the remaining tie bars (if applicable) above the top ports and below the bottom ports of the frame. Starting with the top pair and working down, tighten each pair 1/8" at a time. After each tightening cycle of 1/8", return to the top set of bars and repeat the procedure.
- **NOTE:** On large heat exchangers using 2", 42 mm or 48 mm diameter tie bars, it may only be possible to achieve 1/16" movement during the final stages of tightening.
- 6. Tighten the exchanger to the maximum platage dimension specified on the plate arrangement drawing. The dimension must be the same at all tie bars. See Figure 24

WARNING:

Refer to your plate arrangement drawing for the proper tightening plate dimension.

NOTE: Due to o-ring type gasket seal, the final closed dimension is determined by dimension, not tie bar torque.



Manufacturing tolerances of the plate may result in the actual minimum platage dimension varying. Refer to your plate arrangement drawing for actual minimum and maximum dimensions.

- 7. Pressure test the heat exchanger for leaks by using **potable water** at the desired pressure but do not exceed the pressure specified on the drawing. The test may be done on each side separately or on both sides at once. Make sure all air is vented from the heat exchanger before performing the pressure test.
- 8. If leaks occur, the heat exchanger may be further tightened and retested. It is suggested that this be done in steps of approximately 0.001" per plate until the leak stops or the minimum dimension specified on your general arrangement drawing is reached.
- **9.** If the leaks continue, mark them carefully and open the exchanger in accordance with Paragraph 5.7. Inspect the area of the leaks closely for damaged gaskets, plates, sealing surfaces or debris. Replace all suspect plates or gaskets, clean the sealing surface with a lint free cloth, and repeat steps 1 through 7.

5.7 Opening Tie Bar Frames

Tie bar frames may be opened safely by following steps 1 through 6 in Paragraph 5.6 in reverse order. The tie bars must be loosened in the same sequence and amount as described in each step.



6.0 STARTUP AND OPERATION

6.1 General

Prior to startup, make sure the unit is correctly assembled and the piping connected properly. Also, check that the plates have been compressed to the proper dimension specified on the general arrangement drawing. See **Figure 24** and refer to Section 5.0.

Warning:

Proper assembly and tightening are required for safe startup and operation.

6.2 Startup

Caution:

All pipe lines must be inspected and flushed clean prior to operation. Strainers are recommended to prevent debris from installation from entering the unit.

Sudden surges and rapid changes in pressure or temperature must be avoided, as these may damage the plates and gaskets. Throttling valves, flow diversion valves and shut off valves must be operated slowly. Control flows with throttling valves downstream of the heat exchanger.

Caution

Do not allow the pressure to change more than 150 psig (10 bar) per minute or the temperature more than $20 \circ F$ ($11 \circ C$) per minute.

Improper startup will cause damage to the heat exchanger frame, plates or gaskets. Follow instructions closely.

Valves located on the outlet side of any liquid stream must be opened prior to startup to prevent dead heading the heat exchanger.

If steam or another condensable vapor is used as a heating media, it must be turned on after liquid has been introduced on the product side.

During initial startup, the exchanger may develop minor leaks. If these leaks do not stop when the unit has reached operating temperatures, refer to Paragraph 6.5 Troubleshooting.

Air in the heat exchanger will normally be carried out by the liquid flow. However, it is good practice at startup to vent air from the system at a high point in the piping. This will ensure the system is filled with liquid.

6.3 Operation

During operation, the same precautions against rapid changes of pressure or temperature during start-up must be observed. Once normal operating conditions are reached, temperature and pressure drops must be regularly checked. Increasing pressure drops and/or falling temperature may indicate reduced performance of the heat exchanger. This must be investigated to determine the cause. See Paragraph 6.5 Troubleshooting.

Warning:

Do not exceed the maximum operating pressure or temperature listed on the general arrangement drawing or damage to the heat exchanger will result.

6.4 Shut Down

The heat exchanger must be shut down slowly and allowed to cool naturally to room temperature. Inlet valves, if used, should be closed before outlet valves. If steam is used as a heating media, it must be shut off first. In cooling duties, the cooling liquid must be shut down first to avoid freezing of the product.

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Section 6.0 Page 25 of 36 All liquids must be drained from the heat exchanger after shut down to prevent precipitation of products or scale buildup.

If the heat exchanger will be out of service for six months or longer, it must be properly prepared for storage. See APV Standard Procedure SP5002 for instructions. Contact the Customer Service Department listed in Section 8.0 of this manual for copies of the procedure and assistance.

6.5 Troubleshooting

APV plate heat exchangers are designed to provide trouble free service over the life of the unit. However, conditions or processes may change, resulting in reduced performance or even leakage. The following table provides some guidelines for diagnosing common problems and suggested solutions. This table is intended as a general guide only. Assistance in specific cases may be obtained by calling your nearest Service Center listed in the front of this manual or the Customer Service Department listed in Section 8.0.

		T	roubleshooting Plate Heat Exc	hangers
	Problem		Possible Causes	Suggested Solutions
1. R	educed Heat Transfer	a.	The inlet temperatures or flow rates do not correspond to the original design.	Correct temperatures or flow rates to design conditions.
		b.	Plate surfaces have become fouled on either the product or service side.	Open the heat exchanger and clean the plates or clean the plates in place by circulating a suitable cleaning agent see Section 7.0.
		с.	Freeze up.	Correct temperatures or flow rates to design conditions.
2. In D R	ncreased Pressure prop or Reduced Flow ate	a.	Plate surfaces have become fouled on either the product or service side.	See paragraph 1(b) above.
		b.	Debris is blocking the flow channels.	Open the heat exchanger and clean the plates see Section 6.0. Screens or filters must be installed to prevent debris from entering the unit.
3. V	ïsible leakage	a.	Operating pressure exceeds the rating of the heat exchanger.	Reduce the operating pressure to the rating of the heat exchanger. If the unit continues to leak after the pressure is reduced, the plates or gaskets are damaged and must be replaced. See Section 7.0.

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	Troubleshooting Plate Heat Exchangers		
Problem	Possible Causes	Suggested Solutions	
3. Visible leakage (continued)	b. The heat exchanger is not tightened adequately for the operating conditions.	Tighten the heat exchanger further in increments of .001 inch per plate, checking for leakage each time. Do not tighten below the minimum dimension shown on the general arrangement drawing See Paragraph 5.6. If leaks continue, see paragraph 3(c) below.	
	 Sealing surfaces of plates or gaskets may be damaged or dirty. 	Open the heat exchanger and inspect the plates and gaskets. There must not be any cuts, cracks, debris or flat spots on the gaskets. Paraclip gaskets must not have any debris under the gasket. The plates must be clean and free of heavy scratches or dents on both sides. Replace the defective parts.	
	d. Chemical attack of the gaskets.	Identify the source of chemical attack and correct either by eliminating the corrosive agent or changing the material of the gaskets.	
4. Cross Contamination	a. Cracks in one or more plates. These may be caused by fatigue resulting from pressure fluctuations during operation. Dye penetrant testing may be required to identify cracks in the plates refer to Factory Service, Section 8.0 for assistance.	Open the heat exchanger and inspect the plates. Replace the defective parts. Identify the source of pressure fluctuations and correct.	
	 Holes in the plates caused by corrosion. 	Identify the source of corrosion and correct either by eliminating the corrosive agent or changing the material of the plates.	

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7.0 MAINTENANCE

7.1 Opening the Frame

	WARNING:
Nev	ver open a Paraflow until the unit has
bee	en cooled below 100°F (38°C).
Nev pre	ver open a Paraflow which is under ssure from any source.
Nev	ver open a Paraflow with piping
cor	nected to the follower or connector
grid	ds.

Opening Tie Bar Frames

Drain all fluids from the heat exchanger and allow it to cool. Loosen the tie bars evenly in reverse order of steps 1 through 6 in Paragraph 5.6. Remove the tie bars and push the follower towards the end support (Figure 25). The plates may now be separated for cleaning and inspection.





7.2 Inspection

Check the front and back of every plate for cleanliness and freedom from debris. Product build up and scale will reduce the performance of the heat exchanger and cleaning is required - See Paragraph 7.3.

Check each plate for cracks or holes. Some cracks may not be readily visible and will require dye penetrant inspection to locate them. Contact your nearest APV Service Center listed at the front of this manual.

Gaskets must be thoroughly checked for cuts, flattening, cracks, brittleness, breakage and proper fit of the gasket groove. The gasket groove in the plate must be free of distortion or kinks.

The entire gasket and sealing surfaces of the plates must be totally free of any debris since any foreign material will cause leakage and may damage the gasket. When installing clip in gaskets, careful inspection is required to be sure there is no debris or glue from previous gaskets under the installed gasket which will cause leakage.

7.3 Clean In Place (CIP)

Cleaning in place is accomplished by circulating a suitable cleaning solution through the heat exchanger instead of opening it. This removes deposits or trapped product on the plates. CIP works best in the reverse direction of normal flow. Good results are also possible with same direction flow and higher velocities. If the product to be flushed out has a high viscosity, the circulation flow rate must be large enough to reach a sufficient speed for flushing out the product. If the product pump is volumetric, it may be necessary to insert a pump for the cleaning solution in parallel to the former. It is assumed that the fouling on the plates is soluble in a cleaning solution that does not attack plates and gaskets.

Great care must be taken to select proper cleaning solutions and cycles to avoid damaging the plates and gaskets. Due to the large variety of cleaning needs, each user is responsible for determining the best method for his situation. It is recommended that a

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reputable supplier of cleaning materials be consulted for assistance. The capacities and resistance to corrosion of plate heat exchangers depend on the plate pack being kept clean.

Example of CIP-cleaning:

- Drain off product residues and cooling and heating media.
- Rinse with cold or lukewarm water.
- Circulate with warm cleaning fluid solution.
- Rinse with warm water. Rinse with warm water with softener added to it.
- Rinse with cold or lukewarm water.

Cleaning can also be effected without circulation by pouring a cleaning fluid solution into the system. After some time of standing, wash out the detergent with clean water.

7.3.1 Determination of correct CIP regime.

The plate heat exchanger must be opened for inspection at regular intervals. This is necessary especially during the running-in period, until experience has been gained on the effectiveness of the cleaning process.

With these inspections, it will gradually be possible to determine circulation times, temperatures, and chemical concentrations with great certainty!

Insufficient cleaning is most often due to:

- too small circulation quantity
- too short cleaning period.
- too small chemical consumption in relation
- to the fouling on the plates.
- too long periods of operation.

If the plate heat exchanger is out of operation for a long time, it is advisable to empty it, separate the plates, and clean the unit.

Clamp the plate heat exchanger lightly together, and leave it covered in order to protect the gaskets against dirt and the effect of light!

7.3.2 Acceptable CIP solutions.

The definition of an acceptable CIP solution is brief and to the point. Fouling on the plates must be removed without damaging plates and gaskets or reducing the inherent corrosion resistance. It is important not to decompose the passive (protective)

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film on stainless steel - the film contributes to preserving the resistance of the steel to corrosion.

Do not use chlorine-containing agents such as hydrochloric acid (HCI).

EXAMPLE OF AN ACCEPTABLE CIP SOLUTION: (Basis Stainless 316 plates and Nitrile gaskets in Dairy applications.)

- OIL AND FATS are removed with a water emulsifying oil solvent, e.g. BP-SYSTEM CLEANER.
- ORGANIC AND GREASY COATINGS are removed with SODIUM HYDROXIDE (NaOH) – Typical concentration 1.5% w/w max. temperature 85°C (185-F). 1.5% w/w concentration corresponds to 3.75 litre 30% NaOH per 100 litre water.
- MINERAL SCALE DEPOSITS are removed with NITRIC ACID (HN0₃)-max. concentration 1.0% w/w - max. temperature 65°C (149°F).
 1.0 % w/w concentration corresponds to 1.17 litre 62% HN0₃ per 100 litres water.
- Excess Nitric acid can seriously damage Nitrile rubber gaskets.

Several alternative acids to Nitric can be used, Phosphoric acid can be used at up to 5% and 85°C. Consult APV to find all the alternative CIP regimes possible.

Caution

The heat exchanger must be thoroughly drained and rinsed immediately following CIP. Residue from CIP may cause corrosion if left in the heat exchanger.

7.3.3 Measurement of solution concentration.

SODIUM HYDROXIDE (NaOH) solution is titrated with 0.1 n HYDROCHLORIC ACID (HCI) with methyl orange or methyl red as indicator. NITRIC ACID (HN0₃) solution is titrated with 0.1 n SODIUM HYDROXIDE (NaOH) with phenolphthalein as indicator.

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The concentration of the cleaning fluid in % can be calculated from the titration result according to the following formula:

CONCENTRATION = <u>bxnxm</u> % ax10

- a = ml volume of cleaning fluid in sample for titration
- b = ml vol. titration fluid added to change of color
- n = normality of titration fluid
- m = molecular weight of cleaning fluid (NaOH) molecular weight 40 (HN0₃)molecular weight 63.

In order to use the correct quantity of chemicals for CIP cleaning, the cleaning fluid should be checked immediately before flushing. If the concentration is too low, <0.5%, the plate heat exchanger is probably not clean. If the concentration is too high, >1%, the chemical consumption can be reduced.

7.4 Replacement of plates

Before replacing a plate in a heat exchanger, the new plate must be checked against the plate it is replacing. The new plate must be identical in every way.

The general arrangement drawing provided with the heat exchanger provides information on the material, port punching, gaskets and location of each plate in the heat exchanger.

Note: During the installation, **always alternate left and right hand plates**. For simplification only, whole blocks of identical left or right hand plates are shown on the plate arrangement drawing. The total number of each is given. Vertical flow plates may be changed from left hand to right or vice versa by turning the plate over.

7.5 Regasketing

Plate heat exchanger gaskets are attached to individual plates by one of two methods, glued or clip in. Glued in gaskets are attached by a thermoplastic adhesive which is heat cured for maximum strength.

The clip in gaskets (Paraclip) are attached to the plates by small nubs around the perimeter of the gasket which snap into matching holes.

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Removal of old gaskets

To remove Paraclip clip in gaskets, the gasket may be carefully pulled from the plate. If the gasket is to be reused, pull slowly to avoid tearing off the clips or stretching the gasket.

To remove glued in gaskets, the bond between the plate and gasket is softened by using a propane torch to heat the plate from the nongasketed side directly behind the gasket. As the adhesive softens, use pliers to pull the gasket from the groove. Continue this process until the entire gasket has been removed.

Caution

Avoid overheating the metal. This will discolor and damage the plate.

To remove remaining traces of old adhesive, grease or dirt from gasket grooves, use a solvent such as Acetone or a commercial gasket removal product. Do not use abrasives to clean the gasket grooves.

Attachment of Glued in Gaskets

To attach new replacement gaskets, apply a thin even film of 3M formula EC-1099 adhesive to the plate gasket groove. The adhesive may be spread evenly with a small acid brush dipped in acetone. Allow the adhesive to dry until tacky, about 30 seconds. Press the gasket firmly in place, starting at one corner of the plate and continuing across and along the length of the plate. The entire gasket must be firmly in place with no twists or bumps.

As each plate is gasketed, it should be stacked neatly on a clean, flat surface in the order it will be installed. Take special care not to move the gaskets out of position. After all the plates are regasketed, they may be placed in the frame. The frame is tightened per Paragraph 5.6 to a platage dimension about 10% above the maximum compressed platage specified on the general arrangement drawing.

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Heat treatment is essential to cure the adhesive and obtain maximum bond strength. This is done using steam or hot water to heat the plate pack. Attach a low pressure desuperheated steam line to an upper port and slowly raise the temperature of the plate pack to at least $220 \,^{\circ}$ F ($105 \,^{\circ}$ C). Maintain the temperature for a minimum of three hours.

If steam is not available, hot water may be used with the same temperature and time requirements as steam.

After the required time, allow the heat exchanger to cool naturally to room temperature and complete the tightening to the required dimension per paragraph 5.6.

Attachment of Paraclip Gaskets

Non-glued Paraclip gaskets are an alternative to glued in gaskets that greatly simplifies on site regasketing. The gaskets have a series of small nubs or projections molded into the underside of the gasket. These projections fit into corresponding slots located around the periphery of the plate and port areas, securing the gasket to the plate (Figure 26). When the plate heat exchanger is tightened, a complete and secure seal is assured.

To attach an Paraclip gasket, the gasket is laid out on the plate in its correct position. The projections are firmly pressed into the corresponding slots in the plates. After installing the gasket, the plate may be immediately installed in the frame in preparation for tightening.



Figure 26.1



Figure 26.2



Figure 26.3

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Attachment of EasyClip Gaskets

Non-glued Easyclip gaskets are an alternative to glued in gaskets that greatly simplifies on site regasketing. During fixing the gasket a pressure is applied, which expands 2 tongues into 2 slots in the plate. This barbed effect (fish hook) secures the gasket to the plate, in fact it now takes more force to remove the gasket than to apply it. These tongues fit into corresponding slots located around the periphery of the plate and port areas, securing the gasket to the plate (Figure 27). When the plate heat exchanger is tightened, a complete and secure seal is assured.

To attach an EasyClip gasket, the gasket is laid out on the plate in its correct position. The projections are firmly pressed into the corresponding slots in the plates. After installing the gasket, the plate may be immediately installed in the frame in preparation for tightening.





Figure 27.1



Figure 27.2

Figure 27.3





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8.0 PARTS AND SERVICE

8.1 Ordering Parts

Parts, plates and gaskets may be ordered referencing the W. O. Number listed on the Heat Exchanger nameplate when ordering.

> APV Parts Express Tel: (888) APV 4321 (1-888-278-4321)

8.2 Service

APV maintains service facilities at several locations around the country. These sites are equipped to repair, rebuild or regasket your heat exchanger. Service personnel are also available to provide on-site assistance. Call the number listed below to inquire about or arrange for service.

APV Heat Transfer Customer Service Center

Southwest

APV Service Center 1101A Pleasantville Drive Houston, TX 77029

Phone: (888) 278-1030 Fax: (888) 278-1050

West Coast

APV Service Center 863 East Levin Avenue Tulare, CA 77029

Phone: (559) 685-7400 Fax: (559) 685-5241

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8.3 Documentation

Copies of this manual, the General Arrangement Drawing or other documents referenced by this manual may be ordered from the Customer Service Department listed in Paragraph 8.1.

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9.0 ACCESSORIES

9.1 Manual Tightening Wrenches

Manual tightening wrenches are available for most APV Paraflow Plate Heat Exchangers to allow opening and closing a unit in the field. Ratchet type wrenches specifically designed for tie bars are available for medium to large exchangers. The T4, Junior, H17, SR1, TR1 and SR2 use box wrenches of the correct size. Power tightening equipment is required to tighten LR9, TR9, SR14, B Series and SR23 heat exchangers.

9.2 Power Tightening Equipment

Pneumatic Wrench

To facilitate the closing and tightening of large heat exchangers or units containing numerous plates, pneumatic tightening wrenches are available in two models, both as single or dual units.

Figure 28 shows the pneumatic power tighteners recommended for specific tie bar tightening heat exchangers. **Figure 29** gives a description of each tightener model.

Pneumatic Wrench Recommendations

MODEL	SINGLE PT-5	DUAL PT-5	SINGLE PT-7	DUAL PT-7
SR3	GOOD	BEST		
R4/LR4	GOOD	BEST		
R5	GOOD	BEST		
SR6 SERIES	GOOD	BEST		
R8	GOOD	BEST		
SR9	GOOD	BEST		
TR9/LR9 SERIES			GOOD	BEST
B SERIES			GOOD	BEST
SR14 SERIES			GOOD	BEST
SR23 SERIES			GOOD	BEST

Figure 28

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The power tightener assemblies require clean lubricated air at a minimum of 90 psig at the filterregulator inlet. Air consumption is 25 scfm full load or 40 scfm no load for each tightener.

Tightener Data

TIGHTENER	DRIVE	SPEEDS	WEIGHT
MODEL			EACH
PT-5	1"	1 FORWARD	60 LB.
		1 REVERSE	(27 Kg)
PT-7	1-1/2"	2 FORWARD	80 LB.
		2 REVERSE	(36 Kg)

Figure 29

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9.3 Spray Screen

A spray screen may be supplied for new or existing plate heat exchangers. They are recommended whenever corrosive liquids or high temperatures present a safety hazard to personnel near the exchanger. These spray screens enclose the plate pack completely on the sides and top and are easily removed. The bottom is open to allow leak detection. Figure 30



Figure 30

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Your local contact:

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For more information about our worldwide locations, approvals, certifications, and local representatives, please visit www.apv.com.

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