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Layout

Input values:	*1.234*	or	1.234
Calculated values:	***1.234***	or	**1.234**
Critical values:	*1.234*	or	1.234
Estimated values:	*1.234*	or	1.234

11 EQU
Form for equations

Tables

with comment every three lines

ASME:2017 Example E4.18.9 (not revised) and LV-calculation acc. Add.2013.
Results are arranged in 3 lines. Line1: LV calculation, line 2: ASME,
line 3: difference in %.

psi÷MPa

1	145							
2								
3	0	0	0	0	0	0	0	0

-Stat. tubesheet ---------Sig ---------:---------- ----------Tau ----------:--------:-------								
----- Case1	D1 :	2 D2	: 3 D3	: 1 D1	: 2D2 :	3D3 :	: MaxDiff%	
4	10973	6425	16500	0	0	2250		
5	11000	6420	16500	1260	991	2250		
6	0.2449	0.07788	7.273e-4			0.0176	0	0.2

------- Sigto ----------:								
----- Case1	D1 :	2 D2	: 3 D3 :				: MaxDiff%	
7	2684	2546	5102					
8	2680	2546	5104					
9	0.1531	0.004517	0.03111	0	0	0	0	0.1531

-Float. tubesheet Sig --------:								
----- Case1	D1 :	2 D2	: 3 D3	4 O4	: 5 O1	: 6 O2	: 7 O3	: MaxDiff%
10	4228	750.6	4979	230.4	4091	617.5	4841	
11	4210	748	4950	231	4070	615	4810	
12	0.4315	0.3414	0.5769	0.2475	0.5098	0.4094	0.6357	0.6357

-Float. tubesheet SigC --------:								
----- Case1	D1 :	2 D2	: 3 D3	: 4O4	: 5 O1	: 6 O2	: 7 O3	: MaxDiff%
13	10910	1132	12042	888.7	11799	2020	12931	
14	10900	1120	12000	890	11800	2010	12900	
15	0.09376	1.039	0.3488	0.1485	0.009322	0.5133	0.2367	1.039

Line 16: maxDiff 2009, Line 17: actual calculation								
16	0.2449	0.1614	0.6357	1.039				
17		0.1531	0.6357	1.039				
18		5.431	0	0	0	0	0	5,431
19								

Links

1 11 EQU: psi÷MPa=145
2
3
4 1 UHXc: #138(1)*psi÷MPa: #138(2)*psi÷MPa: #138(3)*psi÷MPa: |#140(1)|*psi÷MPa: |#140(2)|*psi÷MPa: |#140(3)|*psi÷MPa
5 11 EQU: 11000: 6420: 16500: 1260: 991: 2250
6
7 1 UHXc: #263(1)*psi÷MPa: #263(2)*psi÷MPa: #263(3)*psi÷MPa
8 11 EQU: 2680: 2546: 5104
9
10 1 UHXc: #138(4)*psi÷MPa: #138(5)*psi÷MPa: #138(6)*psi÷MPa: #138(7)*psi÷MPa: #138(8)*psi÷MPa: #138(9)*psi÷MPa: #138
11 11 EQU: 4210:748: 4950: 231: 4070: 615: 4810
12
13 1 UHXc: #148(4)*psi÷MPa: #148(5)*psi÷MPa: #148(6)*psi÷MPa: #148(7)*psi÷MPa: #148(8)*psi÷MPa: #148(9)*psi÷MPa: #148
14 11 EQU: 10900: 1120: 12000: 890: 11800: 2010: 12900
15

16 '11 EQU: #187: #211: #235: #259
17 11 EQU: #187: #211: #235: #259
18
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Additional comments

Maximum difference between LV and ASME for stationary and floating tubesheet stresses are 1% for UHX-20.3.2.

Units		**Value**	**Unit**		**Selected Unit**
Conversion	#121=			= #123 =	

1 Stat UHXc D1
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

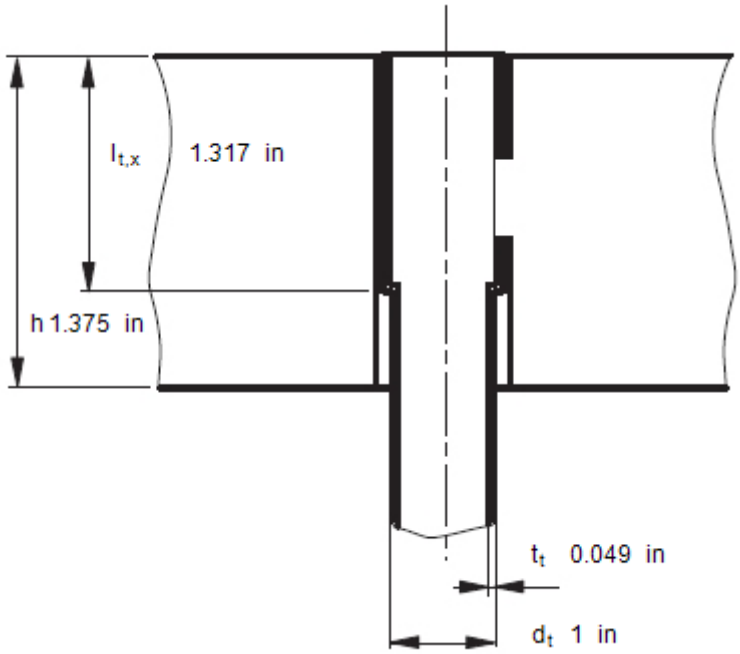
Type of heat exchanger (a,b,c)	WArt	b		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	d		a-f,A-D
Stationary tubesheet gasketed with shell and channel				
Type of channel (1=Cylinder, 2=Hemispherical)			1	(1,2)
Shell side internal operation pressure	P_s		150	psi
Tube side internal operation pressure	P_t		30	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			1	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			1	(1-7)
Tube side pressure only (Ps=0) without thermal expansion				

Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	1.375	in		in	0.049	in		in
Outsidediameter	51	in		in	1	in		in
Poiss.-rat.	0.32		0.3		0.32		0.3	
Allow. c1	0	in		in	0	in		in
Corr.all.c2	0	in		in	0	in		in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	1.48e+7	psi		psi	1.48e+7	psi		psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.	31600	psi		psi	31600	psi		psi
Limit temperature		°F		°F		°F		°F
All.stress	11300	psi	**0**	psi	11300	psi	**0**	psi
Pr.+sec.st	33900	psi	**0**	psi	33900	psi		psi
Properties for testing at 20°C								
Strength	0	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

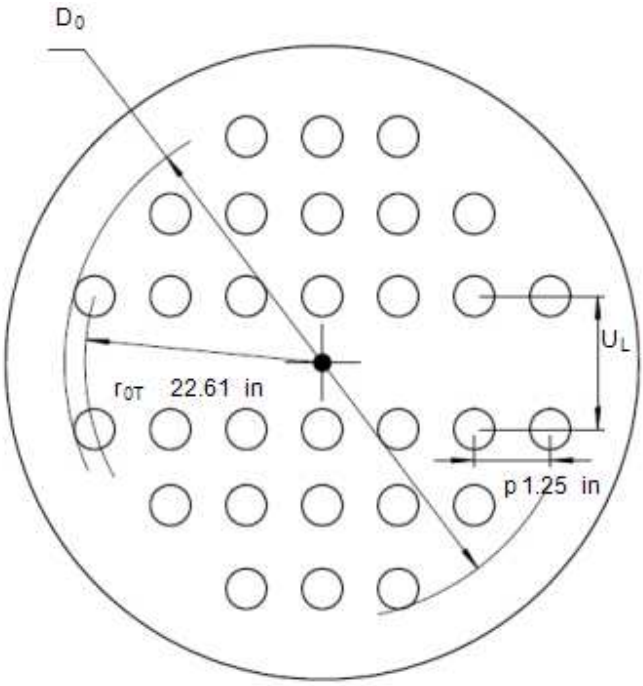
Additional specifications for the geometry and loading

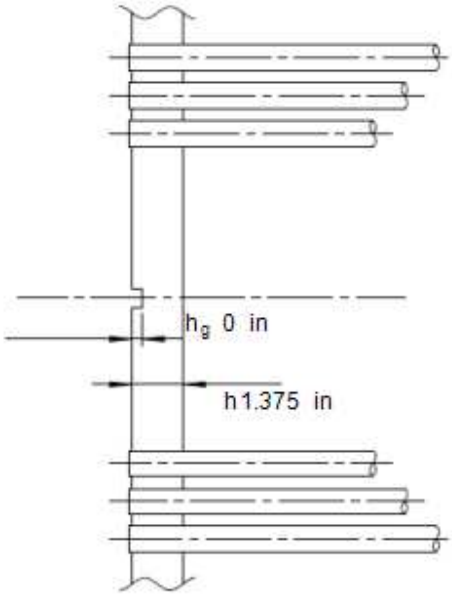
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	1	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	1	(1, 2)
Number of tubes	N_t	1189	



Expanded length of tube in tubesheet		$l_{t,x}$	**1.317**	in
Expanded length ratio $l_{t,x}/h$		ρ	0.958	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	22.61	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)				p	1.25	in
Total untubed area UL1·LL1+UL2·LL2..	UHX-11.2			A_L	0	in²
Depth of tube side pass partition groove				h_g	0	in
Expanded length ratio ltx/h				ρ	0.958	
Tube length between inner tubesheet faces				L	141.3	in
Unsupported tube span for buckling				l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)				k		
Equivalent free buckling length k · l				l_t	16	in
Flange						
Bolt number				n		-
Bolt root diameter				d_B		in
Total bolt area				A_b	0	in²
Bolt material						
Strength operation				K_s		psi
Strength test				K_{sp}		psi
Safety operation				S_s		-
Safety test				S_{sp}		-
Stress increase factor (1.5 acc. App.S)				F_s	1.5	-

Gasket		**Shell Type d,e,f**		**Channel Type B,b,c,d**	
Contact outside diameter	G_a		in		in
Contact inside diameter	G_i		in		in
Theoretical seating width	b_0		in		in
Gasket factor (Table 2-5.1)	m				
Gasket seating pressure	Y		psi	0	psi
Diameter of gasket force	G	49.71	in	49.62	in
Poisson's ratio	v	0.3		0.3	

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W		lbf		lbf
Gasket operating force	W		lbf	288910	lbf
Total required bolt area	A_m		in²		in²
Flange thickness	h_r		in		in

Maximum bolt force for all calculation casese		W_{max}	0	lbf
Bolt root area	0 in² :			

Results acc. to UHX-14

Gasket seating force = $0.5(A_m+A_b)\cdot K_{sp}/S_{sp}$, App.2-5	W	288910	lbf
Channel thickness without allowances	t_c		in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**24.81**	in
Radial shell dimension	a_s	**24.86**	in
Ratio = a_c/a_0	ρ_C	**1.074**	
Ratio = a_s/a_0	ρ_S	**1.076**	
Parameter = $1-N_t\cdot(0.5\cdot d_a TUBE/a_0)^2$	x_s	**0.4432**	
Parameter = $1-N_t\cdot(0.5\cdot d_i TUBE/a_0)^2$	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E*	**4148972**	psi
Ratio of elasticity tubesheet								E*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v*	**0.3374**	
Effective pitch								p*	**1.25**	in
Effective tube hole diameter								d*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.842**	
Z_d	**0.002143**	Z_v	**0.013**	Z_m	**0.1634**	Z_a	**3162**	Z_w	**0.013**	

Step 4

Diameter ratio = A/D0							K	**1.104**	
F	**0.2331**	Φ		**0.3118**			Q_1	**0.06821**	

UHX-14.5.5 Step 5: Coefficients

			ω_S	**0**	in²		ω_S*	**1.589**	in²
ω_C	**0**	in²	ω_C*	**0.9605**	in²		γ_b	**-2.03e-3**	

Results acc. to UHX-14.6 and step 6

T_r =	**68**	°F	T_s* =	**68**	°F		T_c*	**68**	°F
P_s* =	**0**	psi	P_c* =	**0**	psi		P_e	**-30**	psi

UHX-14.5.7 Step 7

Q_2	**-116.4**	lbf	Q_3	**0.08275**			F_m	**0.05941**	
Strength condition for the tubesheet bending stress, case								1	:
σ =	**10976**	psi	<1.5· σ_B =	**16950**	psi		case 1-3		
			< S_{PS} =	33900	psi		case 4-7		

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	<0.8· σ_B =	**9040**	psi

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old N)

F_q	**9.835**		F_s	**1.25**					
Strength condition for the tube stress with cacluation case								1	:
S_{To} =	**2685**	psi	≤ σ_T =	11300	psi		for calculation case 1-3		
S_{To}			≤ 2·σ_T =	**22600**	psi		for calculation case 4-7		
$\lvert S_{To} \rvert$			≤ S_{tb} =	**11300**	psi		(for S_{To} < 0, Buckling)		
r_t	**0.3367**	in	F_t	**47.52**			C_t	**96.15**	

Strength acc. UHX-14.5.9 satisfied

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert \sigma_{Sm} \rvert$ + $\lvert \sigma_{Sb} \rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}					
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
σ_C = $\lvert \sigma_{Cm} \rvert$ + $\lvert \sigma_{Cb} \rvert$ =			**0**	psi	< 1.5 · σ_{allC} or S_{PSc}					
σ_C =	**0**	psi	+	**0**	psi	<	**0**	psi		

Condition UHX-14.5.10 not required for configurations dBCD

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

2 Stat UHXc D2
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

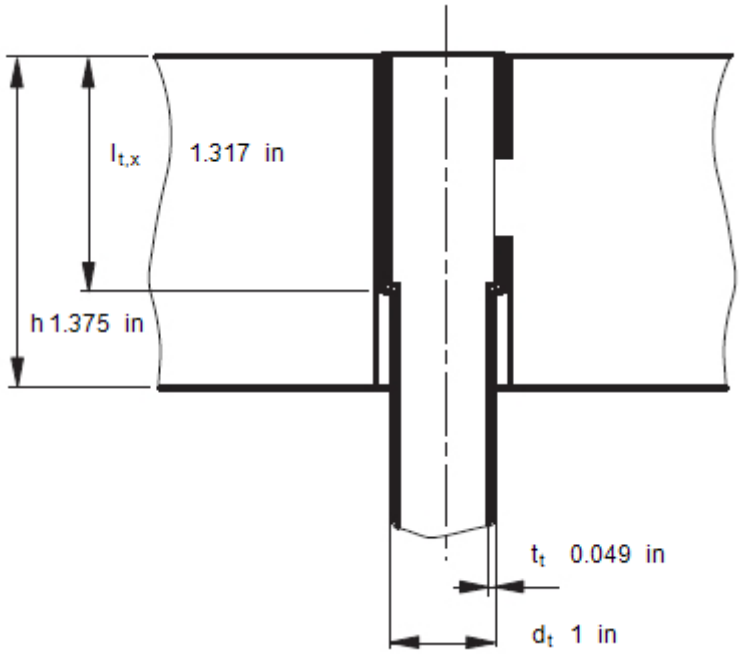
Type of heat exchanger (a,b,c)	WArt	b		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	d		a-f,A-D
Stationary tubesheet gasketed with shell and channel				
Type of channel (1=Cylinder, 2=Hemispherical)			1	(1,2)
Shell side internal operation pressure	P_s		150	psi
Tube side internal operation pressure	P_t		30	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			1	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			2	(1-7)
Shell side pressure only (Pt=0) without thermal expansion				

	Tubesheet		Shell		Tubes		Channel	
Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation								
Temperature		°F		°F		°F		°F
Thickness	1.375	in		in	0.049	in		in
Outsidediameter	51	in		in	1	in		in
Poiss.-rat.	0.32		0.3		0.32		0.3	
Allow. c1	0	in		in	0	in		in
Corr.all.c2	0	in		in	0	in		in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	1.48e+7	psi		psi	1.48e+7	psi		psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.	31600	psi		psi	31600	psi		psi
Limit temperature		°F		°F		°F		°F
All.stress	11300	psi	**0**	psi	11300	psi	**0**	psi
Pr.+sec.st	33900	psi	**0**	psi	33900	psi		psi
Properties for testing at 20°C								
Strength	0	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

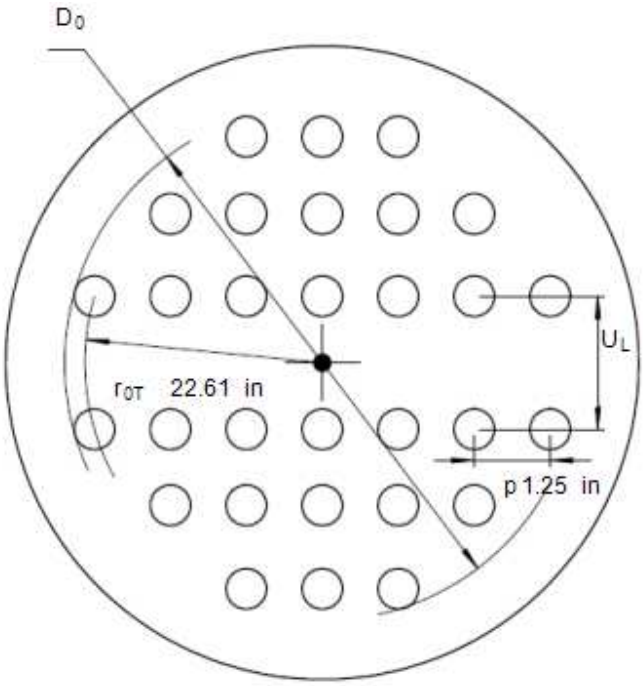
Additional specifications for the geometry and loading

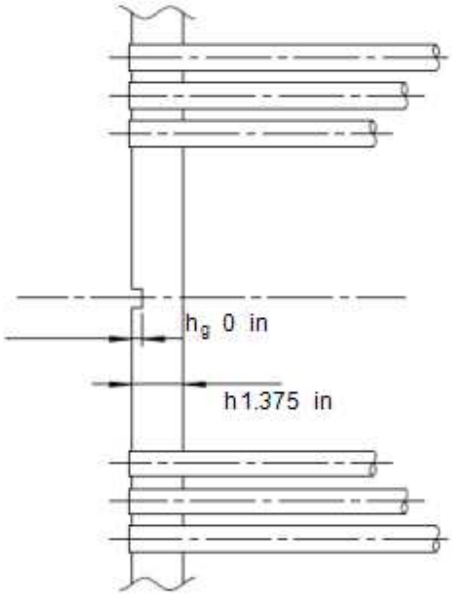
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	1	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	1	(1, 2)
Number of tubes	N_t	1189	



Expanded length of tube in tubesheet		$l_{t,x}$	**1.317**	in
Expanded length ratio $l_{t,x}/h$		ρ	0.958	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	22.61	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)				p	1.25	in
Total untubed area UL1·LL1+UL2·LL2..	UHX-11.2			A_L	0	in²
Depth of tube side pass partition groove				h_g	0	in
Expanded length ratio ltx/h				ρ	0.958	
Tube length between inner tubesheet faces				L	141.3	in
Unsupported tube span for buckling				l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)				k		
Equivalent free buckling length k · l				l_t	16	in
Flange						
Bolt number				n		-
Bolt root diameter				d_B		in
Total bolt area				A_b	0	in²
Bolt material						
Strength operation				K_s		psi
Strength test				K_{sp}		psi
Safety operation				S_s		-
Safety test				S_{sp}		-
Stress increase factor (1.5 acc. App.S)				F_s	1.5	-

Gasket		**Shell Type d,e,f**		**Channel Type B,b,c,d**	
Contact outside diameter	G_a		in		in
Contact inside diameter	G_i		in		in
Theoretical seating width	b_0		in		in
Gasket factor (Table 2-5.1)	m				
Gasket seating pressure	Y		psi	0	psi
Diameter of gasket force	G	49.71	in	49.62	in
Poisson's ratio	v	0.3		0.3	

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W		lbf		lbf
Gasket operating force	W		lbf	288910	lbf
Total required bolt area	A_m		in²		in²
Flange thickness	h_r		in		in

Maximum bolt force for all calculation casese				W_{max}	0 lbf
Bolt root area	0 in²	:			

Results acc. to UHX-14

Gasket seating force = $0.5(A_m+A_b)\cdot K_{sp}/S_{sp}$, App.2-5	W	288910	lbf
Channel thickness without allowances	t_c		in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**24.81**	in
Radial shell dimension	a_s	**24.86**	in
Ratio = a_c/a_0	ρ_C	**1.074**	
Ratio = a_s/a_0	ρ_S	**1.076**	
Parameter = $1-N_t\cdot(0.5\cdot d_a TUBE/a_0)^2$	x_s	**0.4432**	
Parameter = $1-N_t\cdot(0.5\cdot d_i TUBE/a_0)^2$	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E^*	**4148972**	psi
Ratio of elasticity tubesheet								E^*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v^*	**0.3374**	
Effective pitch								p^*	**1.25**	in
Effective tube hole diameter								d^*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.842**	
Z_d	**0.002143**	Z_v	**0.013**	Z_m	**0.1634**	Z_a	**3162**	Z_w	**0.013**	

Step 4

Diameter ratio = A/D0							K	**1.104**
F	**0.2331**	Φ		**0.3118**			Q_1	**0.06821**

UHX-14.5.5 Step 5: Coefficients

		ω_S		**0**	in²	ω_S^*	**1.589**	in²
ω_C	**0** in²	ω_C^*		**0.9605**	in²	γ_b	**-2.03e-3**	

Results acc. to UHX-14.6 and step 6

T_r =	**68** °F	T_s^* =		**68**	°F	T_c^*	**68**	°F
P_s^* =	**0** psi	P_c^* =		**0**	psi	P_e	**-23.58**	psi

UHX-14.5.7 Step 7

Q_2	**137.8** lbf	Q_3		**0.04632**		F_m	**0.04425**	
Strength condition for the tubesheet bending stress, case							2	:
σ =	**6427** psi	$<1.5\cdot\sigma_B$ =		**16950**	psi		case 1-3	
		$< S_{PS}$ =		33900	psi		case 4-7	

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0** psi	$<0.8\cdot\sigma_B$ =	**9040**	psi	

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old N)

F_q	**8.388**	F_s		**1.25**				
Strength condition for the tube stress with cacluation case							2	:
S_{To} =	**2547** psi	$\le \sigma_T$ =		11300	psi	for calculation case 1-3		
S_{To}		$\le 2\cdot\sigma_T$ =		**22600**	psi	for calculation case 4-7		
$\lvert S_{To}\rvert$		$\le S_{tb}$ =		**11300**	psi	(for $S_{To} < 0$, Buckling)		
r_t	**0.3367** in	F_t		**47.52**		C_t	**96.15**	

Strength acc. UHX-14.5.9 satisfied

Step 10: Stress σ_S in the shell and σ_C in the channel

$\sigma_S = \lvert\sigma_{Sm}\rvert + \lvert\sigma_{Sb}\rvert =$		**0**	psi	$< 1.5 \cdot \sigma_{allS}$, S_{PSs} or S_{PSs1}						
$\sigma_S =$	**0** psi	$\lvert +\rvert$	**0** psi	$\lvert <$	**0** psi					
$\sigma_C = \lvert\sigma_{Cm}\rvert + \lvert\sigma_{Cb}\rvert =$		**0**	psi	$< 1.5 \cdot \sigma_{allC}$ or S_{PSc}						
$\sigma_C =$	**0** psi	$\lvert +\rvert$	**0** psi	$\lvert <$	**0** psi					

Condition UHX-14.5.10 not required for configurations dBCD

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

3 Stat UHXc D3
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

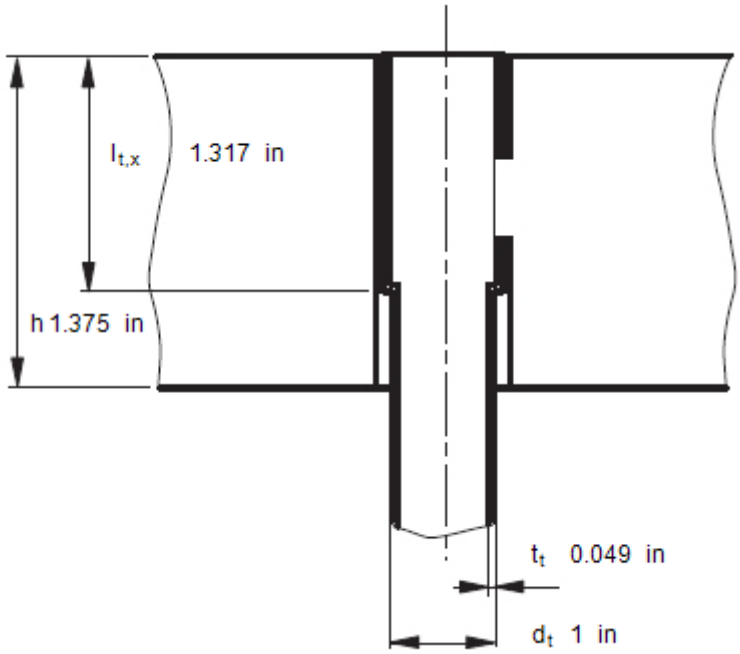
Type of heat exchanger (a,b,c)	WArt	b		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	d		a-f,A-D
Stationary tubesheet gasketed with shell and channel				
Type of channel (1=Cylinder, 2=Hemispherical)			1	(1,2)
Shell side internal operation pressure	P_s		150	psi
Tube side internal operation pressure	P_t		30	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			1	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			3	(1-7)
Tube and shell side pressure acting without thermal expansion				

Tubesheet material									
Shell material (Type abc)									
Tube material									
Channel material(Type aefA)									
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**		
Temperature		°F		°F		°F			°F
Thickness	1.375	in		in	0.049	in			in
Outsidediameter	51	in		in	1	in			in
Poiss.-rat.	0.32		0.3		0.32		0.3		
Allow. c1	0	in		in	0	in			in
Corr.all.c2	0	in		in	0	in			in
Figure									
Strength for the selected load case temperature									
Strength		psi		psi		psi			psi
Safety									
E-module	1.48e+7	psi		psi	1.48e+7	psi			psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F			1E-6/°F
Yield str.	31600	psi		psi	31600	psi			psi
Limit temperature		°F		°F		°F			°F
All.stress	11300	psi	**0**	psi	11300	psi		**0**	psi
Pr.+sec.st	33900	psi	**0**	psi	33900	psi			psi
Properties for testing at 20°C									
Strength	0	psi	0	psi	0	psi		0	psi
Safety									
Yield str.		psi		psi		psi			psi
Tensile str.		psi		psi		psi			psi

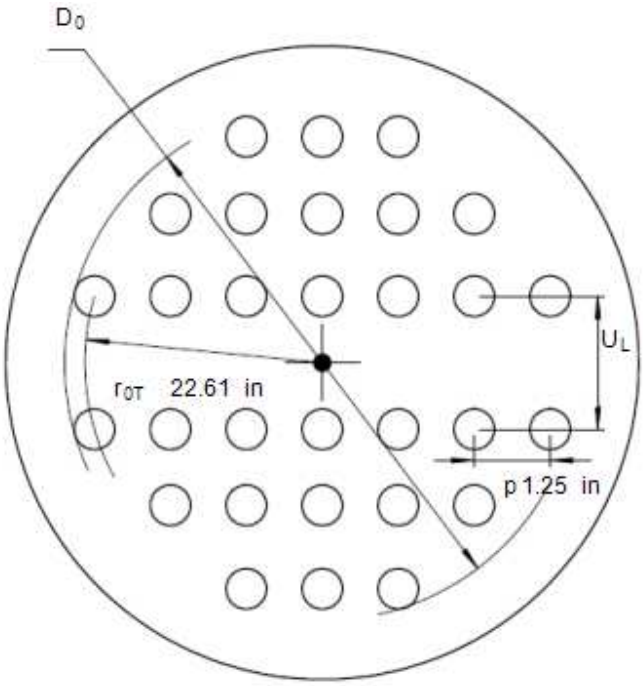
Additional specifications for the geometry and loading

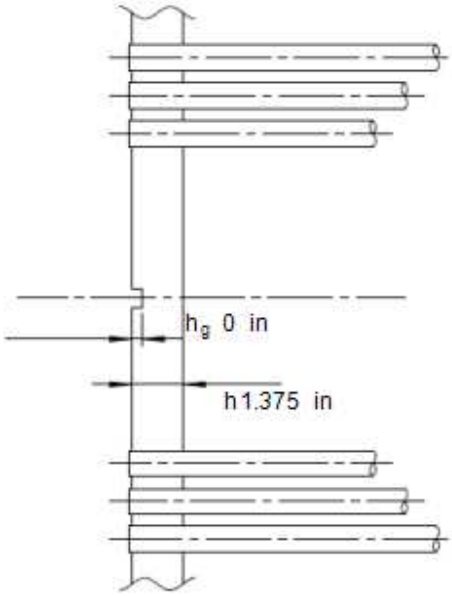
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	1	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	1	(1, 2)
Number of tubes	N_t	1189	



Expanded length of tube in tubesheet		$l_{t,x}$	**1.317**	in
Expanded length ratio $l_{t,x}/h$		ρ	0.958	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	22.61	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)				p	1.25	in
Total untubed area UL1·LL1+UL2·LL2..	UHX-11.2			A_L	0	in²
Depth of tube side pass partition groove				h_g	0	in
Expanded length ratio ltx/h				ρ	0.958	
Tube length between inner tubesheet faces				L	141.3	in
Unsupported tube span for buckling				l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)				k		
Equivalent free buckling length k · l				l_t	16	in
Flange						
Bolt number				n		-
Bolt root diameter				d_B		in
Total bolt area				A_b	0	in²
Bolt material						
Strength operation				K_s		psi
Strength test				K_{sp}		psi
Safety operation				S_s		-
Safety test				S_{sp}		-
Stress increase factor (1.5 acc. App.S)				F_s	1.5	-

Gasket		**Shell Type d,e,f**		**Channel Type B,b,c,d**	
Contact outside diameter	G_a		in		in
Contact inside diameter	G_i		in		in
Theoretical seating width	b_0		in		in
Gasket factor (Table 2-5.1)	m				
Gasket seating pressure	Y		psi	0	psi
Diameter of gasket force	G	49.71	in	49.62	in
Poisson's ratio	v	0.3		0.3	

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W		lbf		lbf
Gasket operating force	W		lbf	288910	lbf
Total required bolt area	A_m		in²		in²
Flange thickness	h_r		in		in

Maximum bolt force for all calculation casese				W_{max}	0 lbf
Bolt root area	0 in²	:			

Results acc. to UHX-14

Gasket seating force = $0.5(A_m+A_b)\cdot K_{sp}/S_{sp}$, App.2-5	W	288910	lbf
Channel thickness without allowances	t_c		in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**24.81**	in
Radial shell dimension	a_s	**24.86**	in
Ratio = a_c/a_0	ρ_C	**1.074**	
Ratio = a_s/a_0	ρ_S	**1.076**	
Parameter = $1-N_t\cdot(0.5\cdot d_a TUBE/a_0)^2$	x_s	**0.4432**	
Parameter = $1-N_t\cdot(0.5\cdot d_i TUBE/a_0)^2$	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E*	**4148972**	psi
Ratio of elasticity tubesheet								E*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v*	**0.3374**	
Effective pitch								p*	**1.25**	in
Effective tube hole diameter								d*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.842**	
Z_d	**0.002143**	Z_v	**0.013**	Z_m	**0.1634**	Z_a	**3162**	Z_w	**0.013**	

Step 4

Diameter ratio = A/D0							K	**1.104**	
F	**0.2331**	Φ		**0.3118**			Q_1	**0.06821**	

UHX-14.5.5 Step 5: Coefficients

			ω_S	**0**	in²		ω_S*	**1.589**	in²
ω_C	**0**	in²	ω_C*	**0.9605**	in²		γ_b	**-2.03e-3**	

Results acc. to UHX-14.6 and step 6

T_r =	**68**	°F	T_s* =	**68**	°F		T_c*	**68**	°F
P_s* =	**0**	psi	P_c* =	**0**	psi		P_e	**-53.58**	psi

UHX-14.5.7 Step 7

Q_2	**110.4**	lbf	Q_3	**0.06049**			F_m	**0.05002**	
Strength condition for the tubesheet bending stress, case								3	:
σ =	**16504**	psi	<1.5· σ_B =	**16950**	psi			case 1-3	
			< S_{PS} =	33900	psi			case 4-7	

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	<0.8· σ_B =	**9040**	psi

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old N)

F_q	**8.951**		F_s	**1.25**					
Strength condition for the tube stress with cacluation case								3	:
S_{To} =	**5104**	psi	≤ σ_T =	11300	psi		for calculation case 1-3		
S_{To}			≤ 2·σ_T =	**22600**	psi		for calculation case 4-7		
$\lvert S_{To} \rvert$			≤ S_{tb} =	**11300**	psi		(for S_{To} < 0, Buckling)		
r_t	**0.3367**	in	F_t	**47.52**			C_t	**96.15**	

Strength acc. UHX-14.5.9 satisfied

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert \sigma_{Sm} \rvert$ + $\lvert \sigma_{Sb} \rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}					
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
σ_C = $\lvert \sigma_{Cm} \rvert$ + $\lvert \sigma_{Cb} \rvert$ =			**0**	psi	< 1.5 · σ_{allC} or S_{PSc}					
σ_C =	**0**	psi	+	**0**	psi	<	**0**	psi		

Condition UHX-14.5.10 not required for configurations dBCD

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

4 Float UHXc D1
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

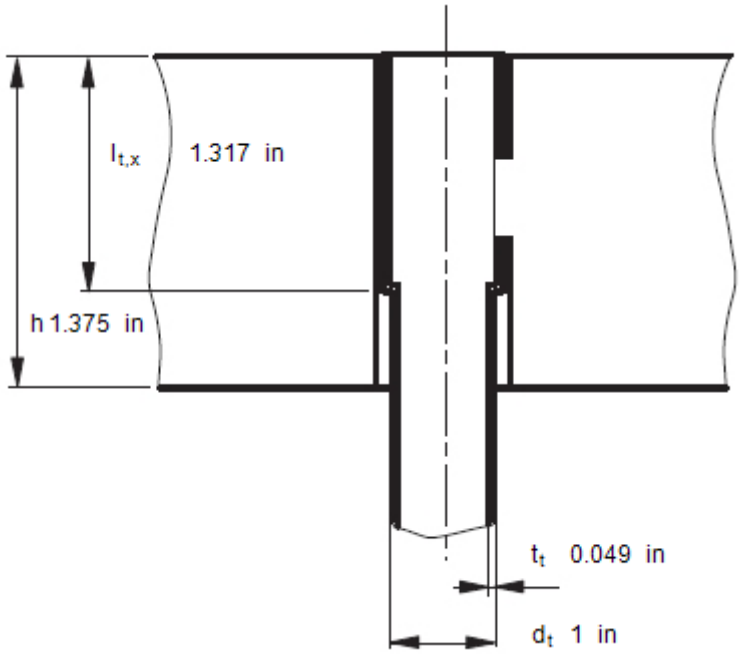
Type of heat exchanger (a,b,c)	WArt	*b*		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	*A*		a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure	P_s		*150*	psi
Tube side internal operation pressure	P_t		*30*	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			1	(1-7)
Tube side pressure only (Ps=0) without thermal expansion				

	Tubesheet		Shell		Tubes		Channel	
Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation								
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.	31600	psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

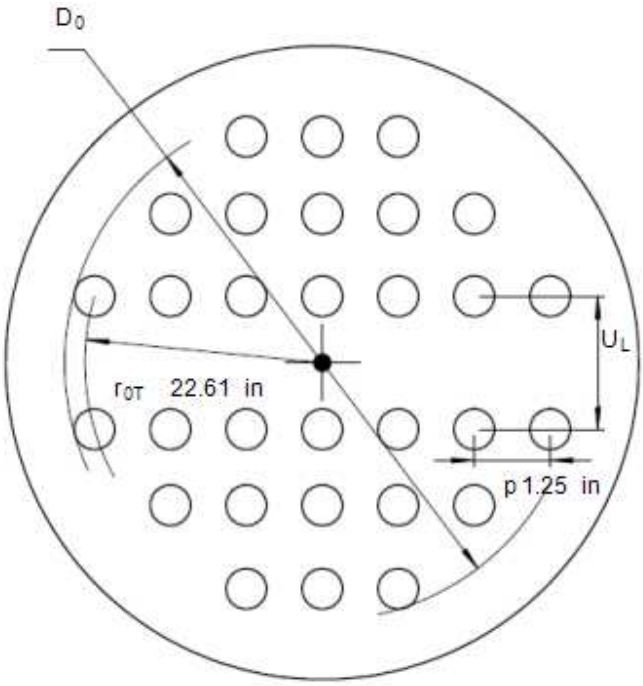
Additional specifications for the geometry and loading

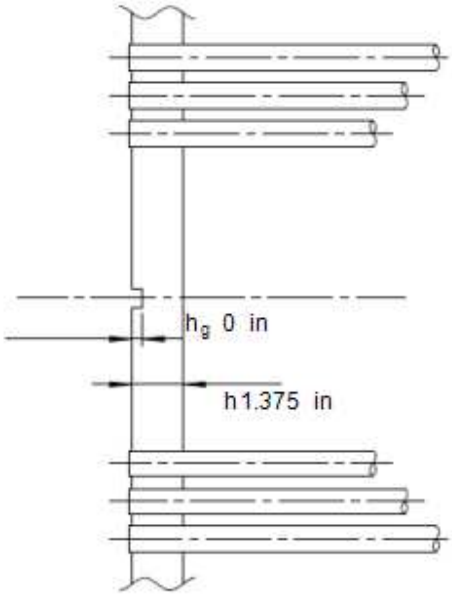
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	*1*	(1, 2)
Number of tubes	N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	***1.317***	in
Expanded length ratio $l_{t,x}$/h		ρ	0.958	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	0.958	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area 0 in² : **sufficient**

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	0	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)²	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)²	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E*	**4148972**	psi
Ratio of elasticity tubesheet								E*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v*	**0.3374**	
Effective pitch								p*	**1.25**	in
Effective tube hole diameter								d*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0								K	**1.031**	
F	**1.343**		Φ		**1.796**			Q_1	**-4.96e-3**	

UHX-14.5.5 Step 5: Coefficients

			ω_S		**0**	in²		ω_S*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C*		**-3.051**	in²		γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s* =		**68**	°F		T_c*	**226.3**	°F
P_s* =	**0**	psi	P_c* =		**0**	psi		P_e	**-30**	psi

UHX-14.5.7 Step 7

Q_2	**70.69**	lbf	Q_3		**-0.01379**			F_m	**0.02289**	
Strength condition for the tubesheet bending stress, case									1	:
σ =	**4229**	psi	<1.5· σ_B	=	**16950**	psi			case 1-3	
			< S_{PS}	=	*33900*	psi			case 4-7	

Step 8

Strength condition for the tubesheet shear stress:										
τ =	**0**	psi	<0.8· σ_B	=	**9040**	psi				

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N* **)**

F_q	**5.982**		F_s		**1.25**					
Strength condition for the tube stress with cacluation case									1	:
S_{To} =	**1571**	psi	≤ σ_T	=	*11300*	psi		for calculation case 1-3		
S_{To}			≤ 2·σ_T	=	**22600**	psi		for calculation case 4-7		
$\lvert S_{To} \rvert$			≤ S_{tb}	=	**11300**	psi		(for S_{To} < 0, Buckling)		
r_t	**0.3367**	in	F_t		**47.52**			C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert \sigma_{Sm} \rvert$ + $\lvert \sigma_{Sb} \rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}					
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
σ_C = $\lvert \sigma_{Cm} \rvert$ + $\lvert \sigma_{Cb} \rvert$ =			**10913**	psi	< 1.5 · σ_{allC} or S_{PSc}					
σ_C =	**1121**	psi	+	**9792**	psi	<	**16950**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: Yes):

Strength conditions are valid for all calculation cases

5 Float UHXc-2 D2
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

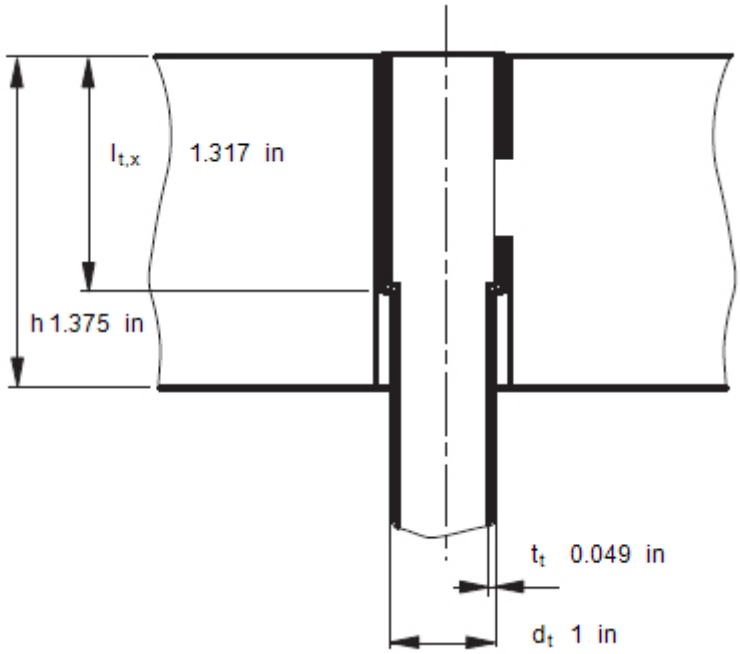
Floating tubesheet according to ASME-UHX-14

Type of heat exchanger (a,b,c)		WArt	*b*	a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)		Type	*A*	a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure		P_s	*150*	psi
Tube side internal operation pressure		P_t	*30*	psi
Shell side internal test pressure		P_{sp}		psi
Tube side internal test pressure		P_{tp}		psi
Load case	(1=operation, 2+3=test at 20°C, 4=other)		*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			2	(1-7)
Shell side pressure only (Pt=0) without thermal expansion				

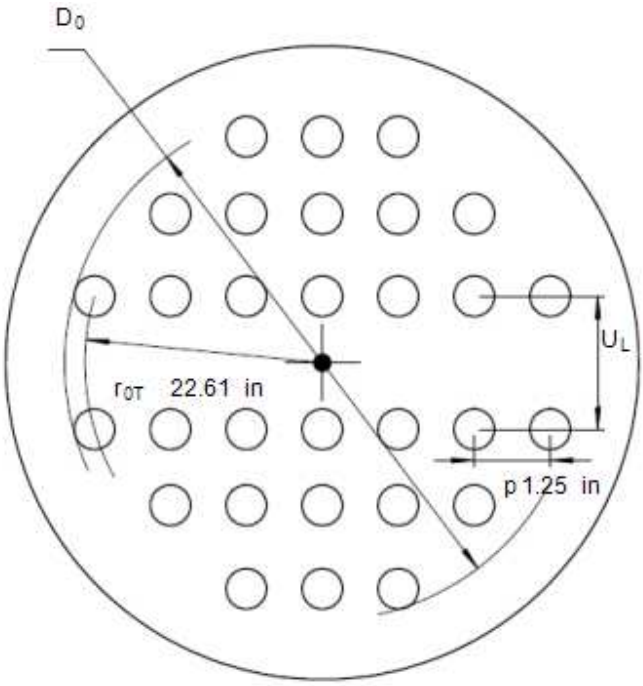
Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

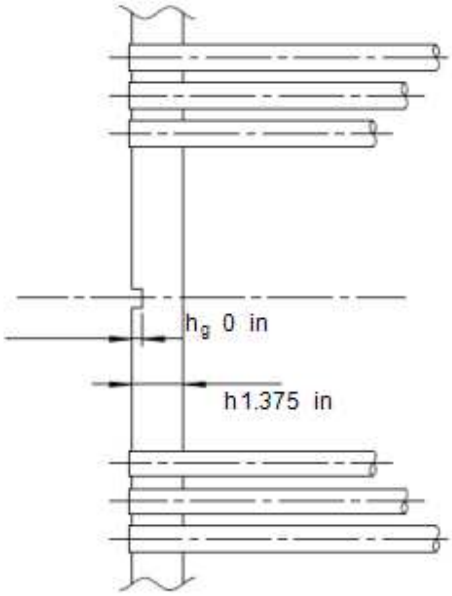
Additional specifications for the geometry and loading

Tubesheet				
Tube-tubesheet joint	(1=expanded, 2=welded)		*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)		*1*	(1, 2)
Number of tubes		N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)²	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)²	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E*	**4148987**	psi
Ratio of elasticity tubesheet								E*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v*	**0.3374**	
Effective pitch								p*	**1.25**	in
Effective tube hole diameter								d*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0								K	**1.031**	
F	**1.343**		Φ		**1.796**			Q_1	**-4.96e-3**	

UHX-14.5.5 Step 5: Coefficients

			ω_S		**0**	in²	ω_S*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C*		**-3.051**	in²	γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s* =		**68**	°F	T_c*	**226.3**	°F	
P_s* =	**0**	psi	P_c* =		**0**	psi	P_e	**-5.173**	psi	

UHX-14.5.7 Step 7

Q_2	**9.116**	lbf	Q_3		**-0.01156**		F_m	**0.02357**	
Strength condition for the tubesheet bending stress, case								2	:
σ =	**750.7**	psi	<1.5· σ_B =		**16950**	psi		case 1-3	
			< S_{PS} =		*33900*	psi		case 4-7	

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	<0.8· σ_B =	**9040**	psi	

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N*)

F_q	**6.07**		F_s		**1.25**				
Strength condition for the tube stress with cacluation case								2	:
S_{To} =	**943**	psi	≤ σ_T =		*11300*	psi	for calculation case 1-3		
S_{To}			≤ 2·σ_T =		**22600**	psi	for calculation case 4-7		
$\lvert S_{To} \rvert$			≤ S_{tb} =		**11300**	psi	(for S_{To} < 0, Buckling)		
r_t	**0.3367**	in	F_t		**47.52**		C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert \sigma_{Sm} \rvert$ + $\lvert \sigma_{Sb} \rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}					
σ_S =	**0**	psi	| + |	**0**	psi	| <	**0**	psi		
σ_C = $\lvert \sigma_{Cm} \rvert$ + $\lvert \sigma_{Cb} \rvert$ =			**1132**	psi	< 1.5 · σ_{allC} or S_{PSc}					
σ_C =	**0**	psi	| + |	**1132**	psi	| <	**16950**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

6 Float UHXc-D3
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

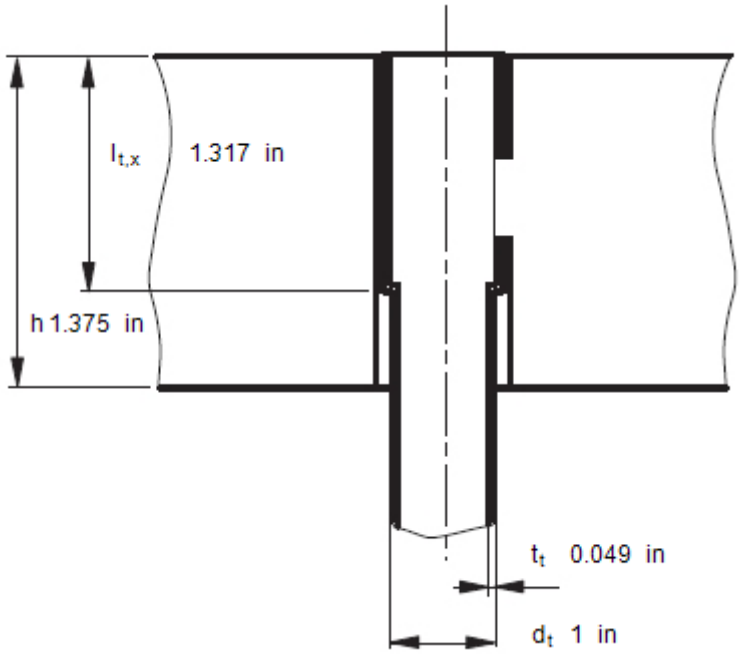
Floating tubesheet according to ASME-UHX-14

Type of heat exchanger (a,b,c)		WArt	*b*	a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)		Type	*A*	a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure		P_s	*150*	psi
Tube side internal operation pressure		P_t	*30*	psi
Shell side internal test pressure		P_{sp}		psi
Tube side internal test pressure		P_{tp}		psi
Load case	(1=operation, 2+3=test at 20°C, 4=other)		*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			3	(1-7)
Tube and shell side pressure acting without thermal expansion				

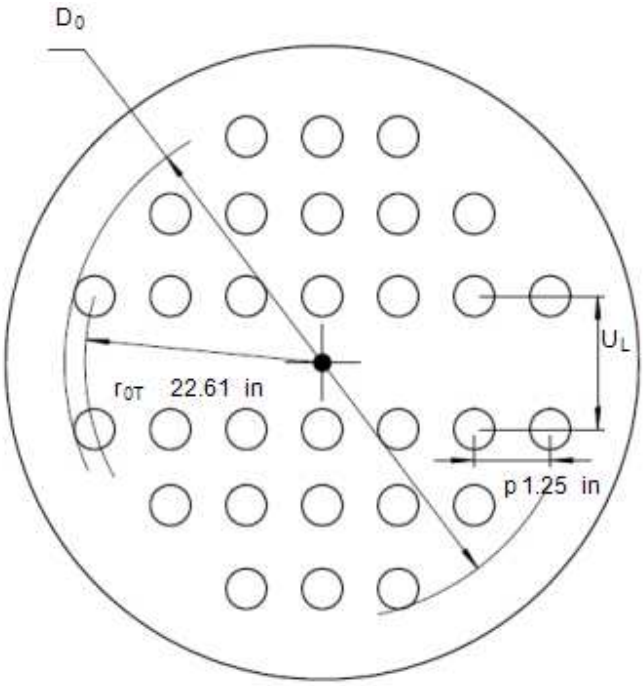
Tubesheet material							
Shell material (Type abc)							
Tube material							
Channel material(Type aefA)							
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**
Temperature		°F		°F		°F	°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125* in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63* in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*
Allow. c1	*0*	in		in	*0*	in	*0* in
Corr.all.c2	*0*	in		in	*0*	in	*0* in
Figure							
Strength for the selected load case temperature							
Strength		psi		psi		psi	psi
Safety							
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7* psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F	1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600* psi
Limit temperature		°F		°F		°F	°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300* psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900* psi
Properties for testing at 20°C							
Strength	*0*	psi	0	psi	0	psi	0 psi
Safety							
Yield str.		psi		psi		psi	psi
Tensile str.		psi		psi		psi	psi

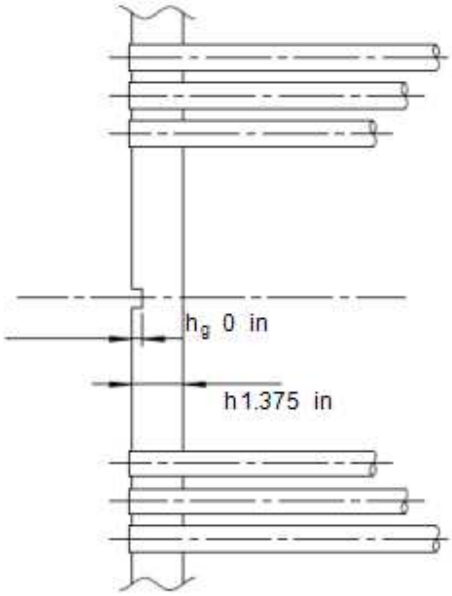
Additional specifications for the geometry and loading

Tubesheet				
Tube-tubesheet joint	(1=expanded, 2=welded)		*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)		*1*	(1, 2)
Number of tubes		N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)²	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)²	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E^*	**4148987**	psi
Ratio of elasticity tubesheet								E^*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v^*	**0.3374**	
Effective pitch								p^*	**1.25**	in
Effective tube hole diameter								d^*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0							K	**1.031**
F	**1.343**	Φ		**1.796**			Q_1	**-4.96e-3**

UHX-14.5.5 Step 5: Coefficients

		ω_S		**0**	in²	ω_S^*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C^*	**-3.051**	in²	γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s^* =	**68**	°F	T_c^*	**226.3**	°F		
P_s^* =	**0**	psi	P_c^* =	**0**	psi	P_e	**-35.17**	psi		

UHX-14.5.7 Step 7

Q_2	**79.81**	lbf	Q_3	**-0.01346**		F_m	**0.02299**	
Strength condition for the tubesheet bending stress, case							3	:
σ =	**4980**	psi	$<1.5\cdot\sigma_B$ =	**16950**	psi		case 1-3	
			$< S_{PS}$ =	*33900*	psi		case 4-7	

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	$<0.8\cdot\sigma_B$ =	**9040**	psi

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N*)

F_q	**5.995**		F_s	**1.25**				
Strength condition for the tube stress with cacluation case							3	:
S_{To} =	**2514**	psi	$\le \sigma_T$ =	*11300*	psi	for calculation case 1-3		
S_{To}			$\le 2\cdot\sigma_T$ =	**22600**	psi	for calculation case 4-7		
$\lvert S_{To}\rvert$			$\le S_{tb}$ =	**11300**	psi	(for $S_{To} < 0$, Buckling)		
r_t	**0.3367**	in	F_t	**47.52**		C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

$\sigma_S = \lvert\sigma_{Sm}\rvert + \lvert\sigma_{Sb}\rvert$ =		**0**	psi			< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}				
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
$\sigma_C = \lvert\sigma_{Cm}\rvert + \lvert\sigma_{Cb}\rvert$ =		**12045**	psi			< 1.5 · σ_{allC} or S_{PSc}				
σ_C =	**1121**	psi	+	**10924**	psi	<	**16950**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

7 Float UHXc-O4
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

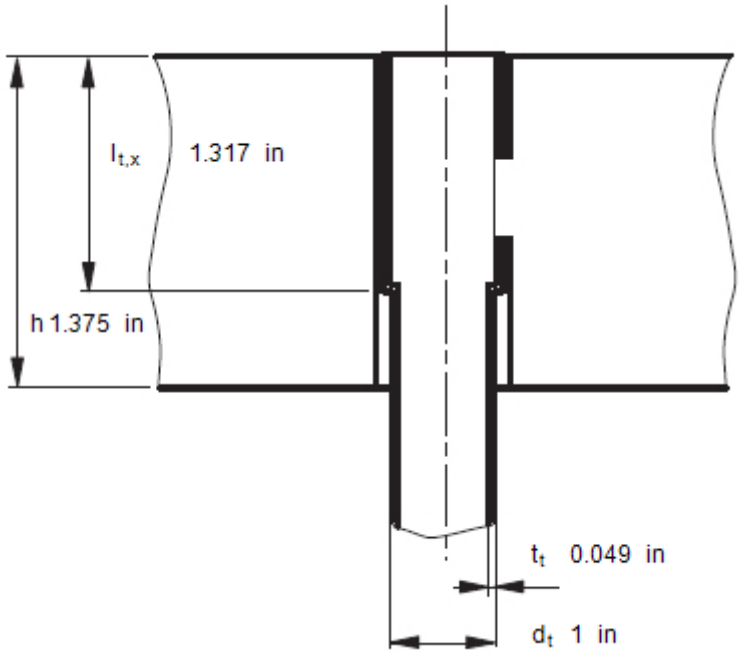
Floating tubesheet according to ASME-UHX-14

Type of heat exchanger (a,b,c)	WArt	*b*		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	*A*		a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure	P_s		*150*	psi
Tube side internal operation pressure	P_t		*30*	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			4	(1-7)
Differential thermal expansion only (Ps=Pt=0)				

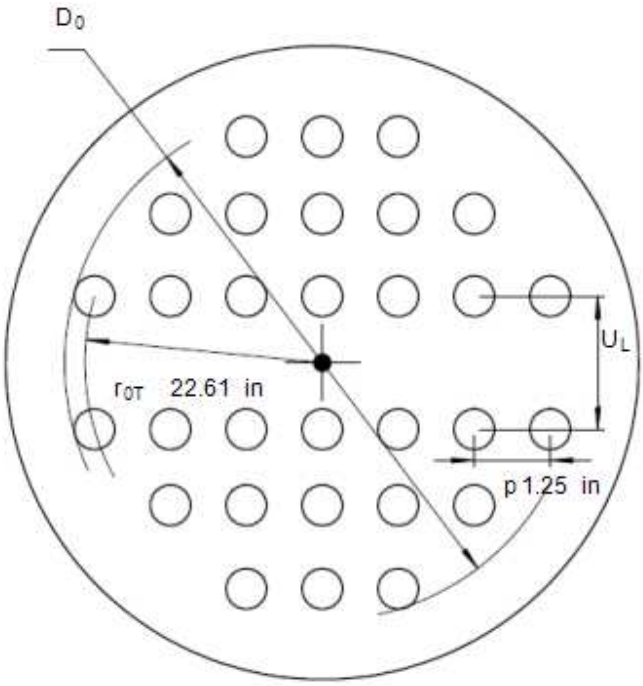
Tubesheet material							
Shell material (Type abc)							
Tube material							
Channel material(Type aefA)							
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

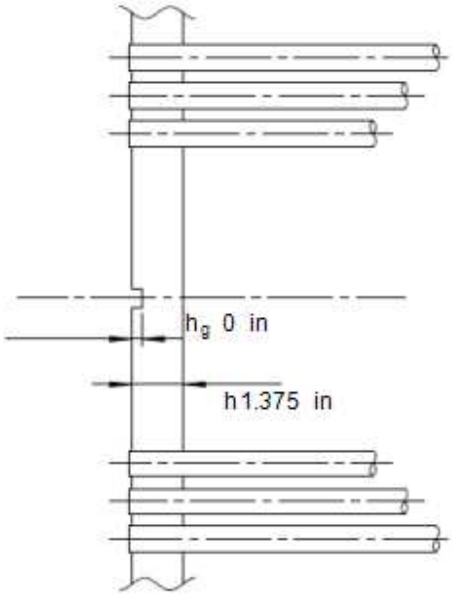
Additional specifications for the geometry and loading

Tubesheet			
Tube-tubesheet joint	(1=expanded, 2=welded)	*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	*1*	(1, 2)
Number of tubes	N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)^2	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)^2	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E^*	**4148987**	psi
Ratio of elasticity tubesheet								E^*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v^*	**0.3374**	
Effective pitch								p^*	**1.25**	in
Effective tube hole diameter								d^*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0							K	**1.031**
F	**1.343**	Φ		**1.796**			Q_1	**-4.96e-3**

UHX-14.5.5 Step 5: Coefficients

		ω_S		**0**	in²	ω_S^*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C^*	**-3.051**	in²	γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s^* =	**68**	°F	T_c^*	**226.3**	°F		
P_s^* =	**0**	psi	P_c^* =	**8.266**	psi	P_e	**0**	psi		

UHX-14.5.7 Step 7

Q_2	**19.98**	lbf	Q_3			F_m		
Strength condition for the tubesheet bending stress, case							4	:
σ =	**230.5**	psi	$<1.5\cdot\sigma_B$ =	**16950**	psi		case 1-3	
			$< S_{PS}$ =	*33900*	psi		case 4-7	

Step 8

Strength condition for the tubesheet shear stress:								
τ =	**0**	psi	$<0.8\cdot\sigma_B$ =	**9040**	psi			

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N* **)**

F_q	**0**	F_s		**1.25**				
Strength condition for the tube stress with cacluation case							4	:
S_{To} =	**-28.43**	psi	$\le \sigma_T$ =	*11300*	psi	for calculation case 1-3		
S_{To}			$\le 2\cdot\sigma_T$ =	**22600**	psi	for calculation case 4-7		
$\lvert S_{To}\rvert$			$\le S_{tb}$ =	**11300**	psi	(for $S_{To} < 0$, Buckling)		
r_t	**0.3367**	in	F_t	**47.52**		C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

$\sigma_S = \lvert\sigma_{Sm}\rvert + \lvert\sigma_{Sb}\rvert$ =		**0**	psi			< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}				
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
$\sigma_C = \lvert\sigma_{Cm}\rvert + \lvert\sigma_{Cb}\rvert$ =		**888.9**	psi			< 1.5 · σ_{allC} or S_{PSc}				
σ_C =	**0**	psi	+	**888.9**	psi	<	**33900**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

8 Float UHXc-O1
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

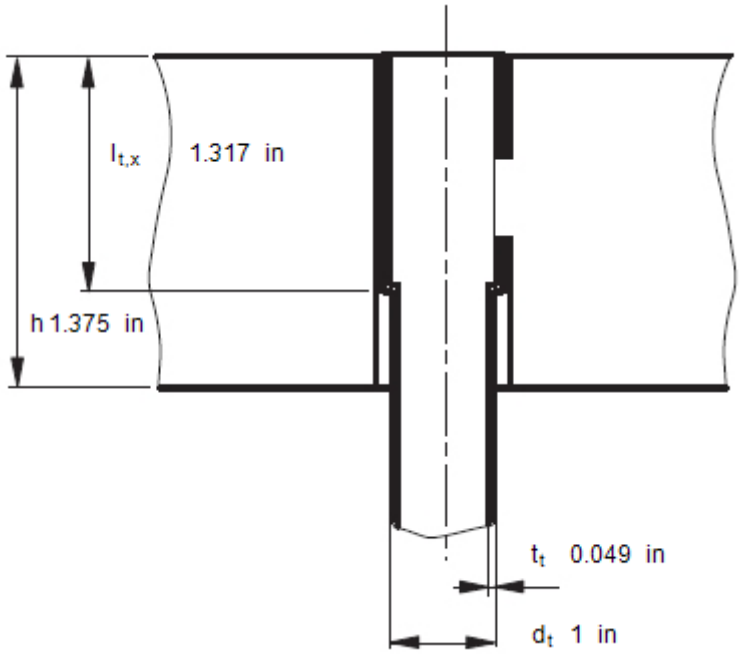
Type of heat exchanger (a,b,c)	WArt	*b*		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	*A*		a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure	P_s		*150*	psi
Tube side internal operation pressure	P_t		*30*	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			5	(1-7)
Tube side pressure only (Ps=0) with thermal expansion				
Tubesheet material				
Shell material (Type abc)				
Tube material				
Channel material(Type aefA)				

Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

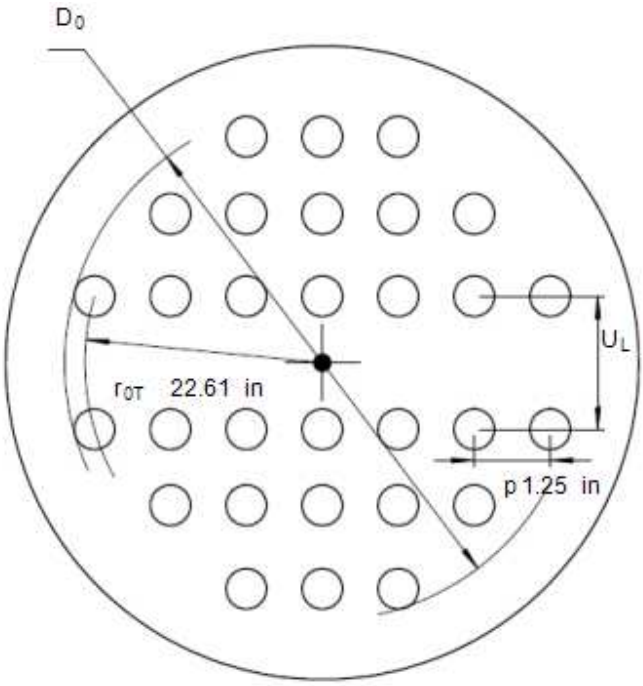
Additional specifications for the geometry and loading

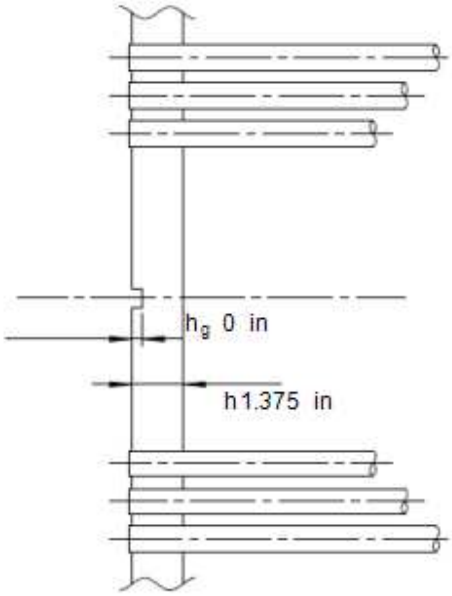
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	*1*	(1, 2)
Number of tubes	N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = $0.5(A_m+A_b)\cdot K_{sp}/S_{sp}$, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	ρ_C	**1.017**	
Ratio = a_s/a_0	ρ_S	**1.017**	
Parameter = $1-N_t\cdot(0.5\cdot d_a TUBE/a_0)^2$	x_s	**0.4432**	
Parameter = $1-N_t\cdot(0.5\cdot d_i TUBE/a_0)^2$	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E^*	**4148987**	psi
Ratio of elasticity tubesheet								E^*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v^*	**0.3374**	
Effective pitch								p^*	**1.25**	in
Effective tube hole diameter								d^*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0							K	**1.031**
F	**1.343**	Φ		**1.796**			Q_1	**-4.96e-3**

UHX-14.5.5 Step 5: Coefficients

		ω_S		**0**	in²	ω_S^*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C^*	**-3.051**	in²	γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s^* =	**68**	°F	T_c^*	**226.3**	°F
P_s^* =	**0**	psi	P_c^* =	**8.266**	psi	P_e	**-30**	psi

UHX-14.5.7 Step 7

Q_2	**90.67**	lbf	Q_3	**-0.01628**		F_m	**0.02215**	

Strength condition for the tubesheet bending stress, case 5 :

σ =	**4092**	psi	$<1.5\cdot\sigma_B$ =	**16950**	psi	case 1-3
			$< S_{PS}$ =	*33900*	psi	case 4-7

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	$<0.8\cdot\sigma_B$ =	**9040**	psi

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N*)

F_q	**5.883**		F_s	**1.25**				

Strength condition for the tube stress with cacluation case 5 :

S_{To} =	**1543**	psi	$\le \sigma_T$ =	*11300*	psi	for calculation case 1-3
S_{To}			$\le 2\cdot\sigma_T$ =	**22600**	psi	for calculation case 4-7
$\lvert S_{To}\rvert$			$\le S_{tb}$ =	**11300**	psi	(for $S_{To} < 0$, Buckling)

r_t	**0.3367**	in	F_t	**47.52**		C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert\sigma_{Sm}\rvert$ + $\lvert\sigma_{Sb}\rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}					
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi		
σ_C = $\lvert\sigma_{Cm}\rvert$ + $\lvert\sigma_{Cb}\rvert$ =			**11802**	psi	< 1.5 · σ_{allC} or S_{PSc}					
σ_C =	**1121**	psi	+	**10681**	psi	<	**33900**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

9 Float UHXc-O2
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

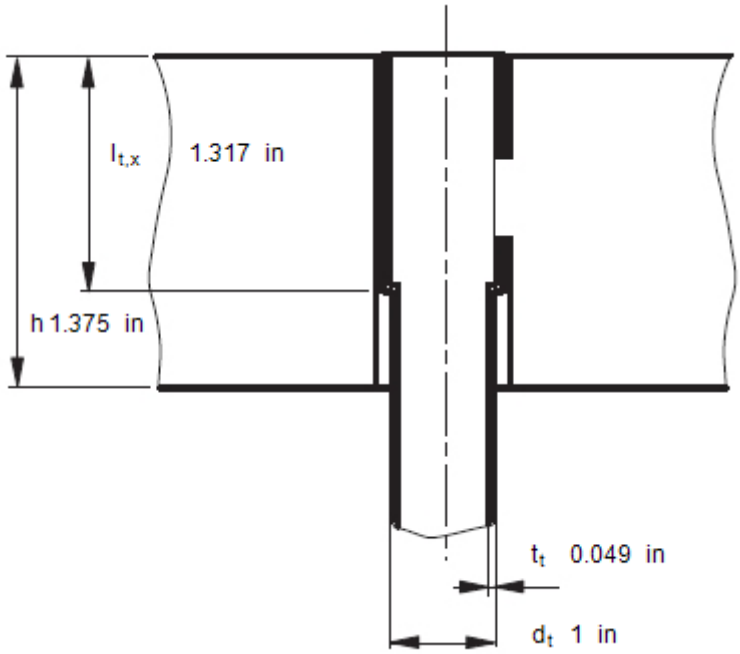
Type of heat exchanger (a,b,c)	WArt	*b*		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	*A*		a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure	P_s		*150*	psi
Tube side internal operation pressure	P_t		*30*	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			6	(1-7)
Shell side pressure only (Pt=0) with thermal expansion				

Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

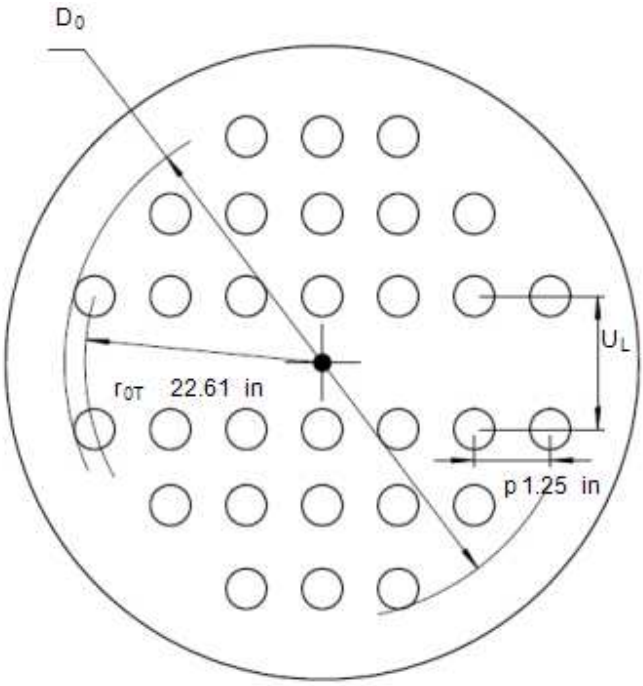
Additional specifications for the geometry and loading

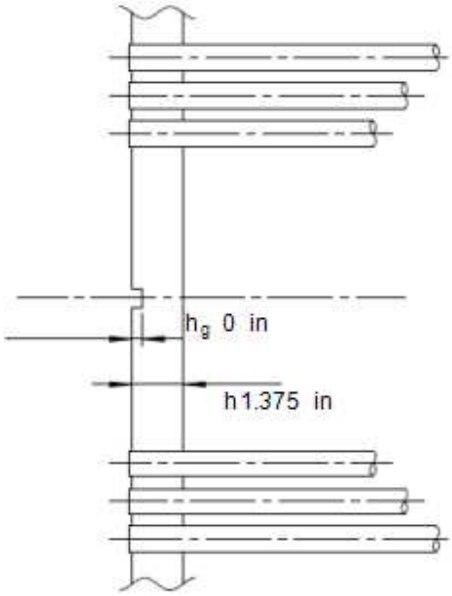
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	*1*	(1, 2)
Number of tubes	N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)²	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)²	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E^*	**4148987**	psi
Ratio of elasticity tubesheet								E^*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v^*	**0.3374**	
Effective pitch								p^*	**1.25**	in
Effective tube hole diameter								d^*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0							K	**1.031**
F	**1.343**	Φ		**1.796**			Q_1	**-4.96e-3**

UHX-14.5.5 Step 5: Coefficients

		ω_S		**0**	in²	ω_S^*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C^*	**-3.051**	in²	γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s^* =	**68**	°F	T_c^*	**226.3**	°F
P_s^* =	**0**	psi	P_c^* =	**8.266**	psi	P_e	**-5.173**	psi

UHX-14.5.7 Step 7

Q_2	**29.1**	lbf	Q_3	**-0.02603**		F_m	**0.01939**	
Strength condition for the tubesheet bending stress, case							6	:
σ =	**617.7**	psi	$<1.5\cdot\sigma_B$ =	**16950**	psi		case 1-3	
			$< S_{PS}$ =	*33900*	psi		case 4-7	

Step 8

Strength condition for the tubesheet shear stress:

τ =	**0**	psi	$<0.8\cdot\sigma_B$ =	**9040**	psi

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N*)

F_q	**5.499**	F_s	**1.25**			
Strength condition for the tube stress with cacluation case						6 :
S_{To} =	**914.6**	psi	$\le \sigma_T$ =	*11300*	psi	for calculation case 1-3
S_{To}			$\le 2\cdot\sigma_T$ =	**22600**	psi	for calculation case 4-7
$\lvert S_{To}\rvert$			$\le S_{tb}$ =	**11300**	psi	(for $S_{To} < 0$, Buckling)
r_t	**0.3367**	in	F_t	**47.52**		C_t **96.15**

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

$\sigma_S = \lvert\sigma_{Sm}\rvert + \lvert\sigma_{Sb}\rvert =$		**0**	psi	$< 1.5 \cdot \sigma_{allS}$, S_{PSs} or S_{PSs1}						
$\sigma_S =$	**0**	psi	$\lvert + \rvert$	**0**	psi	$\rvert <$	**0**	psi		
$\sigma_C = \lvert\sigma_{Cm}\rvert + \lvert\sigma_{Cb}\rvert =$		**2021**	psi	$< 1.5 \cdot \sigma_{allC}$ or S_{PSc}						
$\sigma_C =$	**0**	psi	$\lvert + \rvert$	**2021**	psi	$\rvert <$	**33900**	psi		

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

10 Float UHXc-O3
ASME UHX-14 Floating Tubesheets ASME BPVC Edition 2017

Floating tubesheet according to ASME-UHX-14

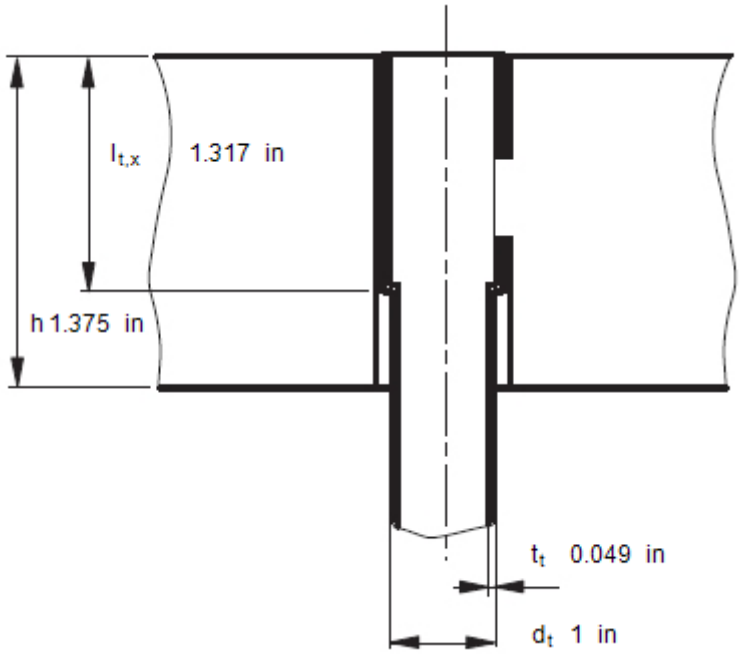
Type of heat exchanger (a,b,c)	WArt	*b*		a,b,c
Heat Exchanger With an Externally Sealed Floating Head (A)				
Configuration of the tubesheet (a-f,A-D)	Type	*A*		a-f,A-D
Floating tubesheet integral				
Type of channel (1=Cylinder, 2=Hemispherical)			*1*	(1,2)
Shell side internal operation pressure	P_s		*150*	psi
Tube side internal operation pressure	P_t		*30*	psi
Shell side internal test pressure	P_{sp}			psi
Tube side internal test pressure	P_{tp}			psi
Load case (1=operation, 2+3=test at 20°C, 4=other)			*1*	
load case: operation				
Calculation case acc. UHX-14.4(a): (1), (2) ... (7)			7	(1-7)
Tube and shell side pressure acting with thermal expansion				

Tubesheet material								
Shell material (Type abc)								
Tube material								
Channel material(Type aefA)								
Operation	**Tubesheet**		**Shell**		**Tubes**		**Channel**	
Temperature		°F		°F		°F		°F
Thickness	*1.375*	in		in	*0.049*	in	*0.3125*	in
Outsidediameter	*47.63*	in		in	*1*	in	*47.63*	in
Poiss.-rat.	*0.32*		*0.3*		*0.32*		*0.32*	
Allow. c1	*0*	in		in	*0*	in	*0*	in
Corr.all.c2	*0*	in		in	*0*	in	*0*	in
Figure								
Strength for the selected load case temperature								
Strength		psi		psi		psi		psi
Safety								
E-module	*1.48e+7*	psi		psi	*1.48e+7*	psi	*1.48e+7*	psi
Therm.dil.		1E-6/°F		1E-6/°F		1E-6/°F		1E-6/°F
Yield str.		psi		psi	*31600*	psi	*31600*	psi
Limit temperature		°F		°F		°F		°F
All.stress	*11300*	psi	***0***	psi	*11300*	psi	*11300*	psi
Pr.+sec.st	*33900*	psi	***0***	psi	*33900*	psi	*33900*	psi
Properties for testing at 20°C								
Strength	*0*	psi	0	psi	0	psi	0	psi
Safety								
Yield str.		psi		psi		psi		psi
Tensile str.		psi		psi		psi		psi

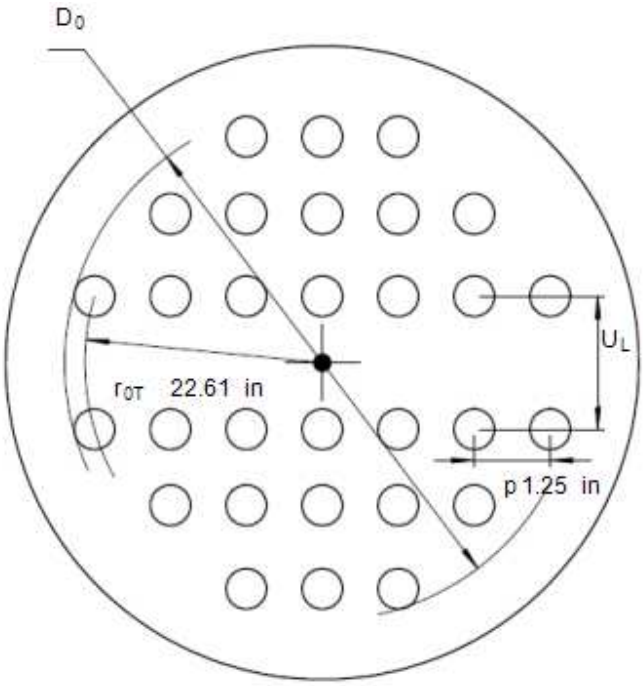
Additional specifications for the geometry and loading

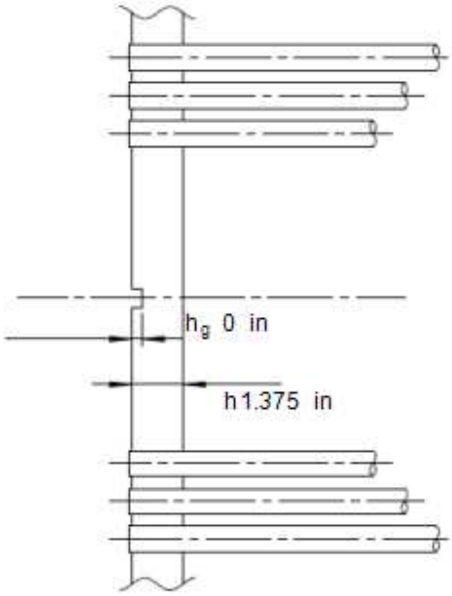
Tubesheet

Tube-tubesheet joint	(1=expanded, 2=welded)	*1*	(1, 2)
Tube pattern	(1=Triangle, 2=Square)	*1*	(1, 2)
Number of tubes	N_t	*1189*	



Expanded length of tube in tubesheet		$l_{t,x}$	*1.317*	in
Expanded length ratio $l_{t,x}/h$		ρ	**0.958**	
Radius to outermost tube hole center	UHX-11.1(a)	r_{0T}	*22.61*	in
Perimeter of the outermost tubes	UHX-12.2	C_p		in
Total area enclosed by C_p	UHX-12.2	A_p		in²





Tube pitch (center distance)	p	*1.25*	in
Total untubed area UL1·LL1+UL2·LL2.. UHX-11.2	A_L	*0*	in²
Depth of tube side pass partition groove	h_g	*0*	in
Expanded length ratio ltx/h	ρ	**0.958**	
Tube length between inner tubesheet faces	L	*143.4*	in
Unsupported tube span for buckling	l		in
Type of tube support (0.6=tubesheet-tubesheet, 0.8=tubesheet - support plate, 1=plate-plate)	k		
Equivalent free buckling length k · l	l_t	*16*	in

Results acc. UHX-9		**Shell**		**Channel**	
Effective seating width	b		in		in
Gasket bolt-up force	W	**0**	lbf	**0**	lbf
Gasket operating force	W	**0**	lbf	**0**	lbf
Total required bolt area	A_m	**0**	in²	**0**	in²
Flange thickness	h_r	**0**	in	**0**	in

Maximum bolt force for all calculation casese	W_{max}	*0*	lbf

Bolt root area in² :

Results acc. to UHX-14

Gasket seating force = 0.5(A_m+A_b)·K_{sp}/S_{sp}, App.2-5	W	**0**	lbf
Channel thickness without allowances	t_c	**0.3125**	in
Shell thickness without allowances	t_s		in

Step 1 acc. UHX 14.5

Basic ligament efficiency for shear	μ	**0.2**	
Effective ligament efficiency for shear	μ*	**0.2751**	
Effective depth of pass partition groove	h_g'	**0**	in
Equivalent radius of outer tube limit circle	a_0	**23.11**	in
Radial channel dimension	a_c	**23.5**	in
Radial shell dimension	a_s	**23.5**	in
Ratio = a_c/a_0	$ρ_C$	**1.017**	
Ratio = a_s/a_0	$ρ_S$	**1.017**	
Parameter = 1-N_t·(0.5·d_aTUBE/a_0)²	x_s	**0.4432**	
Parameter = 1-N_t·(0.5·d_iTUBE/a_0)²	x_t	**0.547**	

Step 2

Step 3

Effective modulus of el. tubesheet (Fig.UHX-11.3)								E*	**4148987**	psi
Ratio of elasticity tubesheet								E*/E	**0.2803**	
Effective Poisson's ratio tubesheet								v*	**0.3374**	
Effective pitch								p*	**1.25**	in
Effective tube hole diameter								d*	**0.9061**	in
Parameter for table UHX-13.1								X_a	**8.809**	
Z_d	**0.002168**	Z_v	**0.01309**	Z_m	**0.1641**	Z_a	**3028**	Z_w	**0.01309**	

Step 4

Diameter ratio = A/D0							K	**1.031**	
F	**1.343**	Φ		**1.796**			Q_1	**-4.96e-3**	

UHX-14.5.5 Step 5: Coefficients

			ω_S	**0**	in²		ω_S*	**0.07868**	in²
ω_C	**3.129**	in²	ω_C*	**-3.051**	in²		γ_b	**0**	

Results acc. to UHX-14.6 and step 6

T_r =	**217.5**	°F	T_s* =	**68**	°F		T_c*	**226.3**	°F
P_s* =	**0**	psi	P_c* =	**8.266**	psi		P_e	**-35.17**	psi

UHX-14.5.7 Step 7

Q_2	**99.79**	lbf	Q_3	**-0.01559**			F_m	**0.02235**	
Strength condition for the tubesheet bending stress, case								7	:
σ =	**4842**	psi	<1.5· σ_B =	**16950**	psi			case 1-3	
			< S_{PS} =	*33900*	psi			case 4-7	

Step 8

Strength condition for the tubesheet shear stress:									
τ =	**0**	psi	<0.8· σ_B =	**9040**	psi				

Strength condition of step 7-8 are satisfied

Step 9, as examples UHX-20.3:2009 (old *N* **)**

F_q	**5.911**		F_s	**1.25**					
Strength condition for the tube stress with cacluation case									7 :
S_{To} =	**2486**	psi	≤ σ_T =	*11300*	psi		for calculation case 1-3		
S_{To}			≤ 2·σ_T =	**22600**	psi		for calculation case 4-7		
$\lvert S_{To} \rvert$			≤ S_{tb} =	**11300**	psi		(for S_{To} < 0, Buckling)		
r_t	**0.3367**	in	F_t	**47.52**			C_t	**96.15**	

Condition UHX-14.5.9 not required for configuration ABCD

Step 10: Stress σ_S in the shell and σ_C in the channel

σ_S = $\lvert \sigma_{Sm} \rvert$ + $\lvert \sigma_{Sb} \rvert$ =			**0**	psi	< 1.5 · σ_{allS}, S_{PSs} or S_{PSs1}						
σ_S =	**0**	psi	+	**0**	psi	<	**0**	psi			
σ_C = $\lvert \sigma_{Cm} \rvert$ + $\lvert \sigma_{Cb} \rvert$ =			**12934**	psi	< 1.5 · σ_{allC} or S_{PSc}						
σ_C =	**1121**	psi	+	**11813**	psi	<	**33900**	psi			

Strength condition UHX-14.5.10 is satisfied

Geometric conditions:

valid

Strength condition for linked modules (Connection activated: No):

Appendix: Material documentation

No materials for documentation