

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 -----
15775A REV A	509.4	AL - DEUTSCHLAND

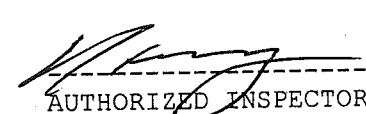
LOADINGS LISTED IN UG-22 HAVE BEEN CONSIDERED IN THE DESIGN OF THE VESSEL AND THE CUSTOMER ADVISED OF THE MAXIMUM LOADS THAT MAY BE APPLIED. YOUR ACCEPTANCE OF THESE CALCULATIONS AND THE VESSEL DESIGN AS MEETING THE MINIMUM REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIV. 1, IS RESPECTFULLY REQUESTED.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

  
-----  
AUTHORIZED INSPECTOR  
HSB CT.

3-15-05  
DATE

SUBJECT: ASME SUBMITTAL CALCULATIONS PER THE 2001 EDITION,  
2003 ADDENDA OF SECTION VIII, DIVISION 1.

CUSTOMER: AL - DEUTSCHLAND  
SALES ORDER: 509.4  
ASSEMBLY DRAWING: 15775A REV A  
ITEM: W43001

## 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	X MATERIAL	O.D.	X WALL	X MATERIAL	
	IN.	X IN.		IN.	X IN.		
A IN	13.620	0.250	SB-209-5083	3.500	0.216	SB-241-5083	149.
A OUT	13.620	0.250	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.

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:

*[Signature]*  
PRODUCT ENGINEERING  
CHART HEAT EXCHANGERS

CHECKED BY:

*[Signature]*  
PRODUCT ENGINEERING  
CHART HEAT EXCHANGERS

**Reviewed****TÜV SÜddeutschland Bau und Betrieb GmbH**

Notified Body for Pressure

Equipment Directive 97/23/EC

**Testing Laboratory-**

APR 01 2005

*[Signature]*

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.)	13.620 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	6.560 INCHES
MINIMUM HEADER THICKNESS (UG-27)	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.086 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 $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.502 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 $W \cdot W \cdot (FR2)$	0.044 IN2
ATOT ATOT=A1+A2+A3+A4	0.743 IN2
REQUIRED AREA	
AREQ= $D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	0.265 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 Handlung  
Beitrag zu den  
Prüfvermerk vom / Review date:

APR 01 2005

TK

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.)	13.620 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	6.560 INCHES
MINIMUM HEADER THICKNESS (UG-27)	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	0.086 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 $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.659 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	0.943 IN2
REQUIRED AREA	
AREQ=D*TR*F+2*TN*TR*F(1-FR1) (F=1.0)	0.348 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:

APR 01 2005

TE

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) OR 2(TN)FR2*H	0.000 IN2
WELD AREA	
A4 W*W*(FR2)	0.044 IN2
ATOT ATOT=A1+A2+A3+A4	0.975 IN2
REQUIRED AREA	
AREQ=D*TR*F+2*TN*TR*F(1-FR1) (F=1.0)	0.041 IN2

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2) Rn/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) X 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 Hauptzeichnung und zugehörig.  
Beitrag zur Zeichnung.  
Prüfvermerk vom / Review date:

APR 01 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 13.620 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 = 149. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 6.810 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.136 \text{ INCHES} \end{aligned}$$

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

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

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

A OUT            HEADER 13.620 O.D. X 0.250 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.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 6.810 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.136 \text{ INCHES} \end{aligned}$$

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

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

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

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:  
APR 01 2005



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

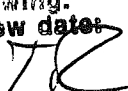
B OUT            HEADER   3.500 O.D. X 0.250 WALL X SB-209-5083-0    WITH BACKING STRIPS  
-----           NOZZLE   2.375 O.D. X 0.154 WALL X SB-241-5083-0    SEAMLESS  
                 DESIGN PRESSURE = 100. PSIG.

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

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

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

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

Zur Hauptzeichnung zugehörig.  
Belongs to the Main Drawing.  
Prüfvermerk vom / Review date:  
APR 01 2005 

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR A IN HEADER 13.620 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 = 5.308 INCHES  
D = LONG SPAN OF A FLAT HEAD = 12.879 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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 5.308/12.879) = 2.41$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.541 \text{ INCHES}$$

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 0.593 IN. (0.625 IN NOM.- 0.032 IN M.T.)  
MEETS OR EXCEEDS TMIN THEREFORE THE DESIGN MEETS THE MINIMUM REQUIREMENTS  
OF THE ASME CODE.

Zur Hauptrechnung zugehörig.  
Gezeichnet  
Prüfvermerk vom / Review date:  
APR 01 2005  
APR 01 2005 T.R



MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR A OUT HEADER 13.620 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:

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

WHERE:

d = SHORT SPAN OF A FLAT HEAD = 5.308 INCHES  
D = LONG SPAN OF A FLAT HEAD = 12.879 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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 5.308/12.879) = 2.41$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQURE ROOT OF}(Z \cdot .33 \cdot P/SE) = 0.541 \text{ INCHES}$$

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.

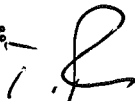
THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

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

THE MINIMUM FLATEND THICKNESS 0.593 IN. (0.625 IN NOM.- 0.032 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:

APR 01 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.  
Revised Main Drawing.  
Prüfungstermin / Review date:

APR 01 2005

T.R.

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 main drawing.  
Prüfvermerk / Review date:

APR 01 2005

T.R.

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

Customer: AL - DEUTSCHLAND  
Sales Order: 509.4  
Assembly drawing: 15775A REV A  
ITEM: W43001

Maximum design temperature 150. F

Test pressure calculation:

Stream	Test Method	CUSTOMER SPECIFIED DESIGN PRESSURE PSIG	CORRECTION Factor	EQUIVALENT DESIGN PSIG	TEST FACTOR	S test/S design	Test Pressure 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	20. layers, 0.380" high at 149. psig =	1132. lb/in
Stream B	19. layers, 0.250" high at 100. psig =	475. lb/in
sum	39. layers	1607. lb/in

$$\text{min sheet} = \frac{1607. \text{ lb/in}}{39. \times 3400. \text{ psi}} = 0.012 \text{ in} < 0.039 \text{ in}$$

Zur Hauptzeichnung zugehörig.  
Belongs to the Main Drawing.  
Prüfvermerk vom / Review date:  
APR 01 2005

72