

TO: AUTHORIZED INSPECTOR
HSB CT.

DATE: 30-DEC-04

SUBJECT: TRANSMITTAL OF ASME SUBMITTAL CALCULATIONS FOR A.I. ACCEPTANCE


GENTLEMEN:

ATTACHED ARE ASME PRESSURE VESSEL CODE CALCULATIONS ACCORDING TO THE 2001 EDITION, 2003 ADDENDA OF SECTION VIII, DIVISION 1, OF THE ASME CODE. THE CALCULATIONS SUPPORT THE DESIGN OF THE FOLLOWING VESSEL.

ASSEMBLY DRAWING -----	SALES ORDER -----	CUSTOMER -----
15774A	509.5	AL-DEUTSCHLAND

LOADINGS LISTED IN UG-22 HAVE BEEN CONSIDERED IN THE DESIGN OF THE VESSEL AND THE CUSTOMER ADVISED OF THE MAXIMUM LOADS THAT MAY BE APPLIED. YOUR ACCEPTANCE OF THESE CALCULATIONS AND THE VESSEL DESIGN AS MEETING THE MINIMUM REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIV. 1, IS RESPECTFULLY REQUESTED. PLEASE ACKNOWLEDGE YOUR ACCEPTANCE BY SIGNING AND DATING THIS FORM IN THE SPACE PROVIDED.

BEST REGARDS,


PRODUCT ENGINEERING
CHART HEAT EXCHANGERS

A.I. ACCEPTANCE

I HAVE REVIEWED THE CALCULATIONS AND THE ABOVE LISTED DRAWING. IN MY OPINION THIS DESIGN DOES MEET THE MINIMUM REQUIREMENTS OF THE ASME CODE SECTION VIII, DIV. 1

 1-24-05

AUTHORIZED INSPECTOR DATE
HSB CT.

SUBJECT: ASME SUBMITTAL CALCULATIONS PER THE 2001 EDITION,
2003 ADDENDA OF SECTION VIII, DIVISION 1.CUSTOMER: AL-DEUTSCHLAND
SALES ORDER: 509.5
ASSEMBLY DRAWING: 15774A
ITEM NO. W43002

DESIGN BASIS:

- CODE JURISDICTION ENDS AT FIRST NOZZLE CIRCUMFERENTIAL WELD JOINT.
- MAXIMUM DESIGN TEMPERATURE= 150. DEGREES F
- CORROSION ALLOWANCE: NONE
- ASME CODE REQUIRED RADIOGRAPHY:

NONE.

FIN DESIGN:

THE MAXIMUM ALLOWABLE DESIGN PRESSURE OF THE FINS USED IN THIS HEAT EXCHANGER MEET OR EXCEED THE STREAM DESIGN PRESSURE. THE RATINGS WERE CALCULATED PER PARAGRAPH U-2(G). THE PROPRIETARY CALCULATION METHOD WAS APPROVED BY CHART AND REVIEWED AND ACCEPTED BY HSB CT.

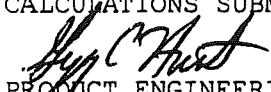
PIPING DESIGN:

CONNECTION	HEADER			NOZZLE			DESIGN PRESSURE P.S.I.G.
	O.D. X WALL IN. X IN.	X MATERIAL		O.D. X WALL IN. X IN.	X MATERIAL		
A IN	20.000	0.375	SB-209-5083	3.500	0.216	SB-241-5083	149.
A OUT	20.000	0.375	SB-209-5083	4.500	0.237	SB-241-5083	149.
B IN	3.500	0.250	SB-209-5083	3.500	0.216	SB-241-5083	100.
B OUT	3.500	0.250	SB-209-5083	2.375	0.154	SB-241-5083	100.
B VENT				1.050	0.113	SB-241-5083	100.

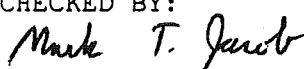
NOTE: PER UG-36(C)(3)(a), REINFORCEMENT CALCULATIONS ARE NOT
MADE FOR 2" NPS NOZZLES OR SMALLER.

NOTE: DESIGN PRESSURES INCREASED BY A FACTOR OF
1.50/1.10 TO ACCOUNT FOR ELEVATED PNEUMATIC TEST PRESSURE.

CALCULATIONS SUBMITTED BY:


PRODUCT ENGINEERING
CHART HEAT EXCHANGERS

CHECKED BY:


PRODUCT ENGINEERING
CHART HEAT EXCHANGERS

Reviewed

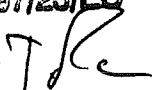
TÜV Süddeutschland Bau und Betrieb GmbH

Notified Body acc. to Pressure

Equipment Directive 97/23/EC

-Testing Laboratory-

MAR 29 2005



HEADER OPENING AND REINFORCING CALCULATION
 PER ASME SECTION VIII, DIV 1., PAR UG-36, UG-40, AND UG-42
 (NOZZLE ABUTTS THE HEADER BODY, REF FIG UW-16.1(a))

STREAM	A IN
DESIGN PRESSURE (P)	149. PSIG
HEADER SIZE (O.D.)	20.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.375 INCHES
INSIDE RADIUS (R)	9.625 INCHES
MINIMUM HEADER THICKNESS (UG-27)	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.127 INCHES
NOZZLE SIZE (O.D.)	3.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.216 INCHES
INSIDE DIAMETER (D)	3.068 INCHES
INSIDE RADIUS (R)	1.534 INCHES
MINIMUM NOZZLE THICKNESS	
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.022 INCHES
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.216 INCHES
ACTUAL WELD LEG (W)	0.216 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	
SHELL: LARGER OF: (NOTE 1)	E1=1.00
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.761 IN2
NOZZLE: SMALLER OF:	
5(TN - TRN)(FR2)(T) OR	
A2 5(TN - TRN)(FR2)(TN)	0.197 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	
A3 (DP - D - 2TN)TE(FR4) OR 2(TN)FR2*H	0.000 IN2
WELD AREA	
A4 W*W*(FR2)	0.044 IN2
ATOT ATOT=A1+A2+A3+A4	1.002 IN2
REQUIRED AREA	
AREQ=D*TR*F+2*TN*TR*F(1-FR1) (F=1.0)	0.389 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY

- (1) E1 NORMALLY EQUALS 1.0. WHEN THE NOZZLE PASSES THROUGH A CATEGORY A WELD JOINT E1 IS TAKEN FROM TABLE UW-12.
- (2) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE OPENING IS GREATER THAN HALF THE HEADER I.D. OR THE OPENING EXCEEDS 20 INCHES.
- (3) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
 FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.
 Belongs to the Main Drawing.
 Prüfvermerk vom / Review date:

MAR 29 2005

FR

HEADER OPENING AND REINFORCING CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36, UG-40, AND UG-42
(NOZZLE ABUTTS THE HEADER BODY, REF FIG UW-16.1(a))

STREAM	A OUT
DESIGN PRESSURE (P)	149. PSIG
HEADER SIZE (O.D.)	20.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.375 INCHES
INSIDE RADIUS (R)	9.625 INCHES
MINIMUM HEADER THICKNESS (UG-27)	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.127 INCHES
NOZZLE SIZE (O.D.)	4.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.237 INCHES
INSIDE DIAMETER (D)	4.026 INCHES
INSIDE RADIUS (R)	2.013 INCHES
MINIMUM NOZZLE THICKNESS	
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.028 INCHES.
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.237 INCHES
ACTUAL WELD LEG (W)	0.237 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	
SHELL: LARGER OF: (NOTE 1)	E1=1.00
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.999 IN2
NOZZLE: SMALLER OF:	
5(TN - TRN)(FR2)(T) OR	
A2 5(TN - TRN)(FR2)(TN)	0.232 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	
A3 (DP - D - 2TN)TE(FR4) OR 2(TN)FR2*H	0.000 IN2
WELD AREA	
A4 W*W*(FR2)	0.053 IN2
ATOT ATOT=A1+A2+A3+A4	1.284 IN2
REQUIRED AREA	
AREQ=D*TR*F+2*TN*TR*F(1-FR1) (F=1.0)	0.510 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY

- (1) E1 NORMALLY EQUALS 1.0. WHEN THE NOZZLE PASSES THROUGH A CATEGORY A WELD JOINT E1 IS TAKEN FROM TABLE UW-12.
- (2) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE OPENING IS GREATER THAN HALF THE HEADER I.D. OR THE OPENING EXCEEDS 20 INCHES.
- (3) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Prüfung Date:
MAR 29 2005

HEADER OPENING AND REINFORCING CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36, UG-40, AND UG-42
(NOZZLE ABUTTS THE HEADER BODY, REF FIG UW-16.1(a))

STREAM	B IN
DESIGN PRESSURE (P)	100. PSIG
HEADER SIZE (O.D.)	3.500 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	1.500 INCHES
MINIMUM HEADER THICKNESS (UG-27)	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.013 INCHES
NOZZLE SIZE (O.D.)	3.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.216 INCHES
INSIDE DIAMETER (D)	3.068 INCHES
INSIDE RADIUS (R)	1.534 INCHES
MINIMUM NOZZLE THICKNESS	
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.014 INCHES
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.216 INCHES
ACTUAL WELD LEG (W)	0.216 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	
SHELL: LARGER OF: (NOTE 1)	E1=1.00
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.726 IN2
NOZZLE: SMALLER OF:	
5(TN - TRN)(FR2)(T) OR	
A2 $5(TN - TRN)(FR2)(TN)$	0.204 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	
A3 $(DP - D - 2TN)TE(FR4) \text{ OR } 2(TN)FR2 \cdot H$	0.000 IN2
WELD AREA	
A4 $W \cdot W \cdot (FR2)$	0.044 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	0.975 IN2
REQUIRED AREA	
AREQ $= D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	0.041 IN2

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2) $R_n/R = 1.02$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.363 IN2
ATOT(1-7) $= A1(1-7) + A2 + A3 + A4$	0.611 IN2
AREQ(1-7) $= (2/3) \times AREQ$	0.027 IN2

- (1) E1 NORMALLY EQUALS 1.0. WHEN THE NOZZLE PASSES THROUGH A CATEGORY A WELD JOINT E1 IS TAKEN FROM TABLE UW-12.
- (2) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE OPENING IS GREATER THAN HALF THE HEADER I.D. OR THE OPENING EXCEEDS 20 INCHES.
- (3) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Überprüfung der Berechnung
Prüfung der Berechnung
MAR 28 2005

T.R.

HEADER AND NOZZLE WALL THICKNESS CALCULATIONS PER APPENDIX 1, PAR. 1-1(a)(1)

NOTE: ALL NOZZLES ARE A MINIMUM OF STD WALL WHICH SATISFIES UG-45(b) REQUIREMENTS

A IN HEADER 20.000 O.D. X 0.375 WALL X SB-209-5083-0 WITH BACKING STRIPS
----- NOZZLE 3.500 O.D. X 0.216 WALL X SB-241-5083-0 SEAMLESS
 DESIGN PRESSURE = 149. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 10.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.199 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.375 \text{ INCHES} - 0.023 \text{ INCH M.T.} = 0.352 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{149. \text{ PSIG} \times 1.750 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 149. \text{ PSIG}} = 0.024 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.216 \text{ INCHES} \times .875 = 0.189 \text{ INCHES}$$

A OUT HEADER 20.000 O.D. X 0.375 WALL X SB-209-5083-0 WITH BACKING STRIPS
----- NOZZLE 4.500 O.D. X 0.237 WALL X SB-241-5083-0 SEAMLESS
 DESIGN PRESSURE = 149. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 10.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.199 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.375 \text{ INCHES} - 0.023 \text{ INCH M.T.} = 0.352 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{149. \text{ PSIG} \times 2.250 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 149. \text{ PSIG}} = 0.031 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.237 \text{ INCHES} \times .875 = 0.207 \text{ INCHES}$$

B IN HEADER 3.500 O.D. X 0.250 WALL X SB-209-5083-0 WITH BACKING STRIPS
----- NOZZLE 3.500 O.D. X 0.216 WALL X SB-241-5083-0 SEAMLESS
 DESIGN PRESSURE = 100. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{100. \text{ PSIG} \times 1.750 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 100. \text{ PSIG}} = 0.023 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.250 \text{ INCHES} - 0.018 \text{ INCH M.T.} = 0.232 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{100. \text{ PSIG} \times 1.750 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 100. \text{ PSIG}} = 0.016 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.216 \text{ INCHES} \times .875 = 0.189 \text{ INCHES}$$

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

MAR 26 2005

T.R.

HEADER AND NOZZLE WALL THICKNESS CALCULATIONS PER APPENDIX 1, PAR. 1-1(a)(1)

NOTE: ALL NOZZLES ARE A MINIMUM OF STD WALL WHICH SATISFIES UG-45(b) REQUIREMENTS

B OUT HEADER 3.500 O.D. X 0.250 WALL X SB-209-5083-0 WITH BACKING STRIPS
----- NOZZLE 2.375 O.D. X 0.154 WALL X SB-241-5083-0 SEAMLESS
 DESIGN PRESSURE = 100. PSIG.

$$\begin{aligned} \text{T REQ. (HEADER)} &= \frac{100. \text{ PSIG} \times 1.750 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 100. \text{ PSIG}} = 0.023 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.250 \text{ INCHES} - 0.018 \text{ INCH M.T.} = 0.232 \text{ INCHES}$$

$$\begin{aligned} \text{T REQ. (NOZZLE)} &= \frac{100. \text{ PSIG} \times 1.188 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 100. \text{ PSIG}} = 0.011 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.154 \text{ INCHES} \times .875 = 0.135 \text{ INCHES}$$

B VENT NOZZLE 1.050 O.D. X 0.113 WALL X SB-241-5083-0 SEAMLESS
----- DESIGN PRESSURE = 100. PSIG

$$\begin{aligned} \text{T REQ. (NOZZLE)} &= \frac{100. \text{ PSIG} \times 0.525 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 100. \text{ PSIG}} = 0.005 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.113 \text{ INCHES} \times .875 = 0.099 \text{ INCHES}$$

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

MAR 29 2005



MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR A IN HEADER 20.000 INCH O.D. BY 0.375 INCH WALL

TWO SETS OF CRITERIA MUST BE MET WHEN ATTACHING UNSTAYED FLATENDS TO HEADERS.

THE FIRST IS FOUND IN SECTION VIII, PARA. UG-34(C)(3)
WHICH YIELDS THE FORMULA:

$$T = d \cdot \text{SQUARE ROOT OF } (ZCP/SE)$$

WHERE:

d = SHORT SPAN OF A FLAT HEAD = 7.788 INCHES
D = LONG SPAN OF A FLAT HEAD = 18.896 INCHES
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)
 m = tr/ts BUT CONSERVATIVELY SET AT 1.0 THUS C = .33
E = JOINT EFFICIENCY FOR CATEGORY A WELDS; THE PLATE IS
 SEAMLESS SO E = 1.0
P = DESIGN PRESSURE = 149. PSIG
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

FOR SB-209-5083-0 ALUMINUM S = 11400. PSI

$$Z = 3.4 - (2.4 \cdot d/D).$$

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 7.788/18.896) = 2.41$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.794 \text{ INCHES}$$

THE SECOND CRITERIA IS BASED ON FIGURE UG-34(E) WHICH SPECIFIES THE FLATEND MUST EXTEND BEYOND THE HEADER BY A DISTANCE NO LESS THAN THE THICKNESS OF THE SHELL (TS). DESIGN PRACTICE IS TO SELECT A NOMINAL PLATE THICKNESS OF AT LEAST (TS+.125 IN) TO ALLOW SOME INSERTION OF THE FLATEND INTO THE HEADER BODY.

THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

$$T(\text{SHELL}) + 0.125 = 0.500 \text{ INCHES}$$

THE MINIMUM FLATEND THICKNESS 0.945 IN. (1.000 IN NOM.- 0.055 IN M.T.)
MEETS OR EXCEEDS TMIN THEREFORE THE DESIGN MEETS THE MINIMUM REQUIREMENTS
OF THE ASME CODE.

Zur Hauptabteilung zurück.
Produktionsabteilung / Review date.
MAR 28 2005

[Signature]

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR A OUT HEADER 20.000 INCH O.D. BY 0.375 INCH WALL

TWO SETS OF CRITERIA MUST BE MET WHEN ATTACHING UNSTAYED FLATENDS TO HEADERS.

THE FIRST IS FOUND IN SECTION VIII, PARA. UG-34(C) (3)
WHICH YIELDS THE FORMULA:

$$T = d \cdot \text{SQUARE ROOT OF } (ZCP/SE)$$

WHERE:

d = SHORT SPAN OF A FLAT HEAD = 7.788 INCHES
D = LONG SPAN OF A FLAT HEAD = 18.896 INCHES
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)
m = tr/ts BUT CONSERVATIVELY SET AT 1.0 THUS C = .33
E = JOINT EFFICIENCY FOR CATEGORY A WELDS; THE PLATE IS
SEAMLESS SO E = 1.0
P = DESIGN PRESSURE = 149. PSIG
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

FOR SB-209-5083-0 ALUMINUM S = 11400. PSI

$$Z = 3.4 - (2.4 \cdot d/D).$$

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 7.788/18.896) = 2.41$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.794 \text{ INCHES}$$

THE SECOND CRITERIA IS BASED ON FIGURE UG-34(E) WHICH SPECIFIES THE FLATEND MUST EXTEND BEYOND THE HEADER BY A DISTANCE NO LESS THAN THE THICKNESS OF THE SHELL (TS). DESIGN PRACTICE IS TO SELECT A NOMINAL PLATE THICKNESS OF AT LEAST (TS+.125 IN) TO ALLOW SOME INSERTION OF THE FLATEND INTO THE HEADER BODY.

THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

$$T(\text{SHELL}) + 0.125 = 0.500 \text{ INCHES}$$

THE MINIMUM FLATEND THICKNESS 0.945 IN. (1.000 IN NOM.- 0.055 IN M.T.) MEETS OR EXCEEDS TMIN THEREFORE THE DESIGN MEETS THE MINIMUM REQUIREMENTS OF THE ASME CODE.

REVIEWED BY: [Signature]
DATE: MAR 29 2005

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR B IN HEADER 3.500 INCH O.D. BY 0.250 INCH WALL

TWO SETS OF CRITERIA MUST BE MET WHEN ATTACHING UNSTAYED FLATENDS TO HEADERS.

THE FIRST IS FOUND IN SECTION VIII, PARA. UG-34(C)(3)
WHICH YIELDS THE FORMULA:

$$T = d \cdot \text{SQUARE ROOT OF } (ZCP/SE)$$

WHERE:

d = SHORT SPAN OF A FLAT HEAD (THE RADIUS) = 1.500 INCHES
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 3.000 INCHES
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)
m = tr/ts BUT CONSERVATIVELY SET AT 1.0 THUS C = .33
E = JOINT EFFICIENCY FOR CATEGORY A WELDS; THE PLATE IS
SEAMLESS SO E = 1.0
P = DESIGN PRESSURE = 100. PSIG
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

FOR SB-209-5083-0 ALUMINUM S = 11400. PSI

$$Z = 3.4 - (2.4 \cdot d/D)$$

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 1.500 / 3.000) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.120 \text{ INCHES}$$

THE SECOND CRITERIA IS BASED ON FIGURE UG-34(E) WHICH SPECIFIES THE
FLATEND MUST EXTEND BEYOND THE HEADER BY A DISTANCE NO LESS THAN THE
THICKNESS OF THE SHELL (TS). DESIGN PRACTICE IS TO SELECT A NOMINAL
PLATE THICKNESS OF AT LEAST (TS+.125 IN) TO ALLOW SOME INSERTION OF THE
FLATEND INTO THE HEADER BODY.

THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

$$T(\text{SHELL}) + 0.125 = 0.375 \text{ INCHES}$$

THE MINIMUM FLATEND THICKNESS 0.352 IN. (0.375 IN NOM.- 0.023 IN M.T.)
MEETS OR EXCEEDS TMIN THEREFORE THE DESIGN MEETS THE MINIMUM REQUIREMENTS
OF THE ASME CODE.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:
MAR 29 2005 T. Ku

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR B OUT HEADER 3.500 INCH O.D. BY 0.250 INCH WALL

TWO SETS OF CRITERIA MUST BE MET WHEN ATTACHING UNSTAYED FLATENDS TO HEADERS.

THE FIRST IS FOUND IN SECTION VIII, PARA. UG-34(C)(3)
WHICH YIELDS THE FORMULA:

$$T = d \cdot \text{SQUARE ROOT OF } (ZCP/SE)$$

WHERE:

d = SHORT SPAN OF A FLAT HEAD (THE RADIUS) = 1.500 INCHES
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 3.000 INCHES
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)
m = tr/ts BUT CONSERVATIVELY SET AT 1.0 THUS C = .33
E = JOINT EFFICIENCY FOR CATEGORY A WELDS; THE PLATE IS
SEAMLESS SO E = 1.0
P = DESIGN PRESSURE = 100. PSIG
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

FOR SB-209-5083-0 ALUMINUM S = 11400. PSI

$$Z = 3.4 - (2.4 \cdot d/D).$$

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 1.500 / 3.000) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.120 \text{ INCHES}$$

THE SECOND CRITERIA IS BASED ON FIGURE UG-34(E) WHICH SPECIFIES THE FLATEND MUST EXTEND BEYOND THE HEADER BY A DISTANCE NO LESS THAN THE THICKNESS OF THE SHELL (TS). DESIGN PRACTICE IS TO SELECT A NOMINAL PLATE THICKNESS OF AT LEAST (TS+.125 IN) TO ALLOW SOME INSERTION OF THE FLATEND INTO THE HEADER BODY.

THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

$$T(\text{SHELL}) + 0.125 = 0.375 \text{ INCHES}$$

THE MINIMUM FLATEND THICKNESS 0.352 IN. (0.375 IN NOM.- 0.023 IN M.T.)
MEETS OR EXCEEDS TMIN THEREFORE THE DESIGN MEETS THE MINIMUM REQUIREMENTS
OF THE ASME CODE.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Date: MAR 29 2005 T.K.

Subject: Supplemental ASME submittal calculations per the 2001 Edition, 2003 Addenda of Section VIII, Division 1.

Customer: AL-DEUTSCHLAND
Sales Order: 509.5
Assembly drawing: 15774A
ITEM NO. W43002

Maximum design temperature 150. F

Test pressure calculation:

Stream	Test Method	CUSTOMER SPECIFIED DESIGN PRESSURE		CORRECTION Factor	EQUIVALENT DESIGN PRESSURE		TEST FACTOR	S test/ S design		Test Pressure PSIG
		PSIG			PSIG					
A	PNEU	109.	X	1.50/1.1	= 149.	X	1.10	X	1.000	= 164.
B	PNEU	73.	X	1.50/1.1	= 100.	X	1.10	X	1.000	= 110.

NOTE: CUSTOMER MANDATED PNEU TEST PRESSURE OF 1.50 TIMES THEIR SPECIFIED DESIGN PRESSURE. CALCULATIONS WERE BASED ON AN EQUIVALENT DESIGN PRESSURE TO CORRECT FOR THE ELEVATED PNEUMATIC TEST PRESSURES.

Calculations for Core block components:

Parting sheet calculations:

The parting sheet thickness is selected to carry the outward pressure force on the bar columns of the exchanger. The required thickness is a function of the layer heights and pressures. The calculation method is outlined as follows.

Equation:

$$t_{\text{required}} = \frac{\text{outward pressure}}{\# \text{ of layers} \times S_a}$$

Where: S_a is the allowable parting sheet stress.

Outward pressure = sum of the product of the layer heights x layer pressure.

Section 1 :

Stream A	27. layers, 0.380" high at	149. psig =	1529. lb/in
Stream B	26. layers, 0.250" high at	100. psig =	650. lb/in
sum	53. layers		2179. lb/in

$$\text{min sheet} = \frac{2179. \text{ lb/in}}{53. \times 3400. \text{ psi}} = 0.012 \text{ in} < 0.039 \text{ in}$$

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

12.12.04

[Signature]

MANIFOLD AND NOZZLE WALL THICKNESS CALCULATIONS PER ASME B31.3

A DRAIN MANIFOLD 3.500 INCH O.D. X 0.216 INCH WALL X SB-241-5083-0
----- NOZZLE 1.315 INCH O.D. X 0.179 INCH WALL X SB-241-5083-0
 DESIGN PRESSURE = 150. PSIG.

$$\begin{aligned} T \text{ REQ. (MANIFOLD)} &= \frac{150. \text{ PSIG} \times 3.500 \text{ INCHES}}{2(10700. \text{ PSI} \times 1.00 + .4 \times 150. \text{ PSIG})} = 0.024 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM MANIFOLD THICKNESS} = 0.216" \times .875 - .0000" \text{ C.A.} = 0.189 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{150. \text{ PSIG} \times 1.315 \text{ INCHES}}{2(10700. \text{ PSI} \times 1.00 + .4 \times 150. \text{ PSIG})} = 0.009 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.179" \times .875 - .0000" \text{ C.A.} = 0.157 \text{ INCHES}$$

WALL THICKNESS CALCULATIONS FOR ADDITIONAL PIPING PER ASME B31.3

A RET ELBOW SIZE 4.500 INCH O.D. X 0.237 INCH WALL X SB-241-5083-0
----- DESIGN PRESSURE = 150. PSIG.

$$\begin{aligned} T \text{ REQUIRED} &= \frac{150. \text{ PSIG} \times 4.500 \text{ INCHES}}{2(10700. \text{ PSI} \times 1.00 + .4 \times 150. \text{ PSIG})} = 0.031 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM THICKNESS} = 0.237" \times .875 - .0000" \text{ C.A.} = 0.207 \text{ INCHES}$$

A LIQ ELBOW SIZE 3.500 INCH O.D. X 0.216 INCH WALL X SB-241-5083-0
----- DESIGN PRESSURE = 150. PSIG.

$$\begin{aligned} T \text{ REQUIRED} &= \frac{150. \text{ PSIG} \times 3.500 \text{ INCHES}}{2(10700. \text{ PSI} \times 1.00 + .4 \times 150. \text{ PSIG})} = 0.024 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM THICKNESS} = 0.216" \times .875 - .0000" \text{ C.A.} = 0.189 \text{ INCHES}$$

Reviewed

TÜV Süddeutschland Plan und Betrieb GmbH

Notified Body No. 0103 acc. to Pressure

Equipment Directive 97/23/EC

-Testing Laboratory-

MAR 29 2005



MANIFOLD THICKNESS, OPENING AND REINFORCEMENT CALCULATION
PER THE ASME B31.3 PIPING CODE

STREAM	A DRAIN
DESIGN PRESSURE	150 PSIG
MANIFOLD SIZE O.D.	3.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (SE)	10700 X 1.00 PSI
WALL THICK (TH)	0.216" X .875 -.0000" C.A.= 0.189 INCHES
MINIMUM MANIFOLD THICKNESS	
TRH=PD/2(SE+.4P) WHERE E= 1.00	0.024 INCHES
NOZZLE SIZE O.D.	1.315 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (SE)	10700 X 1.00 PSI
WALL THICK (TN)	0.179" X .875 -.0000" C.A.= 0.157 INCHES
(D1) NOZZLE O.D.-2*TN	1.002 INCHES
(D2) LARGER OF D1 OR TN+TH+D1/2	1.002 INCHES
MINIMUM NOZZLE THICKNESS	
TRN=PD/2(SE+.4P)	0.009 INCHES
MANIFOLD/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF NOZ WALL OR .25/.707=	0.179 INCHES
ACTUAL WELD LEG (W)	0.179 INCHES

REINFORCEMENT CALCULATION

AVAILABLE AREA	
SHELL:	
A2 (2*D2-D1) (TH-TRH)	0.165 IN2
NOZZLE: SMALLER OF:	
2(2.5*TH) (TN-TRN) (FR1) OR	
A3 2(2.5*TN) (TN-TRN) (FR1)	0.115 IN2
WELD AREA:	
A4 W*W* (FR1)	0.032 IN2
A5 AREA OF REIN. PAD IF USED	0.000 IN2
ATOT ATOT=A2+A3+A4+A5	0.312 IN2
REQUIRED AREA:	
AREQ= (TRH*D1)	0.024 IN2

NOTES: (FR1) = (S) NOZ / (S) MANI = 1.000

Zur Hauptzeichnung gehört.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

29.1.2005

F.R.

TO: AUTHORIZED INSPECTOR
HSB CT.

DATE: 13-JAN-05

SUBJECT: TRANSMITTAL OF ASME SUBMITTAL CALCULATIONS FOR A.I. ACCEPTANCE

GENTLEMEN:

ATTACHED ARE ASME PRESSURE VESSEL CODE CALCULATIONS ACCORDING TO THE 2001 EDITION, 2003 ADDENDA OF SECTION VIII, DIVISION 1 OF THE ASME CODE. THE CALCULATIONS SUPPORT THE DESIGN OF THE FOLLOWING VESSEL.

SPEC SHEET -----	ASSEMBLY DRAWING -----	SALES ORDER -----	CUSTOMER -----
15774	15774Y	509.7	AL-DEUTSCHLAND

LOADS LISTED IN UG-22 HAVE BEEN CONSIDERED IN THE DESIGN OF THE VESSEL AND THE CUSTOMER ADVISED OF THE MAXIMUM LOADS THAT MAY BE APPLIED. YOUR ACCEPTANCE OF THESE CALCULATIONS AND THE VESSEL DESIGN AS MEETING THE MINIMUM REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIV. 1, IS RESPECTFULLY REQUESTED. PLEASE ACKNOWLEDGE YOUR ACCEPTANCE BY SIGNING AND DATING THIS FORM IN THE SPACE PROVIDED.

BEST REGARDS,



PRODUCT ENGINEER
CHART HEAT EXCHANGERS

A.I. ACCEPTANCE

I HAVE REVIEWED THE CALCULATIONS AND THE ABOVE LISTED DRAWING. IN MY OPINION THIS DESIGN DOES MEET THE MINIMUM REQUIREMENTS OF THE ASME CODE SECTION VIII, DIV. 1



AUTHORIZED INSPECTOR
HSB CT.

4-5-05

DATE

SUBJECT: ASME SUBMITTAL CALCULATIONS PER THE 2001 EDITION,
2003 ADDENDA OF SECTION VIII, DIVISION 1.CUSTOMER: AL-DEUTSCHLAND
SPEC SHEET: 15774
SALES ORDER: 509.7
ASSEMBLY DRAWING: 15774Y
ITEM NO. B43001SHELL DESIGN:
OUTSIDE DIAMETER: 16.000 INCHES
SHELL LENGTH: 74.00 INCHES
NOM. WALL THICKNESS: 0.375 INCHES
SHELL MATERIAL: SB-209-5083-0

DESIGN BASIS:

- CODE JURISDICTION ENDS AT FIRST NOZZLE CIRCUMFERENTIAL WELD JOINT.
- DESIGN PRESSURE = 109. PSIG.
- MAXIMUM DESIGN TEMP. = 150. DEGREES F.
- ASME CODE REQUIRED RADIOGRAPHY:
 - TYPE 1 LONG SEAM, NO RADIOGRAPHY ASSUMED FOR CALCS.
 - TYPE 2 CIRC SEAM, NO RADIOGRAPHY ASSUMED FOR CALCS.

LIQUID HEAD SUMMARY:

SHELL & HEAD	74." @	62.4 LB/FT3 = 2.7 PSIG	DESIGN PRESSURE =	111.7 PSIG
A VAPOR	0." @	62.4 LB/FT3 = 0.0 PSIG	DESIGN PRESSURE =	109.0 PSIG
A RETURN	8." @	62.4 LB/FT3 = 0.3 PSIG	DESIGN PRESSURE =	109.3 PSIG
A INLET	16." @	62.4 LB/FT3 = 0.6 PSIG	DESIGN PRESSURE =	109.6 PSIG
A LIQUID	74." @	62.4 LB/FT3 = 2.7 PSIG	DESIGN PRESSURE =	111.7 PSIG
A LLC	74." @	62.4 LB/FT3 = 2.7 PSIG	DESIGN PRESSURE =	111.7 PSIG

Test pressure calculation:

Stream	Test Method	Test Factor	MAWP PSIG	S test/ S design	Test Pressure PSIG
TANK	PNEU	1.10 X	109. X	1.000	= 120.

CALCULATIONS SUBMITTED BY:

*Mark T. Jank*PRODUCT ENGINEERING
CHART HEAT EXCHANGERS

CHECKED BY:

*Paul L. Bickel*PRODUCT ENGINEERING
CHART HEAT EXCHANGERS

Reviewed

TÜV Süddeutschland Bau und Betrieb GmbH

Notified body in accordance to Pressure

Equipment Directive 97/23/EC

Testing Laboratory

MAR 29 2005

T.R.

SHELL THICKNESS REQUIRED, APPENDIX 1, PAR 1-1(a)(1):

$$\begin{array}{rcl} T_{req} = P R_o & = & \frac{112. \text{ PSIG} \times 8.000 \text{ INCHES}}{SE+.4P \quad 11400. \text{ PSI} \times 0.70+.4 \times 112. \text{ PSIG}} = 0.111 \text{ INCHES} \end{array}$$

$$\text{MIN. SHELL THICK} = 0.375 \text{ IN.} - 0.023 \text{ IN. (M.T.)} - 0.000 \text{ IN. (C.A.)} = 0.352 \text{ IN.}$$

END CLOSURE DESIGN:

TYPE: FLAT, PER UG-34(C)(2) EQ(1) T REQ = D* SQ.RT. OF (CP/SE)
MATERIAL: SB-209-5083-0
D= 16.000 IN -2*(0.375 IN-0.000 IN C.A.) = 15.250 INCHES

$$\begin{array}{rcl} T \text{ REQ} = 15.250 \text{ INCHES} \times \text{SQ.RT. OF} & \frac{.33 \times 112. \text{ PSIG}}{11400. \text{ PSI} \times 1.0} & = 0.867 \text{ INCHES} \end{array}$$

SECOND CRITERIA PER FIG. UW-13.2 (C)

$$T \text{ MIN} = t_s + t_p = 0.375 \text{ IN} + 0.250 \text{ IN} = 0.625 \text{ IN}$$

$$\text{MIN. DISK THICK.} = 1.500 \text{ IN.} - 0.055 \text{ IN (M.T.)} - 0.000 \text{ IN. (C.A.)} = 1.445 \text{ IN.}$$

PER FIG. UG-34(H), WHEN FLAT END CLOSURES ARE USED, THE MINIMUM SHELL THICKNESS IS 1.25 TIMES THE REQUIRED THICKNESS OF A SEAMLESS SHELL

$$\begin{array}{rcl} T \text{ REQ} = 1.25 P R_o & = & \frac{1.25 \times 112. \text{ PSIG} \times 8.000 \text{ INCHES}}{SE+.4P \quad 11400. \text{ PSI} \times 1.0 + .4 \times 112. \text{ PSIG}} = 0.098 \text{ INCHES} \end{array}$$

$$\text{MIN. SHELL THICK} = 0.375 \text{ IN.} - 0.023 \text{ IN. (M.T.)} - 0.000 \text{ IN. (C.A.)} = 0.352 \text{ IN.}$$

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk NOT. / Review date:

MAR 29 2005

TIZ

NOZZLE WALL THICKNESS CALCULATIONS PER APPENDIX 1, PAR. 1-1(a) (1)

A VAPOR NOZZLE 6.625 INCHES O.D. X 0.280 INCHES WALL X SB-241-5083-0

DESIGN PRESSURE = 109. PSIG.

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{109. \text{ PSIG} \times 3.312 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 109. \text{ PSIG}} = 0.034 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.280 \text{ IN.} \times .875 - 0.000 \text{ IN. (C.A.)} = 0.245 \text{ IN.}$$

A RETURN NOZZLE 4.500 INCHES O.D. X 0.237 INCHES WALL X SB-241-5083-0

DESIGN PRESSURE = 109. PSIG.

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{109. \text{ PSIG} \times 2.250 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 109. \text{ PSIG}} = 0.023 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.237 \text{ IN.} \times .875 - 0.000 \text{ IN. (C.A.)} = 0.207 \text{ IN.}$$

A INLET NOZZLE 4.500 INCHES O.D. X 0.237 INCHES WALL X SB-241-5083-0

DESIGN PRESSURE = 110. PSIG.

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{110. \text{ PSIG} \times 2.250 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 110. \text{ PSIG}} = 0.023 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.237 \text{ IN.} \times .875 - 0.000 \text{ IN. (C.A.)} = 0.207 \text{ IN.}$$

A LIQUID NOZZLE 3.500 INCHES O.D. X 0.216 INCHES WALL X SB-241-5083-0

DESIGN PRESSURE = 112. PSIG.

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{112. \text{ PSIG} \times 1.750 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 112. \text{ PSIG}} = 0.018 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.216 \text{ IN.} \times .875 - 0.000 \text{ IN. (C.A.)} = 0.189 \text{ IN.}$$

A LLC NOZZLE 0.940 INCHES O.D. X 0.345 INCHES WALL X SB-241-5083-0

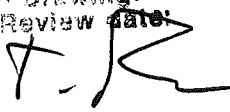
DESIGN PRESSURE = 112. PSIG.

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{112. \text{ PSIG} \times 0.470 \text{ INCHES}}{11400. \text{ PSI} \times 1.00 + .4 \times 112. \text{ PSIG}} = 0.005 \text{ INCHES} \end{aligned}$$

THE END OF THE NOZZLE IS MACHINED TO 0.070 IN. WALL -0.000 IN(C.A.)=0.070 IN.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfung... Review date:

JAN 29 2005



SHELL OPENING AND REINFORCEMENT CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36,UG-40,AND UG-42
(NOZZLE LOCATED ON FLATEND CLOSURE)
(NOZZLE ATTACHMENT IS ABUTTING STYLE, REF FIG. UW-16.1(a))

NOZZLE	A VAPOR
SHELL DESIGN PRESSURE	109. PSIG
SHELL SIZE O.D.	16.000 INCHES
WALL (T) 0.375 IN.-.023 IN. M.T.-.000 IN. C.A.	0.352 INCHES
INSIDE RADIUS (R) (BASED ON NOM. WALL & C.A.)	7.625 INCHES
REQUIRED FLATEND THICKNESS (1&2)	
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
t=D X SQUARE ROOT OF (CP/SE) C=.33	0.857 INCHES
FLATEND THICK (T) 1.500 IN - 0.055 MT- 0.000 CA	1.445 INCHES
NOZZLE SIZE O.D.	6.625 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL (TN) 0.280 IN.-.000 IN. M.T.-.000 IN. C.A.	0.280 INCHES
INSIDE DIAMETER (D) BASED ON NOM. WALL & C.A.	6.065 INCHES
REQUIRED NOZZLE THICKNESS (2)	
TRN=(DP/2)/(SE-.6P) E=1	0.031 INCHES
SHELL/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.280 INCHES
ACTUAL WELD LEG (W)	0.280 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA

SHELL: LARGER OF: (E1=1.0) (F=1.0)

A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ (4) 3.569

A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ 2.030 3.569 IN2

NOZZLE: SMALLER OF:

A2 $5(TN - TRN)(T)(FR2)$ OR 0.327 IN2

ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)

A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN - C.A.)FR2 \cdot H$ 0.000 IN2

WELD AREA

A4 $W \cdot W \cdot (FR2)$ 0.074 IN2

ATOT ATOT=A1+A2+A3+A4 3.969 IN2

REQUIRED AREA REF:UG-39(B)

AREQ=0.5*D*t+t*TN*(1-FR1) 2.598 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY (3)

- (1) REFERENCE PAR. UG-34 (C) (2)
- (2) E=1, REF UG-37 (A) DEFINITION OF TR & TRN
- (3) REFERENCE PAR. UG-36 (B-1). THIS CALCULATION IS REQUIRED WHEN THE NOZZLE I.D. IS GREATER THAN HALF THE SHELL I.D. OR THE NOZZLE I.D. EXCEEDS 20 INCHES.
- (4) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfer:  Date:

MAR 29 2005

SHELL OPENING AND REINFORCEMENT CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36,UG-40,AND UG-42
(NOZZLE LOCATED ON SHELL)
(NOZZLE ATTACHMENT IS ABUTTING STYLE, REF FIG. UW-16.1(a))

NOZZLE	A RETURN
SHELL DESIGN PRESSURE	109. PSIG
SHELL SIZE O.D.	16.000 INCHES
WALL (T) 0.375 IN.-.023 IN. M.T.-.000 IN. C.A.	0.352 INCHES
INSIDE RADIUS (R) (BASED ON NOM. WALL & C.A.)	7.625 INCHES
REQUIRED SHELL THICKNESS (1&2)	
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
TR=PR/(SE-.6P)	0.074 INCHES
NOZZLE SIZE O.D.	4.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL (TN) 0.237 IN.-.000 IN. M.T.-.000 IN. C.A.	0.237 INCHES
INSIDE DIAMETER (D) BASED ON NOM. WALL & C.A.	4.026 INCHES
REQUIRED NOZZLE THICKNESS (2)	
TRN=(DP/2)/(SE-.6P) E=1	0.021 INCHES
SHELL/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF(T), (TN) OR .25/.707	0.237 INCHES
ACTUAL WELD LEG (W)	0.237 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA
SHELL: LARGER OF: (E1=1.0) (F=1.0)
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ (4) 1.121
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ 0.328 1.121 IN2
NOZZLE: SMALLER OF:
5(TN-TRN)(T)(FR2) OR
A2 5(TN-TRN)(TN)(FR2) 0.241 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN - C.A.)FR2 \cdot H$ 0.000 IN2
WELD AREA
A4 $W \cdot W \cdot (FR2)$ 0.053 IN2
ATOT ATOT=A1+A2+A3+A4 1.414 IN2
REQUIRED AREA
AREQ= $D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ 0.296 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY (3)

- (1) REFERENCE PAR. UG-27(C)(1)
- (2) E=1, REF UG-37(A) DEFINITION OF TR & TRN
- (3) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE NOZZLE I.D. IS GREATER THAN HALF THE SHELL I.D. OR THE NOZZLE I.D. EXCEEDS 20 INCHES.
- (4) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

MAR 29 2005

T.R.

SHELL OPENING AND REINFORCEMENT CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36,UG-40,AND UG-42
(NOZZLE LOCATED ON SHELL)
(NOZZLE ATTACHMENT IS ABUTTING STYLE, REF FIG. UW-16.1(a))

NOZZLE	A INLET
SHELL DESIGN PRESSURE	110. PSIG
SHELL SIZE O.D.	16.000 INCHES
WALL (T) 0.375 IN.-.023 IN. M.T.-.000 IN. C.A.	0.352 INCHES
INSIDE RADIUS (R) (BASED ON NOM. WALL & C.A.)	7.625 INCHES
REQUIRED SHELL THICKNESS (1&2)	
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
TR=PR/(SE-.6P)	0.074 INCHES
NOZZLE SIZE O.D.	4.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL (TN) 0.237 IN.-.000 IN. M.T.-.000 IN. C.A.	0.237 INCHES
INSIDE DIAMETER (D) BASED ON NOM. WALL & C.A.	4.026 INCHES
REQUIRED NOZZLE THICKNESS (2)	
TRN=(DP/2)/(SE-.6P) E=1	0.021 INCHES
SHELL/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.237 INCHES
ACTUAL WELD LEG (W)	0.237 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA
SHELL: LARGER OF: (E1=1.0) (F=1.0)
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ (4) 1.120
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ 0.328 1.120 IN2
NOZZLE: SMALLER OF:
A2 $5(TN - TRN)(T)(FR2)$ OR 0.241 IN2
 $5(TN - TRN)(TN)(FR2)$
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN - C.A.)FR2 \cdot H$ 0.000 IN2
WELD AREA
A4 $W \cdot W \cdot (FR2)$ 0.053 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$ 1.414 IN2
REQUIRED AREA
 $AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ 0.297 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY (3)

- (1) REFERENCE PAR. UG-27(C) (1)
- (2) E=1, REF UG-37(A) DEFINITION OF TR & TRN
- (3) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE NOZZLE I.D. IS GREATER THAN HALF THE SHELL I.D. OR THE NOZZLE I.D. EXCEEDS 20 INCHES.
- (4) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:
MAR 29 2005

T.R.

SHELL OPENING AND REINFORCEMENT CALCULATION
PER ASME SECTION VIII, DIV 1., PAR UG-36,UG-40,AND UG-42
(NOZZLE LOCATED ON FLATEND CLOSURE)
(NOZZLE ATTACHMENT IS ABUTTING STYLE, REF FIG. UW-16.1(a))

NOZZLE	A LIQUID
SHELL DESIGN PRESSURE	112. PSIG
SHELL SIZE O.D.	16.000 INCHES
WALL (T) 0.375 IN.-.023 IN. M.T.-.000 IN. C.A.	0.352 INCHES
INSIDE RADIUS (R) (BASED ON NOM. WALL & C.A.)	7.625 INCHES
REQUIRED FLATEND THICKNESS (1&2)	
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
t=D X SQUARE ROOT OF (CP/SE) C=.33	0.867 INCHES
FLATEND THICK (T) 1.500 IN - 0.055 MT- 0.000 CA	1.445 INCHES
NOZZLE SIZE O.D.	3.500 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL (TN) 0.216 IN.-.000 IN. M.T.-.000 IN. C.A.	0.216 INCHES
INSIDE DIAMETER (D) BASED ON NOM. WALL & C.A.	3.068 INCHES
REQUIRED NOZZLE THICKNESS (2)	
TRN=(DP/2)/(SE-.6P) E=1	0.016 INCHES
SHELL/NOZZLE WELD JOINT	
MIN. WELD LEG =SMALLER OF (T), (TN) OR .25/.707	0.216 INCHES
ACTUAL WELD LEG (W)	0.216 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA

SHELL: LARGER OF: (E1=1.0) (F=1.0)

A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ (4) 1.773

A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$ 1.920 1.920 IN2

NOZZLE: SMALLER OF:

5(TN-TRN)(T)(FR2) OR

A2 $5(TN - TRN)(TN)(FR2)$ 0.203 IN2

ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)

A3 $(DP - D - 2TN)TE(FR4) \text{ OR } 2(TN - C.A.)FR2 \cdot H$ 0.000 IN2

WELD AREA

A4 $W \cdot W \cdot (FR2)$ 0.044 IN2

ATOT $ATOT = A1 + A2 + A3 + A4$ 2.166 IN2

REQUIRED AREA REF:UG-39(B)

$AREQ = 0.5 \cdot D \cdot t + t \cdot TN \cdot (1 - FR1)$ 1.330 IN2

REINFORCEMENT CALCULATION PER APPENDIX 1-7 DOES NOT APPLY (3)

- (1) REFERENCE PAR. UG-34(C)(2)
- (2) E=1, REF UG-37(A) DEFINITION OF TR & TRN
- (3) REFERENCE PAR. UG-36(B-1). THIS CALCULATION IS REQUIRED WHEN THE NOZZLE I.D. IS GREATER THAN HALF THE SHELL I.D. OR THE NOZZLE I.D. EXCEEDS 20 INCHES.
- (4) FR1=1.0 OR SN/SV FOR INSERTED NOZZLES.
FR2=SN/SV, FR3=(LESSER OF SN OR SP)/SV, FR4=SP/SV.

Zur Hauptzeichnung zugehörig.
Belongs to the Main Drawing.
Prüfvermerk vom / Review date:

MAR 23 2005

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