



5 - PARTS DATA

. 5.1 Equipment data sheets

For CE 603	D5-FF-22-26-8481
For CE 607	D5-FF-22-26-8482

SECRET

ITEM CE 607

VENDORS FRONT SHEET
FOR A4 DOCUMENTS

PURCHASE ORDER NO.:--
PO FF 22 26 1006
PROCUREMENT PACKAGE NO.:--
MA 006

PAGE 1 OF 10

VENDOR INFORMATION

COMPANY NAME: DE LAUNAY & FILS

ADDRESS: 6 RUE VALMY BP 429

76057 LE HAVRE FRANCE

TELEX/FAX: 35254327

TELEPHONE: 35253136

VENDOR DATA CONTROL CONTACT:

EXT:

VENDOR DOCUMENT NUMBER: 93250 TDS 2 -

DOCUMENT TITLE: EQUIP DATA SHEETS - CE 607
- EQUITHERM -
(3 feuilles)
+ (6 feuilles)

PROJECT DOCUMENT N° DS-FF-22-26-8482

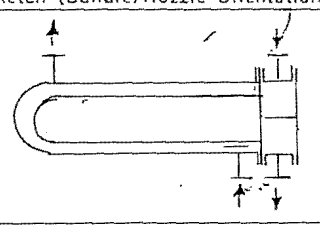
FRØY INTEGRATION WORK ON TCP2			
EQUIPMENT DESCRIPTION:			
- FRØY OIL INLET HEATER -			
PKCE TAG NO: PA006		LOCATION: M35.	
VORL CODES: C07			
ITEM TAG Nos: CE607			
P.O. NUMBER	SEQUENCE No.	REV.	VORL CAT.
PO.FF.22.26.1006		02	C



VERITEC

HEAT EXCHANGER SPECIFICATION SHEET

1		Job No.
2	Customer ELF PETROLEUM NORGE A/S	Reference No. 50E 038
3	Address PROJECT - FROY INTEGRATION ON TCP2	Proposal No.
4	Plant Location TCP2 - MODULE 35	Date 26-02-93 Rev. 2
5	Service of Unit FAOY OIL INLET HEATER	Item No. CE 607
6	Size 740 x 4600 Type AEU (Hor/Vert)	Connected In - Parallel - Series
7	Surf/Unit 122. m² Shells/Unit 1	Surf/Shell 122.11 m² (1)
8	PERFORMANCE OF ONE UNIT DESIGN CASE YEAR 1997	
9	Fluid Allocation	Shell Side Tube Side
10	Fluid Name	PARTIALLY STABILIZED CRUDE OIL 30% TEG
11	Fluid Quantity, Total kg/h	309248.8 (3) 78387
12	Vapor (In/Out) kg/h	6202.6 9015.6
13	Liquid kg/h	253061 250248 78387 78387
14	Steam kg/h	49 176
15	Water kg/h	49858 49731
16	Noncondensable kg/h	78 78
17	Temperature (In/Out) °C	41.4 65.8 180 120
18	Specific Gravity L/V kg/m³	830.6 / 14.822 815 / 15.0138 905.4 962.7
19	Viscosity, Liquid L/V cp	3.622 / 0.0119 2.638 / 0.0124 0.2569 0.5654
20	Molecular Weight, Vapor	23.55 26.54
21	Molecular Weight, Noncondensable	
22	Specific Heat L/V KJ/kg.°C	2.3924 / 2.0561 2.4788 / 2.079 4.2113 3.8934
23	Thermal Conductivity L/V W/m.°C	0.1522 / 0.0314 0.1474 / 0.0325 0.5131 0.5095
24	Latent Heat	
25	Inlet Pressure BAR A	15.5 17
26	Velocity m/s	2.20
27	Pressure Drop, Allow./Calc. BAR	0.5 0.46 2.0 1.41
28	Fouling Resistance (Min.) m²/w	0.000528 0.000352
29	Heat Exchanged 5413 kW	MTD (Corrected) 92.4 °C
30	Transfer Rate, Service 479 w/m².°C Clean 882 w/m².°C	
31	CONSTRUCTION OF ONE SHELL	
32		Sketch (Bundle/Nozzle Orientation)
33	Design/Test Pressure BAR G	Shell Side 18.5 / 27.75 Tube Side 2.8 / 4.8
34	Design Temperature °C	-20 / 120.5 -20 / 120.5
35	No. Passes per Shell	1 8
36	Corrosion Allowance mm	3 0
37	Connections	In - 12" 300# RF Out 6" 300# RF
38	Size &	In - 12" 300# RF Out 6" 300# RF
39	Rating	Intermediate
40	Tube No. 216 U^o 19.05 mm Thk	1.65 mm; Length 4600 mm Pitch 25.4 mm ± 90
41	Tube Type SEAMLESS	Material
42	Shell C.S 10 740 mm OD	Shell Cover C.S (Integ.) (Remov.)
43	Channel or Bonnet 316L	Channel Cover 316L
44	Tubesheet-Stationary 316L	Tubesheet-Floating
45	Floating Head Cover -	Impingement Protection 316L
46	Baffles-Cross 316L	Type DOUBLE SEGM. VERT. % Cut (Diam/) 26.6 Spacing: c/c 370 Inlet 1700
47	Baffles-Long	Seal Type
48	Supports-Tube 316L	U-Bend (2) Type
49	Bypass Seal Arrangement 2 PAIRS MINI.	Tube-Tubesheet Joint WELDED
50	Expansion Joint	Type
51	no. Inlet Nozzle 4334 kg/m²	Bundle Entrance Bundle Exit
52	Gaskets-Shell Side	Tube Side
53	Floating Head	
54	Code Requirements BS 5500 CAT. 1	TEMA Class R
55	Weight/Shell 6250	Filled with Water 7585 Bundle 2700 (Vas)
56	Remarks (1) U BENDS ARE INCLUDED IN HEAT TRANSFER SURFACE. 10% OVERSURFACE REQUIRED	
57	(2) BENDS ARE IN HORIZONTAL PLANE. PROVIDE STIFFENERS ON OUTER U BENDS.	
58	(3) MAXI. CO ₂ CONTENT IS 1.5% MOLE.	
59	5 MOD. N ₂ TUBES	3-05-93 TCP
60	4 MOD. MATERIALS	20-04-93 TCP
61	3 ISSUED AS A	10-03-93 TEP
	2 REV. 3 OF CLIENT SPEC.	26-02-93 TCP
	REV DESCRIPTION	DATE BY CHK APP
	5 MOD. LIQES 14,36, 40.	12-5-93 TCP
	EQUITHERM	CE 607 (DESIGN CASE YEAR 1997)
		N° SPEC. P92061. CE 607



225/6/93

HEAT EXCHANGER SPECIFICATION SHEET

1	Customer ELF PETROLEUM NORGE AS	Job No.
2	Address PROCT FROY INTEGRATION ON TCP2	Reference No. SAE 078
3	Plant Locallon TCP2 - MODULE 35	Proposal No.
4	Service of Unit FROY OIL INLET HEATER	Date 26.02.93 Rev. 2
5	Size 740 x 4600 Type AEU (Hor/Vert)	Item No. CE 607
6	Surf/Unit 122 m² Shells/Unit	Connected In - Parallel - Series
7	PERFORMANCE OF ONE UNIT DESIGN CASE YEAR 2000	
8	Fluid Allocation	Shell Side Tube Side
9	Fluid Name	PARTIALLY STABILIZED CRUDE OIL 30% TEG
10	Fluid Quantity, Total	321 968,4 43172,1
11	Vapor (In/Out)	- 23,3
12	Liquid HC.	122 376,1 122 352,4 43172 43172
13	Steam	- 511
14	Water	199 592,3 199 587,6
15	Noncondensable	
16	Temperature (In/Out)	49,6 59
17	Specific Gravity L/V	912 / - 904,6 / 13,2272
18	Viscosity, Liquid /V	18,51 / - 15,79 / 0,0125
19	Molecular Weight, Vapor	- 23,23
20	Molecular Weight, Noncondensable	
21	Specific Heat L/V	3,4503 / - 3,4698 / 2,1162
22	Thermal Conductivity L/V	0,3371 / - 0,3382 / 0,0341
23	Latent Heat	
24	Inlet Pressure	BARA 15,5
25	Velocity	m/s 1,21
26	Pressure Drop, Allow./Calc.	0,5 1 0,195 2,0 0,48
27	Fouling Resistance (Min.)	m².°C / W 0,000528 0,000352
28	Heat Exchanged	2982 Kw MTD (Corrected) 92,2 °C
29	Transfer Rate, Service	256 W/m².°C Clean 339 W/m².°C
30	CONSTRUCTION OF ONE SHELL	
31		Sketch (Bundle/Nozzle Orientation)
32	Design/Test Pressure	/ /
33	Design Temperature	
34	No. Passes per Shell	
35	Corrosion Allowance	
36	Connections	
37	Size & Rating	
38	In	
39	Out	
40	Intermediate	
41	Tube No.	OD Thk (Min/Avg) Length Pitch 30 60 90 45
42	Tube Type	Material
43	Shell	ID OD Shell Cover (Integ.) (Remov.)
44	Channel or Bonnet	Channel Cover
45	Tubesheet-Stationary	Tubesheet-Floating
46	Floating Head Cover	Impingement Protection
47	Baffles-Cross	Type % Cut (Diam/Area) Spacing: c/c Inlet
48	Baffles-Long	Seal Type
49	Supports-Tube	U-Bend Type
50	Bypass Seal Arrangement	Tube-Tubesheet Joint
51	Expansion Joint	Type
52	rv-Inlet Nozzle	Bundle Entrance Bundle Exit
53	Gaskets-Shell Side	Tube Side
54	-Floating Head	
55	Code Requirements	TEMA Class
56	Weight/Shell	Filled with Water Bundle
57	Remarks	CALCULATED OVERDESIGN 88 %
58	6	MOD. LIGNE 29 27.05.93 JCP del. del.
59	5	MOD. NB. TUBES 03.05.93 JCP del. del.
60	4	Rev. Folio 1 20.04.93 JCP del. del.
61	3	REV. FOLIO 1 10.03.93 JCP del. del.
62	2	REV. 3 OF CLIENT SPEC. 26.02.93 JCP del. del.
63	REV	DESCRIPTION DATE BY CHK APP.
EQUITHERM		CE.607
(DESIGN CASE YEAR 2000)		N° SPEC. P92081-CE607
		P92061
		2/5
		25/6/94

3

FOLIO

HEAT EXCHANGER SPECIFICATION SHEET

1 Customer ELF PETROLEUM NORGE A/S	Job No.
2 Address	Reference No. 50E038
3 Plant Location TCP2: M35 FROY TIE IN	Proposal No.
4 Service of Unit FROY OIL INLET HEATER	Date 26.02.93 Rev. 2
5 Size 740 x 4600 Type AEU (Hor/Vert)	Item No. CE-607
6 Surf/Unit 122 m² Shells/Unit 1 Surf/Shell 122 m²	Connected In - Parallel - Series

PERFORMANCE OF ONE UNIT CASE START UP YEAR 2000				
Fluid Allocation	Shell Side		Tube Side	
10 Fluid Name	STABILIZED CRUDE OIL		30% TEG	
11 Fluid Qty, Total kg/h	36041 (1)		82914	
12 Vapor (In/Out)	-	82.8		
13 Liquid	36207	36124.2	82914	82914
14 Steam	-	11.2		
15 Water	59834	59822.8		
16 Noncondensable				
17 Temperature (In/Out) °C	5.14	66.1	180	120
18 Specific Gravity L/V kg/m ³	946.4 /	899.2 /		
19 Viscosity, Liquid L/V cp	47.062 /	14.068 /	↑	
20 Molecular Weight, Vapor	73.2059	24.1401		
21 Molecular Weight, Noncondensable			(SEE FOLIO 1/1)	
22 Specific Heat L/V kJ/kg °C	3.3803 /	3.486 /	↓	
23 Thermal Conductivity L/V W/m °C	0.3263 /	0.3388 /		
24 Latent Heat				
25 Inlet Pressure BAR A.	15.5		17	
26 Velocity m/s	0.16		2.35	
27 Pressure Drop, Allow./Calc. BAR	0.5	/ 0.03	2	/ 1.56
28 Fouling Resistance (Min.) m ² °C / W	0.000528		0.000352	
29 Heat Exchanged. 5600 KW	: MTD (Corrected)		107.7 °C	
30 Transfer Rate, Service 425	Clean	715	W / m ² °C	

CONSTRUCTION OF ONE SHELL				Sketch (Bundle/Nozzle Orientation)
		Shell Side	Tube Side	
33 Design/Test Pressure	/		/	
34 Design Temperature				
35 No. Passes per Shell				
36 Corrosion Allowance				
37 Connections	In	N/A		
38 Size & Rating	Out			
	Intermediate			
40 Tube No.	OD	Thk (Min/Avg)	Length	Pitch
41 Tube Type			Material	
42 Shell	ID	OD	Shell Cover	(Integ.) (Remov.)
43 Channel or Bonnet			Channel Cover	
44 Tubesheet-Stationary			Tubesheet-Floating	
45 Floating Head Cover			Impingement Protection	
46 Baffles-Cross	Type	% Cut (Diam/Area)		Spacing: c/c Inlet
47 Baffles-Long			Seal Type	
48 Supports-Tube	U-Bend		Type	
49 Bypass Seal Arrangement			Tube-Tubesheet Joint	
50 Expansion Joint			Type	
51 pvf-Inlet Nozzle	Bundle Entrance		Bundle Exit	
52 Gaskets-Shell Side			Tube Side	
53 -Floating Head				

54 Code Requirements	TEMA Class
55 Weight/Shell	Filled with Water Bundle
56 Remarks (1) FLOW RATES DETERMINED BY PERFORMANCES OF EXCHANGER, THE TEMPERATURES BEING IMPOSED.	

58	MOD. FOLIOS 1 & 2	17.05.93	JCP	chk.	APP.	
59	MOD. NB TUBES	02.05.93	JIP	chk.	APP.	
60	REV. FOLIO 1	20.04.93	EP	chk.	APP.	(4)
61	REV. FOLIO 1	10.05.93	JCP	chk.	APP.	
2	REV. 3 OF CLIENT SPEC.	16.02.93	JCP	chk.	APP.	
REV	DESCRIPTION	DATE	BY	CHK	APP.	

EQUITHERM	CE 607 (START-UP YEAR 2000)	P 92061	FOLIO 3/5
		N° SPEC. P 92061-CE 607	16/23/6/93

PROBLEM DESCRIPTION-P92061 ELF NORGE TCP2 YEAR 1997 -

CASE-CE607.3

FLOW INDUCED VIBRATION ANALYSIS (LEVEL 1.00) 2-PHASE MIX. SHELLSIDE

		-----POSITION IN BUNDLE-----		
		INLET	CENTER	U-BEND
01	LOG DECREMENT 0.1000 AXIAL STRESS LOADING		0.0 (MPA)	
02	BETA 2.711 ADDED MASS FACTOR 2.4733			
03	LENGTH FOR NATURAL FREQUENCY (M)	1.060	0.740	2.052
04	LENGTH/TEMA MAXIMUM SPAN (---)	0.694	0.485	1.092*
05	NUMBER OF SPANS (---)	6	7	1
06	TUBE NATURAL FREQUENCY (HZ)	56.69+	71.15	6.55
07	SHELL ACOUSTIC FREQUENCY (HZ)	---	---	---
- FLOW VELOCITIES -				
08	WINDOW PARALLEL VELOCITY (M/S)	1.72	1.92	2.13
09	BUNDLE CROSSFLOW VELOCITY (M/S)	0.97	2.02	1.60
10	BUNDLE/SHELL VELOCITY (M/S)	0.40	0.83	0.66
- FLUIDELASTIC INSTABILITY CHECK -				
11	BAFFLE TIP CROSS VELOCITY (M/S)	0.81	1.68	1.33
12	AVERAGE CROSSFLOW VELOCITY (M/S)	0.97	2.02	1.60
13	CRITICAL VELOCITY (M/S)	2.68	2.60	2.91
- ACOUSTIC VIBRATION CHECK -				
14	VORTEX SHEDDING RATIO (---)	---	---	---
15	TURBULENT BUFFETING RATIO (---)	---	---	---
- TUBE VIBRATION CHECK -				
16	VORTEX SHEDDING RATIO (---)	0.318	0.663*	0.526*
17	TURBULENT BUFFETING RATIO (---)	---	---	---
18	PARALLEL FLOW AMPLITUDE (MM)	0.004	0.006	0.116
19	CROSSFLOW AMPLITUDE (MM)	0.100	0.149	3.873*
20	TUBE GAP (MM)	6.300	6.300	6.300
21	CROSSFLOW RHO-V-SQ (KG/M-S2)	361.	1405.	799.
- DAMAGE NUMBER CHECK -				
22	BAFFLE DAMAGE NUMBER (---)	0.0477	0.0905	0.3957*
23	COLLISION DAMAGE NUMBER (---)	0.0352	0.0325	1.0939*
24	CRITICAL DAMAGE NUMBER LIMIT (---)	0.2871	0.2831	0.2799
25	RHO/SQRT(MU) (LB**5FT**-2.5HR**5)	8.2455	8.0135	7.8331
BUNDLE PARAMETERS AT NOZZLES		ENTRANCE	EXIT	
26	IMPINGEMENT PLATE	YES	--	
27	FLOW AREA (AESC) (M2)	0.0720	0.0883	
28	VELOCITY (VEFC) (M/S)	3.09	3.12	
29	RHO-V-SQ (RV2E) (KG/M-S2)	3683.	3032.	
30	TEMA E SHELL WITH VERT DBL. SEG. BAFFLES AND U-T BUNDLE			
31				
32	PLAIN 316 S. STL TUBES 19.1000 DIAMETER (MM)			90 DEGREE LAYOUT
33	PITCH RATIO 1.330			

+ FREQUENCY RATIOS ARE BASED UPON LOWEST NATURAL OR ACOUSTIC FREQUENCY OMITTING THE U-BEND. CALCULATIONS ASSUME NO INTERMEDIATE SUPPORTS

NOTE -- U-BEND EXCEEDS THE TEMA MAXIMUM SPAN. CONSIDER ADDING STIFFNESS TO THE U-BEND REGION.

5

1c 3/5/93
 due at 1c 3/5/93
 JCP 1c 3/5/93

R 4/5/93
 1/E

FINAL RESULTS* PROBLEM DESCRIPTION-P92061 ELF NORGE TCP2 YEAR 1997 -
 RATING CASE MULTIPASS FLOW IN A T.E.M.A. AEU SHELL WITH DOUBLE-SEG. BAFFLES

CASE-CE607.3
 ALT. SOLN.-**

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**** PROCESS DATA ****
01 FLUID NAME                CRUDE                TEG30Z
02 FLUID CONDITION           2-PHASE MIX,        SENS. LIQUID
03 TOTAL FLOW RATE           (KG/S)              85.903            21.774

04 TEMPERATURE, IN/OUT      (DEG C)             41.4 / 35.8      180.0 / 120.0
05 TEMPERATURE, AVERAGE/SKIN (DEG C)             53.6 / 89.4      150.0 / 143.8
06 PRESSURE, INLET/AVERAGE  (KPA)               1550.0 / 1525.0   0.0 / 0.0

07 PRESSURE DROP, TOTAL/ALLOW (KPA)              45.92 / 50.00    140.67 / 130.00
08 VELOCITY, CALC./MAX.ALLOW (M/S)                   0.85 / 0.00      2.20 / 0.00

09 FILM COEF (SAF.FACT)     (W/M2-C)            1441.77 (0.75)   10089.28 (1.00)
10 FOULING RESISTANCE       (M2-C/W)            0.00053          0.00035

11 DENSITY                   (KG/M3)             822.8360         934.4736
12 THERMAL CONDUCTIVITY     (W/M-C)             0.1495           0.5113
13 SPECIFIC HEAT CAPACITY   (KJ/KG-C)           2.4373           4.0521
14 VISCOSITY AT AVERAGE TEMP (MPA-S)             3.05343          0.37056
15 VISCOSITY AT SKIN TEMP   (MPA-S)             2.00782          0.40217

**** SHELLSIDE PERFORMANCE ****
01 NOM. VEL, X-FLOW/WINDOW   0.73 / 0.81
02 FILM COEF, X-FLOW/WINDOW 2542.7 / 2033.9
03 FLOW FRACTIONS FOR HEAT TRANSFER= 0.765
04 A=0.004 B=0.638 C=0.031 E=0.038 F=0.290

**** SHELLSIDE HEAT TRANSFER CORRECTIONS ****
05 TOTAL BETA GAMMA END FIN
06 0.952 0.895 1.064 0.954 1.000

**** PRESSURE DROPS **** (PERCENT TOTAL DP)
07 WIND 47.62 NOZZLE SHELL 10.07 / 9.28
08 END 11.41 (IN/OUT) TUBE 0.62 / 0.37

**** H.T. PARAMETERS **** SHELL TUBE
09 WALL CORRECTION          1.058 0.986
10 PRANDTL NO.              20.5 2.9
11 AVERAGE REYNOLDS NO.    6977 87774
12 BUNDLE INLET REYNOLDS NO. 10958 126561
13 BUNDLE OUTLET REYNOLDS NO. 15151 57568
14 FOULING LAYER (MM)      0.00000 0.00000

**** OVERALL PERFORMANCE DATA ****
16 TOTAL HEAT DUTY REQUIRED (MEGAWATTS) 5.413051
17 EFFECTIVE KTD, (LMTD) (F) (DELTA) = (DEG C) 95.28(0.97)(1.00)= 92.4
18 F FACTOR=(TUBE) (BAFFLES) (F/G) (HOT/COLD)=(0.972)(1.000)(1.000)(0.997)
19 OVERALL COEF, REOD/CLEAN/ACTUAL (W/M2-C) 477.82/1090.63/ 534.64

**** THERMAL RESISTANCES **** (PCT. OVERALL)
15 SHELL TUBE FOULING METAL OVER DES
16 37.08 6.41 50.98 5.533 11.891
17 TOTAL FOULING RESISTANCE 0.000954
18 DIFFERENTIAL RESISTANCE 0.000222

**** CONSTRUCTION INFORMATION ****
20 NO. SHELLS SERIES 1 PARALLEL 1 TOTAL SURFACE AREA (M2) 126
21 NO. PASSES SHELL 1 TUBE B EFF. SURF. AREA (M2/SHELL) 122.6
22 SHELL I.D. (MM) 740.000 TEMA SHELL TYPE E REAR HEAD U-T

**** SHELL NOZZLE INFO. **** INLET OUTLET
19 INSIDE DIAMETER (MM) 289.1 289.1
20 VELOCITY (M/S) 3.32 4.17
21 DENSITY (KG/M3) 393.201 313.802
22 NOZZLE R-V-SQ (KG/M-S2) 4334 5458
23 SHELL ENT. R-V-SQ (KG/M-S2) 3683 3031
24 HEIGHT UNDER NOZZLE (MM) 94.0 94.0

** TUBE NOZZLES (RADIAL) ** INLET OUTLET
25 INSIDE DIAMETER (MM) 152.0 152.0
26 VELOCITY (M/S) 1.32 1.25
27 DENSITY (KG/M3) 905.974 962.973

**** DIAMETRAL CLEARANCES ****
28 BAFFLE-TO-SHELL (MM) 4.0098
29 BUNDLE-TO-SHELL (MM) 12.7008
30 TUBE-TO-BAFFLEHOLE (MM) 0.4000
31 MULTI.SEG. BAFFLE OVERLAP (MM) 50.800
32

20 NO. SHELLS SERIES 1 PARALLEL 1 TOTAL SURFACE AREA (M2) 126
21 NO. PASSES SHELL 1 TUBE B EFF. SURF. AREA (M2/SHELL) 122.6
22 SHELL I.D. (MM) 740.000 TEMA SHELL TYPE E REAR HEAD U-T

23 BAFFLE TYPE VERT DBL. SEG. NO. CROSSPASSES/SHELL PASS 12
24 CENTRAL SPACING (MM) 370.000 BAFFLE CUT (PCT. DIA) 26.60
25 INLET SPACING (MM) 690.000 CUT AREA(PCT) 1) 41.8 2) 42.3 3) 0.0
26 OUTLET SPACING (MM) 516.000 CUT HEIGHT FROM CENTER LINE (MM)
27 BAFFLE THICKNESS (MM) 7.937 POS-1) 173.2 2) 122.4 3) 0.0

28 PAIRS SEAL STRIPS 2 TOT.TUBESHEET(MM) 110.0 IMPINGEMENT PLATE YES
29 F-STREAM SEAL ROBS (MM) 19.100 NO. 6 PCT.TUBES REM.(BOTH) 15.38

30 TUBE TYPE PLAIN TUBECOUNT PER SHELL 432
31 OVERALL LENGTH (M) 4.841 TUBE PITCH (MM) 25.3999
32 EFFECTIVE LENGTH (M) 4.731 OUTSIDE DIAMETER (MM) 19.100
33 LAYOUT ANGLE (DEG) 90 INSIDE DIAMETER (MM) 15.800
34 PITCH RATIO 1.330 SURFACE AREA RATIO (OUT/IN) 1.209
35
36 WEIGHT ESTIMATION (KG/SHELL) DRY 4608 WET 6901
  
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*** WARNING MESSAGES ***

NOTE - THE PHYSICAL PROPERTIES FOR THE COLD FLUID SHOWN ON LINES 11 THROUGH 15 ON THE LEFT SIDE OF THE FINAL RESULTS PRINTOUT ARE FOR THE LIQUID PHASE ONLY.

⑥
 JCP 12/31/93
 R4/5/9
 2/8

START-UP YEAR 2000

FINAL RESULTS: PROBLEM DESCRIPTION-F92061 ELF NORGE TCP2 START-UP YAR 2000
 RATING CASE MULTIPASS FLOW IN A T.E.M.A. AEU SHELL WITH DOUBLE-SEG. BAFFLES

CE 607
 ALT. SOLN.-EE

**** PROCESS DATA ****		COLD SHELLSIDE	HOT TUBESIDE	**** SHELLSIDE PERFORMANCE ****	
01 FLUID NAME		CRUDE	TEG30%	01 NOM. VEL, X-FLOW/WINDOW	0.21/ 0.23
02 FLUID CONDITION		SENS. LIQUID	SENS. LIQUID	02 FILM COEF, X-FLOW/WINDOW	1004.0/ 1008.9
03 TOTAL FLOW RATE	(KG/S)	26.678	23.032	03 FLOW FRACTIONS FOR HEAT TRANSFER=	0.577
				04 A=0.003 B=0.443 C=0.009 E=0.033 F=0.511	
04 TEMPERATURE, IN/OUT	(DEG C)	5.1 / 66.1	130.0 / 120.0	**** SHELLSIDE HEAT TRANSFER CORRECTIONS ****	
05 TEMPERATURE, AVERAGE/SKIN	(DEG C)	35.6/ 93.6	150.0/ 144.5	05 TOTAL BETA GAMMA END FIN	
06 PRESSURE, INLET/AVERAGE	(KPA)	1550.0/ 1532.5	0.0/ 0.0	06 0.905 0.905 1.000 0.951 1.000	
07 PRESSURE DROP, TOTAL/ALLOW	(KPA)	2.67/ 35.00	156.28/ 130.00	**** PRESSURE DROPS **** (PERCENT TOTAL DP)	
08 VELOCITY, CALC./MAX.ALLOW	(M/S)	0.16/ 0.00	2.34/ 0.00	07 WIND 39.56 NOZZLE SHELL 12.05/ 7.00	
09 FILM COEF (SAF.FACT)	(W/M2-C)	824.40 (0.95)	10563.81 (1.00)	08 END 21.77 (IN/OUT) TUBE 0.63/ 0.33	
10 FOULING RESISTANCE	(M2-C/W)	0.00054	0.00035	**** H.T. PARAMETERS **** SHELL TUBE	
11 DENSITY	(KG/M3)	894.8578	931.4737	09 WALL CORRECTION	1.135 0.988
12 THERMAL CONDUCTIVITY	(W/M-C)	0.3325	0.5113	10 PRANDTL NO.	258.9 2.9
13 SPECIFIC HEAT CAPACITY	(KJ/KG-C)	3.4327	4.0521	11 AVERAGE REYNOLDS NO.	145 92846
14 VISCOSITY AT AVERAGE TEMP	(MPA-S)	25.06566	0.37056	12 BUNDLE INLET REYNOLDS NO.	77 133873
15 VISCOSITY AT SKIN TEMP	(MPA-S)	10.14872	0.39837	13 BUNDLE OUTLET REYNOLDS NO.	242 60894
				14 FOULING LAYER (MM)	0.00000 0.00000
**** OVERALL PERFORMANCE DATA ****				**** THERMAL RESISTANCES **** (PCT, OVERALL)	
16 TOTAL HEAT DUTY REQUIRED	(MEGAWATTS)		5.600053	15 SHELL TUBE FOULING METAL OVER DES	
17 EFFECTIVE NTU, (LNTD)(F)(DELTA) = (DEG C)		114.39(0.95)(0.97)	= 107.7	16 50.66 4.78 40.24 4.322	-0.543
18 F FACTOR=(TUBE)(BAFFLES)(F/G)(HOT/COLD)=(0.952)(1.000)(1.000)(0.999)				17 TOTAL FOULING RESISTANCE	0.000964
19 OVERALL COEF, REQD/CLEAN/ACTUAL	(W/M2-C)	419.18/ 698.84/ 417.63		18 DIFFERENTIAL RESISTANCE	-0.000011
**** CONSTRUCTION INFORMATION ****					
20 NO. SHELLS SERIES 1 PARALLEL 1	TOTAL SURFACE AREA (M2)		126	**** SHELL NOZZLE INFO. **** INLET OUTLET	
21 NO. PASSES SHELL 1 TUBE 3	EFF. SURF. AREA (M2/SHELL)		122.6	19 INSIDE DIAMETER (MM)	289.1 289.1
22 SHELL I.D. (MM) 740.000	TEMA SHELL TYPE E	REAR HEAD U-T		20 VELOCITY (M/S)	0.43 0.48
23 BAFFLE TYPE VERT DBL. SEG. NO. CROSSPASSES/SHELL PASS			12	21 DENSITY (KG/M3)	945.740 843.976
24 CENTRAL SPACING (MM) 370.000	BAFFLE CUT (PCT. DIA)		26.60	22 NOZZLE R-V-SQ (KG/M-S2)	174 196
25 INLET SPACING (MM) 700.000	CUT AREA(PCT) 1) 42.0 2) 44.4 3) 0.0			23 SHELL ENT. R-V-SQ (KG/M-S2)	174 125
26 OUTLET SPACING (MM) 506.205	CUT HEIGHT FROM CENTER LINE (MM)			24 HEIGHT UNDER NOZZLE (MM)	87.0 87.0
27 BAFFLE THICKNESS (MM) 7.937	POS-1) 173.2 2) 129.2 3) 0.0			** TUBE NOZZLES (RADIAL) ** INLET OUTLET	
28 PAIRS SEAL STRIPS 2	TOT. TUBESHEET (MM) 110.0	IMPINGEMENT PLATE YES		25 INSIDE DIAMETER (MM)	152.0 152.0
29 F-STREAM SEAL RODS (MM) 19.100	NO. 6	PCT. TUBES REM. (HALF) 7.41		26 VELOCITY (M/S)	1.40 1.33
				27 DENSITY (KG/M3)	905.974 956.973
30 TUBE TYPE PLAIN	TUBECOUNT PER SHELL		432	**** DIAMETRAL CLEARANCES ****	
31 OVERALL LENGTH (M) 4.841	TUBE PITCH (MM)		25.3999	28 BAFFLE-TO-SHELL (MM)	4.0090
32 EFFECTIVE LENGTH (M) 4.731	OUTSIDE DIAMETER (MM)		19.100	29 BUNDLE-TO-SHELL (MM)	12.7000
33 LAYOUT ANGLE (DEG) 30	INSIDE DIAMETER (MM)		15.800	30 TUBE-TO-BAFFLEHOLE (MM)	0.7937
34 PITCH RATIO 1.330	SURFACE AREA RATIO (OUT/IN)		1.209	31 MULTI.SEG. BAFFLE OVERLAP (MM)	43.998
35				32	
36 WEIGHT ESTIMATION (KG/SHELL)	DRY 4600	WET 6893			

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START-UP YEAR 2000

PROBLEM DESCRIPTION-P92061 ELF NORGE TCP2 START-UP 2000-

CE-607

FLOW INDUCED VIBRATION ANALYSIS (LEVEL 1.00) SEWS. LIQUID SHELLSIDE

		INLET	CENTER	U-BEND
01	LOG DECREMENT 0.1000 AXIAL STRESS LOADING	0.0		(MPA)
02	BETA 4.958 ADDED MASS FACTOR 2.5233	-----POSITION IN BUNDLE-----		
		INLET	CENTER	U-BEND
03	LENGTH FOR NATURAL FREQUENCY (M)	1.070	0.740	2.032
04	LENGTH/TEMA MAXIMUM SPAN (---)	0.701	0.485	1.079*
05	NUMBER OF SPANS (---)	6	7	1
06	TUBE NATURAL FREQUENCY (HZ)	47.98*	61.23	5.74
07	SHELL ACOUSTIC FREQUENCY (HZ)	---	---	---
	- FLOW VELOCITIES - - - - -			
08	WINDOW PARALLEL VELOCITY (M/S)	0.21	0.22	0.24
09	BUNDLE CROSSFLOW VELOCITY (M/S)	0.08	0.16	0.13
10	BUNDLE/SHELL VELOCITY (M/S)	0.02	0.03	0.02
	- FLUIDELASTIC INSTABILITY CHECK - -			
11	BAFFLE TIP CROSS VELOCITY (M/S)	0.07	0.14	0.11
12	AVERAGE CROSSFLOW VELOCITY (M/S)	0.08	0.16	0.13
13	CRITICAL VELOCITY (M/S)	3.08	3.13	3.18
	- ACOUSTIC VIBRATION CHECK - - - - -			
14	VORTEX SHEDDING RATIO (---)	---	---	---
15	TURBULENT BUFFETING RATIO (---)	---	---	---
	- TUBE VIBRATION CHECK - - - - -			
16	VORTEX SHEDDING RATIO (---)	0.020	0.040	0.031
17	TURBULENT BUFFETING RATIO (---)	---	---	---
18	PARALLEL FLOW AMPLITUDE (MM)	0.000	0.000	0.003
19	CROSSFLOW AMPLITUDE (MM)	0.002	0.001	0.045
20	TUBE GAP (MM)	6.300	6.300	6.300
21	CROSSFLOW RHO-V-SQ (KG/M-SQ)	6.	24.	13.
	- DAMAGE NUMBER CHECK - - - - -			
22	BAFFLE DAMAGE NUMBER (---)	0.0011	0.0019	0.0082
23	COLLISION DAMAGE NUMBER (---)	0.0015	0.0013	0.0431
24	CRITICAL DAMAGE NUMBER LIMIT (---)	0.2354	0.2678	0.2958
25	RHO/SQRT(MU) (LB**5.FT**2.5HR**2.5)	5.5415	7.1730	8.7481

BUNDLE PARAMETERS AT NOZZLES		ENTRANCE	EXIT
26	IMPINGEMENT PLATE	YES	--
27	FLOW AREA (AESC) (M2)	0.0656	0.0819
28	VELOCITY (VESC) (M/S)	0.43	0.39
29	RHO-V-SQ (RV2E) (KG/M-SQ)	175.	126.

30 TEMA E SHELL WITH VERT DBL. SEG. BAFFLES AND U-T BUNDLE
 31
 32 PLAIN 316 S. STL TUBES 19.1000 DIAMETER (MM) 30 DEGREE LAYOUT
 33 PITCH RATIO 1.330

* FREQUENCY RATIOS ARE BASED UPON LOWEST NATURAL OR ACOUSTIC FREQUENCY OMITTING THE U-BEND. CALCULATIONS ASSUME NO INTERMEDIATE SUPPORTS FOR THE U-BEND.

FLOW-INDUCED VIBRATION WARNING MESSAGES

NOTE -- U-BEND EXCEEDS THE TEMA MAXIMUM SPAN. CONSIDER ADDING STIFFNESS TO THE U-BEND REGION.

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PROBLEM DESCRIPTION-F92061 ELF NORGE TCP2 YEAR 2000 -

CASE-CE607

FLOW INDUCED VIBRATION ANALYSIS (LEVEL 1.00) SENS. LIQUID SHELLSIDE

		-----POSITION IN BUNDLE-----		
		INLET	CENTER	U-BEND
01	LOG DECREMENT (0.1000 AXIAL STRESS LOADING	0.0	(MPA)	
02	BETA 2.711 ADDED MASS FACTOR 2.4733			
03	LENGTH FOR NATURAL FREQUENCY (M)	1.070	0.740	2.032
04	LENGTH/TEMA MAXIMUM SPAN (---)	0.701	0.485	1.079*
05	NUMBER OF SPANS (---)	6	7	1
06	TUBE NATURAL FREQUENCY (HZ)	48.55*	61.33	5.68
07	SHELL ACOUSTIC FREQUENCY (HZ)	---	---	---
- FLOW VELOCITIES - - - - -				
08	WINDOW PARALLEL VELOCITY (M/S)	0.77	0.78	0.78
09	BUNDLE CROSSFLOW VELOCITY (M/S)	0.42	0.81	0.60
10	BUNDLE/SHELL VELOCITY (M/S)	0.11	0.22	0.16
- FLUIDELASTIC INSTABILITY CHECK - -				
11	BAFFLE TIP CROSS VELOCITY (M/S)	0.37	0.70	0.51
12	AVERAGE CROSSFLOW VELOCITY (M/S)	0.42	0.81	0.60
13	CRITICAL VELOCITY (M/S)	1.71	1.72	1.72
- ACOUSTIC VIBRATION CHECK - - - - -				
14	VORTEX SHEDDING RATIO (---)	---	---	---
15	TURBULENT BUFFETING RATIO (---)	---	---	---
- TUBE VIBRATION CHECK - - - - -				
16	VORTEX SHEDDING RATIO (---)	0.163	0.310	0.227
17	TURBULENT BUFFETING RATIO (---)	---	---	---
18	PARALLEL FLOW AMPLITUDE (MM)	0.002	0.003	0.044
19	CROSSFLOW AMPLITUDE (MM)	0.044	0.039	1.136*
20	TUBE GAP (MM)	6.300	6.300	6.300
21	CROSSFLOW RHO-V-SQ (KG/M-S2)	164.	593.	319.
- DAMAGE NUMBER CHECK - - - - -				
22	BAFFLE DAMAGE NUMBER (---)	0.0277	0.0477	0.1937*
23	COLLISION DAMAGE NUMBER (---)	0.0406	0.0335	1.0253*
24	CRITICAL DAMAGE NUMBER LIMIT (---)	0.2917	0.2965	0.3013
25	RHO/SQRT(MU) (LB**/5FT**-2.5HR**/S)	8.5067	8.7921	9.0762

BUNDLE PARAMETERS AT NOZZLES		ENTRANCE	EXIT
26	IMPINGEMENT PLATE	YES	---
27	FLOW AREA (AESC) (M2)	0.0656	0.0819
28	VELOCITY (VESC) (M/S)	1.52	1.24
29	RHO-V-SQ (RV2E) (KG/M-S2)	2114.	1377.

30 TEMA E SHELL WITH VERT DBL. SEG. BAFFLES AND U-T BUNDLE
 31
 32 PLAIN 316 S. STL TUBES 19.1000 DIAMETER (MM) 90 DEGREE LAYOUT
 33 PITCH RATIO 1.330

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FLOW-INDUCED VIBRATION WARNING MESSAGES

NOTE -- U-BEND EXCEEDS THE TEMA MAXIMUM SPAN. CONSIDER ADDING STIFFNESS TO THE U-BEND REGION.

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