

TO: AUTHORIZED INSPECTOR  
HSB CT.

DATE: 28-JAN-05

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

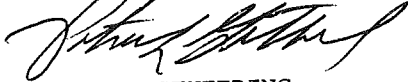
GENTLEMEN:

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.

ASSEMBLY DRAWING -----	SALES ORDER -----	CUSTOMER -----
15770A REV A	509.8	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

 2-4-05  
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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: 509.8  
ASSEMBLY DRAWING: 15770A REV A  
ITEM: W20000

## 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	16.000	0.375	SB-209-5083	12.750	0.375	SB-241-5083	149.
A OUT	10.000	0.250	SB-209-5083	8.625	0.322	SB-241-5083	149.
B IN	13.000	1.000	SB-209-5083	6.625	0.432	SB-241-5083	914.
B OUT	10.750	0.750	SB-209-5083	6.625	0.432	SB-241-5083	914.
C IN	10.750	0.750	SB-209-5083	4.500	0.237	SB-241-5083	914.
C OUT	5.563	0.375	SB-209-5083	3.500	0.216	SB-241-5083	914.
D IN	6.625	0.375	SB-209-5083	2.375	0.154	SB-241-5083	580.
D OUT	10.750	0.500	SB-209-5083	4.500	0.237	SB-241-5083	580.
E IN	2.875	0.203	SB-241-5083	1.900	0.145	SB-241-5083	435.
E OUT	10.750	0.375	SB-209-5083	3.500	0.216	SB-241-5083	435.
F IN	10.750	0.250	SB-209-5083	10.750	0.365	SB-241-5083	40.
F OUT	14.000	0.250	SB-209-5083	12.750	0.375	SB-241-5083	40.
G IN	14.000	0.250	SB-209-5083	14.000	0.250	SB-209-5083	40.
G OUT	18.000	0.250	SB-209-5083	14.000	0.250	SB-209-5083	40.

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

THE C IN HEADER NOZZLE JOINT REQUIRES A 0.250 IN FILLET WELD.  
THE C OUT HEADER NOZZLE JOINT REQUIRES A 0.375 IN FILLET WELD.

NOTE: A, F & G STREAM 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

TÜV Süddeutschland Bau und Betrieb GmbH

Noting acc. to Pressure

Equipment Directive 97/23/EC

-Testing Laboratory- MAR 29 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.)	16.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.375 INCHES
INSIDE RADIUS (R)	7.625 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.100 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
NOZZLE SIZE (O.D.)	12.750 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.375 INCHES
INSIDE DIAMETER (D)	12.000 INCHES
INSIDE RADIUS (R)	6.000 INCHES
MINIMUM NOZZLE THICKNESS	0.084 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.354 INCHES
ACTUAL WELD LEG (W)	0.375 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	3.295 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T) \text{ OR } 5(TN - TRN)(FR2)(TN)$	0.512 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4) \text{ OR } 2(TN)FR2 \cdot H$	
WELD AREA	0.132 IN2
A4 $W \cdot W \cdot (FR2)$	3.938 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	1.205 IN2
AREQ $AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1) \quad (F=1.0)$	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 0.79$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.647 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.291 IN2
ATOT(1-7) $= A1(1-7) + A2 + A3 + A4$	0.804 IN2
AREQ(1-7) $= (2/3) \times AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
Gezeichnet in der Zeichnung.  
Prüfvermerk vom / Review 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	A OUT
DESIGN PRESSURE (P)	149. PSIG
HEADER SIZE (O.D.)	10.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	4.750 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.063 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
NOZZLE SIZE (O.D.)	8.625 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.322 INCHES
INSIDE DIAMETER (D)	7.981 INCHES
INSIDE RADIUS (R)	3.990 INCHES
MINIMUM NOZZLE THICKNESS	0.056 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.250 INCHES
ACTUAL WELD LEG (W)	0.322 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $0.5(D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)) (1 - FR1)$	1.496 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR) (1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$	0.312 IN2
A2 $5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.097 IN2
A4 $W \cdot W \cdot (FR2)$	1.905 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.499 IN2
AREQ $AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F (1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2) Rn/R= 0.84

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $0.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR) (1 - FR1)$	0.748 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR) (1 - FR1)$	1.157 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.333 IN2
AREQ(1-7) = (2/3) X AREQ	

- (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.

Prepared by: [Signature]  
Reviewed by: [Signature]  
Approval date: [Signature]

MAR 29 2005

T.R.

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)		914. PSIG
HEADER SIZE (O.D.)		13.000 INCHES
MATERIAL	SB-209-5083-0	
ALLOWABLE STRESS (S)		11400. PSI
WALL THICKNESS (T)		1.000 INCHES
INSIDE RADIUS (R)		5.500 INCHES
MINIMUM HEADER THICKNESS (UG-27)		
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		0.463 INCHES
NOZZLE SIZE (O.D.)		6.625 INCHES
MATERIAL	SB-241-5083-0	
ALLOWABLE STRESS (S)		10700. PSI
WALL THICKNESS (TN)		0.432 INCHES
INSIDE DIAMETER (D)		5.761 INCHES
INSIDE RADIUS (R)		2.881 INCHES
MINIMUM NOZZLE THICKNESS		
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		0.259 INCHES
HEADER/NOZZLE WELD JOINT		
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707		0.354 INCHES
ACTUAL WELD LEG (W)		0.432 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	3.092 IN2
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	
$5(TN - TRN)(FR2)(TN)$	0.350 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	0.000 IN2
WELD AREA	
A4 $W \cdot W \cdot (FR2)$	0.175 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	3.617 IN2
REQUIRED AREA	
AREQ $= D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	2.669 IN2

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 0.52$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.546 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.071 IN2
ATOT(1-7) $= A1(1-7) + A2 + A3 + A4$	1.779 IN2
AREQ(1-7) $= (2/3) \cdot X \cdot AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (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

T.R.

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 OUT
DESIGN PRESSURE (P)	914. PSIG
HEADER SIZE (O.D.)	10.750 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.750 INCHES
INSIDE RADIUS (R)	4.625 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.390 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
NOZZLE SIZE (O.D.)	6.625 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.432 INCHES
INSIDE DIAMETER (D)	5.761 INCHES
INSIDE RADIUS (R)	2.881 INCHES
MINIMUM NOZZLE THICKNESS	0.259 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.354 INCHES
ACTUAL WELD LEG (W)	0.432 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.077 IN2
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.350 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.175 IN2
A4 $W \cdot W \cdot (FR2)$	2.602 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	2.244 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 0.62$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.038 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.563 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	1.496 IN2
$AREQ(1-7) = (2/3) \cdot X \cdot AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF SN OR SP})/SV$ ,  $FR4 = SP/SV$ .
- (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

T.R.

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	C IN
DESIGN PRESSURE (P)	914. PSIG
HEADER SIZE (O.D.)	10.750 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.750 INCHES
INSIDE RADIUS (R)	4.625 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.390 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
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	0.181 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.237 INCHES
ACTUAL WELD LEG (W)	0.250 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.451 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.062 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.059 IN2
A4 $W \cdot W \cdot (FR2)$	1.572 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	1.568 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
 Bezieht sich auf die Zeichnung.  
 Prüfvermerk vom / Review 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	C OUT
DESIGN PRESSURE (P)	914. PSIG
HEADER SIZE (O.D.)	5.563 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.375 INCHES
INSIDE RADIUS (R)	2.407 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.203 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
	3.500 INCHES
NOZZLE SIZE (O.D.)	SB-241-5083-0
MATERIAL	10700. PSI
ALLOWABLE STRESS (S)	0.216 INCHES
WALL THICKNESS (TN)	3.068 INCHES
INSIDE DIAMETER (D)	1.534 INCHES
INSIDE RADIUS (R)	
MINIMUM NOZZLE THICKNESS	0.138 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.216 INCHES
ACTUAL WELD LEG (W)	0.375 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.529 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.079 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.132 IN2
A4 $W \cdot W \cdot (FR2)$	0.740 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.622 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 0.64$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.264 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.475 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.415 IN2
$AREQ(1-7) = (2/3) \cdot X \cdot AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (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

T-R



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	D OUT	
DESIGN PRESSURE (P)	580. PSIG	
HEADER SIZE (O.D.)	10.750 INCHES	
MATERIAL	SB-209-5083-0	
ALLOWABLE STRESS (S)	11400. PSI	
WALL THICKNESS (T)	0.500 INCHES	
INSIDE RADIUS (R)	4.875 INCHES	
MINIMUM HEADER THICKNESS (UG-27)	0.256 INCHES	
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
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	0.113 INCHES	
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
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	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.983 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.138 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.053 IN2
A4 $W \cdot W \cdot (FR2)$	1.174 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	1.030 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
Belongs to the Main Drawing.  
Prüfungstermin / Review 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	E OUT
DESIGN PRESSURE (P)	435. PSIG
HEADER SIZE (O.D.)	10.750 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.375 INCHES
INSIDE RADIUS (R)	5.000 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.195 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
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	0.064 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
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	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	0.551 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.154 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.044 IN2
A4 $W \cdot W \cdot (FR2)$	0.749 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.599 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
Belongs to the Main Drawing.  
Prüfer: [Signature] / Review date:

MAR 29 2005

T.R.

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	F IN	40. PSIG
DESIGN PRESSURE (P)		10.750 INCHES
HEADER SIZE (O.D.)	SB-209-5083-0	
MATERIAL		11400. PSI
ALLOWABLE STRESS (S)		0.250 INCHES
WALL THICKNESS (T)		5.125 INCHES
INSIDE RADIUS (R)		
MINIMUM HEADER THICKNESS (UG-27)		0.018 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
NOZZLE SIZE (O.D.)	SB-241-5083-0	10.750 INCHES
MATERIAL		10700. PSI
ALLOWABLE STRESS (S)		0.365 INCHES
WALL THICKNESS (TN)		10.020 INCHES
INSIDE DIAMETER (D)		5.010 INCHES
INSIDE RADIUS (R)		
MINIMUM NOZZLE THICKNESS		0.019 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
HEADER/NOZZLE WELD JOINT		0.250 INCHES
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707		0.365 INCHES
ACTUAL WELD LEG (W)		

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.324 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
5(TN - TRN)(FR2)(T) OR	0.406 IN2
A2 5(TN - TRN)(FR2)(TN)	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.125 IN2
A4 $W \cdot W \cdot (FR2)$	2.856 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.181 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 0.98$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.162 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.693 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.120 IN2
AREQ(1-7) = (2/3) X AREQ	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
 Belong to the Main Drawing.  
 Date: MAR 29 2005

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	F OUT
DESIGN PRESSURE (P)	40. PSIG
HEADER SIZE (O.D.)	14.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	6.750 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.024 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
NOZZLE SIZE (O.D.)	12.750 INCHES
MATERIAL	SB-241-5083-0
ALLOWABLE STRESS (S)	10700. PSI
WALL THICKNESS (TN)	0.375 INCHES
INSIDE DIAMETER (D)	12.000 INCHES
INSIDE RADIUS (R)	6.000 INCHES
MINIMUM NOZZLE THICKNESS	0.022 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.250 INCHES
ACTUAL WELD LEG (W)	0.375 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.715 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR	0.414 IN2
$5(TN - TRN)(FR2)(TN)$	
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.132 IN2
A4 $W \cdot W \cdot (FR2)$	3.261 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.285 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2) Rn/R= 0.89

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.358 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.903 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.190 IN2
AREQ(1-7) = (2/3) X AREQ	

- (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.  
Belge zur Main Drawing.  
Prüfung am 29. März 2005

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	G IN	40. PSIG
DESIGN PRESSURE (P)		14.000 INCHES
HEADER SIZE (O.D.)	SB-209-5083-0	11400. PSI
MATERIAL		0.250 INCHES
ALLOWABLE STRESS (S)		6.750 INCHES
WALL THICKNESS (T)		
INSIDE RADIUS (R)		
MINIMUM HEADER THICKNESS (UG-27)		0.024 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
NOZZLE SIZE (O.D.)	SB-209-5083-0	14.000 INCHES
MATERIAL		11400. PSI
ALLOWABLE STRESS (S)		0.250 INCHES
WALL THICKNESS (TN)		13.500 INCHES
INSIDE DIAMETER (D)		6.750 INCHES
INSIDE RADIUS (R)		
MINIMUM NOZZLE THICKNESS		0.024 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))		
HEADER/NOZZLE WELD JOINT		0.250 INCHES
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707		0.250 INCHES
ACTUAL WELD LEG (W)		

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	3.055 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR $5(TN - TRN)(FR2)(TN)$	0.283 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.063 IN2
A4 $W \cdot W \cdot (FR2)$	3.400 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.320 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $Rn/R = 1.00$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.527 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.873 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.214 IN2
$AREQ(1-7) = (2/3) \times AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

Zur Hauptzeichnung zugehörig.  
 Belongs to the Main Drawing.  
 Approved for use / Review date:

MAR 29 2005

T.R.

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	G OUT
DESIGN PRESSURE (P)	40. PSIG
HEADER SIZE (O.D.)	18.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (T)	0.250 INCHES
INSIDE RADIUS (R)	8.750 INCHES
MINIMUM HEADER THICKNESS (UG-27)	0.031 INCHES
TR=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
NOZZLE SIZE (O.D.)	14.000 INCHES
MATERIAL	SB-209-5083-0
ALLOWABLE STRESS (S)	11400. PSI
WALL THICKNESS (TN)	0.250 INCHES
INSIDE DIAMETER (D)	13.500 INCHES
INSIDE RADIUS (R)	6.750 INCHES
MINIMUM NOZZLE THICKNESS	0.024 INCHES
TRN=PR/(SE-.6P) (E=1.0 REFERENCE NOTE (4))	
HEADER/NOZZLE WELD JOINT	
MIN. WELD LEG = SMALLER OF (T), (TN) OR .25/.707	0.250 INCHES
ACTUAL WELD LEG (W)	0.250 INCHES

REINFORCEMENT CALCULATION UG-37

AVAILABLE AREA	E1=1.00
SHELL: LARGER OF: (NOTE 1)	
A1A $D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	2.960 IN2
A1B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	
NOZZLE: SMALLER OF:	
A2 $5(TN - TRN)(FR2)(T)$ OR $5(TN - TRN)(FR2)(TN)$	0.283 IN2
ADDITIONAL AREA IF USED (RE-PAD OR INWARD NOZZLE)	0.000 IN2
A3 $(DP - D - 2TN)TE(FR4)$ OR $2(TN)FR2 \cdot H$	
WELD AREA	0.063 IN2
A4 $W \cdot W \cdot (FR2)$	3.305 IN2
ATOT $ATOT = A1 + A2 + A3 + A4$	
REQUIRED AREA	0.415 IN2
$AREQ = D \cdot TR \cdot F + 2 \cdot TN \cdot TR \cdot F(1 - FR1)$ (F=1.0)	

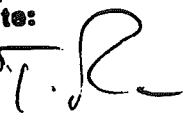
REINFORCEMENT CALCULATION APPENDIX (1-7a). (NOTE 2)  $R_n/R = 0.77$

A1(1-7) = LARGER OF A1(1-7)A OR A1(1-7)B	
A1(1-7)A $.5 \cdot D(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.480 IN2
A1(1-7)B $2(T + TN)(E1 \cdot T - F \cdot TR) - 2 \cdot TN(E1 \cdot T - F \cdot TR)(1 - FR1)$	1.825 IN2
ATOT(1-7) = A1(1-7) + A2 + A3 + A4	0.277 IN2
$AREQ(1-7) = (2/3) \times AREQ$	

- (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.  
 $FR2 = SN/SV$ ,  $FR3 = (\text{LESSER OF } SN \text{ OR } SP)/SV$ ,  $FR4 = SP/SV$ .
- (4) TR & TRN ARE BASED ON SEAMLESS MATERIAL PER DEFINITIONS IN UG-37.

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

MAR 29 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 OR ARE CHECKED FOR COMPLIANCE WITH UG-45(b)(1).

A IN      HEADER 16.000 O.D. X 0.375 WALL X SB-209-5083-0      WITH BACKING STRIPS  
----- NOZZLE 12.750 O.D. X 0.375 WALL X SB-241-5083-0      SEAMLESS  
DESIGN PRESSURE = 149. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 8.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.160 \text{ INCHES} \end{aligned}$$

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

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{149. \text{ PSIG} \times 6.375 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 149. \text{ PSIG}} = 0.088 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.375 \text{ INCHES} \times .875 = 0.328 \text{ INCHES}$$

A OUT      HEADER 10.000 O.D. X 0.250 WALL X SB-209-5083-0      WITH BACKING STRIPS  
----- NOZZLE 8.625 O.D. X 0.322 WALL X SB-241-5083-0      SEAMLESS  
DESIGN PRESSURE = 149. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{149. \text{ PSIG} \times 5.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 149. \text{ PSIG}} = 0.100 \text{ INCHES} \end{aligned}$$

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

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{149. \text{ PSIG} \times 4.312 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 149. \text{ PSIG}} = 0.060 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.322 \text{ INCHES} \times .875 = 0.282 \text{ INCHES}$$

B IN      HEADER 13.000 O.D. X 1.000 WALL X SB-209-5083-0      WITH BACKING STRIPS  
----- NOZZLE 6.625 O.D. X 0.432 WALL X SB-241-5083-0      SEAMLESS  
DESIGN PRESSURE = 914. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{914. \text{ PSIG} \times 6.500 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 914. \text{ PSIG}} = 0.764 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 1.000 \text{ INCHES} - 0.055 \text{ INCH M.T.} = 0.945 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{914. \text{ PSIG} \times 3.312 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 914. \text{ PSIG}} = 0.274 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.432 \text{ INCHES} \times .875 = 0.378 \text{ INCHES}$$

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

MAR 29 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 OR ARE CHECKED FOR COMPLIANCE WITH UG-45(b)(1).

B OUT      HEADER 10.750 O.D. X 0.750 WALL X SB-209-5083-0      WITH BACKING STRIPS  
-----      NOZZLE 6.625 O.D. X 0.432 WALL X SB-241-5083-0      SEAMLESS  
             DESIGN PRESSURE = 914. PSIG.

$$\begin{aligned} \text{T REQ. (HEADER)} &= \frac{914. \text{ PSIG} \times 5.375 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 914. \text{ PSIG}} = 0.632 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.750 \text{ INCHES} - 0.043 \text{ INCH M.T.} = 0.707 \text{ INCHES}$$

$$\begin{aligned} \text{T REQ. (NOZZLE)} &= \frac{914. \text{ PSIG} \times 3.312 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 914. \text{ PSIG}} = 0.274 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.432 \text{ INCHES} \times .875 = 0.378 \text{ INCHES}$$

C IN      HEADER 10.750 O.D. X 0.750 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 = 914. PSIG.

$$\begin{aligned} \text{T REQ. (HEADER)} &= \frac{914. \text{ PSIG} \times 5.375 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 914. \text{ PSIG}} = 0.632 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.750 \text{ INCHES} - 0.043 \text{ INCH M.T.} = 0.707 \text{ INCHES}$$

$$\begin{aligned} \text{T REQ. (NOZZLE)} &= \frac{914. \text{ PSIG} \times 2.250 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 914. \text{ PSIG}} = 0.186 \text{ INCHES} \end{aligned}$$

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

C OUT      HEADER 5.563 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 = 914. PSIG.

$$\begin{aligned} \text{T REQ. (HEADER)} &= \frac{914. \text{ PSIG} \times 2.782 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 914. \text{ PSIG}} = 0.327 \text{ INCHES} \end{aligned}$$

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

$$\begin{aligned} \text{T REQ. (NOZZLE)} &= \frac{914. \text{ PSIG} \times 1.750 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 914. \text{ PSIG}} = 0.145 \text{ INCHES} \end{aligned}$$

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

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

*D.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 OR ARE CHECKED FOR COMPLIANCE WITH UG-45(b)(1).

D IN      HEADER 6.625 O.D. X 0.375 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 = 580. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{580. \text{ PSIG} \times 3.312 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 580. \text{ PSIG}} = 0.251 \text{ INCHES} \end{aligned}$$

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

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{580. \text{ PSIG} \times 1.188 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 580. \text{ PSIG}} = 0.063 \text{ INCHES} \end{aligned}$$

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

D OUT      HEADER 10.750 O.D. X 0.500 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 = 580. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{580. \text{ PSIG} \times 5.375 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 580. \text{ PSIG}} = 0.408 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.500 \text{ INCHES} - 0.032 \text{ INCH M.T.} = 0.468 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{580. \text{ PSIG} \times 2.250 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 580. \text{ PSIG}} = 0.119 \text{ INCHES} \end{aligned}$$

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

E IN      HEADER 2.875 O.D. X 0.203 WALL X SB-241-5083-0      WITHOUT BACKING STRIPS  
----- NOZZLE 1.900 O.D. X 0.145 WALL X SB-241-5083-0      SEAMLESS  
DESIGN PRESSURE = 435. PSIG.

$$\begin{aligned} T \text{ REQ. (HEADER)} &= \frac{435. \text{ PSIG} \times 1.438 \text{ INCHES}}{10700. \text{ PSI} \times 0.60 + .4 \times 435. \text{ PSIG}} = 0.095 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM HEADER THICKNESS} = 0.203 \text{ INCHES} \times .875 = 0.178 \text{ INCHES}$$

$$\begin{aligned} T \text{ REQ. (NOZZLE)} &= \frac{435. \text{ PSIG} \times 0.950 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 435. \text{ PSIG}} = 0.038 \text{ INCHES} \end{aligned}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.145 \text{ INCHES} \times .875 = 0.127 \text{ INCHES}$$

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

MAR 29 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 OR ARE CHECKED FOR COMPLIANCE WITH UG-45(b)(1).

E OUT      HEADER 10.750 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 = 435. PSIG.

$$T \text{ REQ. (HEADER)} = \frac{435. \text{ PSIG} \times 5.375 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 435. \text{ PSIG}} = 0.308 \text{ INCHES}$$

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

$$T \text{ REQ. (NOZZLE)} = \frac{435. \text{ PSIG} \times 1.750 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 435. \text{ PSIG}} = 0.070 \text{ INCHES}$$

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

F IN      HEADER 10.750 O.D. X 0.250 WALL X SB-209-5083-0      WITH BACKING STRIPS  
 -----      NOZZLE 10.750 O.D. X 0.365 WALL X SB-241-5083-0      SEAMLESS  
              DESIGN PRESSURE = 40. PSIG.

$$T \text{ REQ. (HEADER)} = \frac{40. \text{ PSIG} \times 5.375 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.029 \text{ INCHES}$$

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

$$T \text{ REQ. (NOZZLE)} = \frac{40. \text{ PSIG} \times 5.375 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 40. \text{ PSIG}} = 0.020 \text{ INCHES}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.365 \text{ INCHES} \times .875 = 0.319 \text{ INCHES}$$

F OUT      HEADER 14.000 O.D. X 0.250 WALL X SB-209-5083-0      WITH BACKING STRIPS  
 -----      NOZZLE 12.750 O.D. X 0.375 WALL X SB-241-5083-0      SEAMLESS  
              DESIGN PRESSURE = 40. PSIG.

$$T \text{ REQ. (HEADER)} = \frac{40. \text{ PSIG} \times 7.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.038 \text{ INCHES}$$

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

$$T \text{ REQ. (NOZZLE)} = \frac{40. \text{ PSIG} \times 6.375 \text{ INCHES}}{10700. \text{ PSI} \times 1.00 + .4 \times 40. \text{ PSIG}} = 0.024 \text{ INCHES}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.375 \text{ INCHES} \times .875 = 0.328 \text{ INCHES}$$

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

MAR 29 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 OR ARE CHECKED FOR COMPLIANCE WITH UG-45(b)(1).

G IN      HEADER 14.000 O.D. X 0.250 WALL X SB-209-5083-0      WITH BACKING STRIPS  
----- NOZZLE 14.000 O.D. X 0.250 WALL X SB-209-5083-0      TYPE (2) BUTT JOINT  
DESIGN PRESSURE = 40. PSIG.

$$T \text{ REQ. (HEADER)} = \frac{40. \text{ PSIG} \times 7.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.038 \text{ INCHES}$$

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

$$T \text{ REQ. (NOZZLE)} = \frac{40. \text{ PSIG} \times 7.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.038 \text{ INCHES}$$

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

UG-45(b)(1) CHECK: 0.232 INCHES > 0.038 INCHES, UG-45(b) CRITERIA MET

G OUT      HEADER 18.000 O.D. X 0.250 WALL X SB-209-5083-0      WITH BACKING STRIPS  
----- NOZZLE 14.000 O.D. X 0.250 WALL X SB-209-5083-0      TYPE (2) BUTT JOINT  
DESIGN PRESSURE = 40. PSIG.

$$T \text{ REQ. (HEADER)} = \frac{40. \text{ PSIG} \times 9.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.048 \text{ INCHES}$$

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

$$T \text{ REQ. (NOZZLE)} = \frac{40. \text{ PSIG} \times 7.000 \text{ INCHES}}{11400. \text{ PSI} \times 0.65 + .4 \times 40. \text{ PSIG}} = 0.038 \text{ INCHES}$$

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

UG-45(b)(1) CHECK: 0.232 INCHES > 0.048 INCHES, UG-45(b) CRITERIA MET

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

MAR 29 2005

T.R.

ASME REQUIREMENTS FOR ALUMINUM FLAT UNSTAYED DISKS

DISK DESIGN FOR A OUT NOZZLE 8.625 INCH O.D. BY 0.322 INCH WALL

DESIGN PRESSURE = 149. PSIG  
OUTSIDE DIAMETER OF PIPE = 8.625 INCHES  
WALL THICKNESS OF PIPE = 0.322 INCHES  
INSIDE DIAMETER OF PIPE (D) = 7.981 INCHES  
PIPE MATERIAL = SB-241-5083-0 ALUMINUM  
ALLOWABLE STRESS OF PIPE = 10700. PSI  
DISK MATERIAL = SB-209-5083-0 ALUMINUM  
ALLOWABLE STRESS OF DISK = 11400. PSI  
THE DISK IS WELDED WITH A BACKING RING.

FACTOR FOR HEAD ATTACHMENT (C) = .33 PER FIG UG-34(H)  
JOINT EFFICIENCY (E) = 1.0 FOR SEAMLESS DISKS

PER UG-34(C) (2), SECTION VIII, DIVISION 1, OF THE ASME CODE:

$$T_{MIN}(1) = D \cdot \text{SQUARE ROOT OF } (C/P/SE) = 0.524 \text{ INCHES}$$

PER FIG UW-13.2(C):  $T_{MIN}(2) = TP + B$

WHERE: TP = THE SMALLER OF TN OR .25  
B = TN FOR DISKS BEVELED AT A 45 DEGREE ANGLE

$$T_{MIN}(2) = 0.572 \text{ INCHES}$$

WHEN A DISK CLOSURE IS USED A CHECK MUST BE MADE ON THE REQUIRED PIPE WALL THICKNESS. TO COMPLY WITH FIG UG-34(H), A NOZZLE THICKNESS OF 1.25(TR) IS REQUIRED.

PER UG-27(C) (1):

$$TR = PR / (SE - .6P)$$

THUS THE MINIMUM REQUIRED NOZZLE THICKNESS IS:

$$TR = 1.25PR / (SE - .6P) = 0.070 \text{ INCHES}$$

$$\text{MINIMUM NOZZLE THICKNESS} = 0.322 \text{ INCHES} \times .875 = 0.282 \text{ INCHES}$$

SINCE THE DISK THICKNESS 0.593 IN. (0.625 IN - 0.032 IN M.T.), MEETS OR EXCEEDS  $T_{MIN}(1)$  AND  $T_{MIN}(2)$  AND THE ACTUAL PIPE WALL THICKNESS EXCEEDS 1.25(TR) 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.R.

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR A IN HEADER 16.000 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 (THE RADIUS) = 7.625 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 15.250 INCHES  
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)  
m =  $t_r/t_s$  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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 7.625/15.250) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.743 \text{ INCHES}$$

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 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 OUT HEADER 10.000 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 (THE RADIUS) = 4.750 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 9.500 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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 4.750 / 9.500) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQURE ROOT OF}(Z \cdot .33 \cdot P/SE) = 0.463 \text{ INCHES}$$

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.

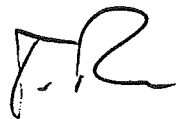
THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

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

THE MINIMUM FLATEND THICKNESS 0.468 IN. (0.500 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 / Review date:

MAR 29 2005



MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR C OUT      HEADER      5.563 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 (THE RADIUS) = 2.407 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 4.813 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 = 914. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 2.407 / 4.813) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.581 \text{ INCHES}$$

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.

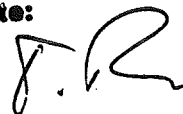
THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

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

THE MINIMUM FLATEND THICKNESS 0.593 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:

MAR 29 2005



MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR D IN HEADER 6.625 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 (THE RADIUS) = 2.938 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 5.875 INCHES  
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)  
m =  $t_r/t_s$  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 = 580. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 2.938 / 5.875) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.565 \text{ INCHES}$$

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 0.593 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:

MAR 29 2005





MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR D OUT HEADER 10.750 INCH O.D. BY 0.500 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) = 4.875 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 9.750 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 = 580. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 4.875 / 9.750) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.937 \text{ INCHES}$$

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:

$$T(\text{SHELL}) + 0.125 = 0.625 \text{ INCHES}$$

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

MAR 29 2005

T-R

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR E IN HEADER 2.875 INCH O.D. BY 0.203 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 (THE RADIUS) = 1.235 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 2.469 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 = 435. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 1.235 / 2.469) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQURE ROOT OF}(Z \cdot .33 \cdot P/SE) = 0.205 \text{ INCHES}$$

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:

$$T(\text{SHELL}) + 0.125 = 0.328 \text{ INCHES}$$

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 2 5 44

T.R.

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR E OUT HEADER 10.750 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:

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

WHERE:

d = SHORT SPAN OF A FLAT HEAD (THE RADIUS) = 5.000 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 10.000 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 = 435. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 5.000/10.000) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQURE ROOT OF}(Z \cdot .33 \cdot P/SE) = 0.832 \text{ INCHES}$$

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

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR F IN HEADER 10.750 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 (THE RADIUS) = 5.125 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 10.250 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 = 40. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 5.125/10.250) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQURE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.259 \text{ INCHES}$$

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:

29.1.2005

T. L.

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR F OUT HEADER 14.000 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) = 6.750 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 13.500 INCHES  
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)  
m =  $t_r/t_s$  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 = 40. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 6.750/13.500) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQUARE ROOT OF } (Z \cdot .33 \cdot P/SE) = 0.341 \text{ INCHES}$$

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.

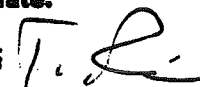
THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

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

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



MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR G IN HEADER 14.000 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:

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

WHERE:

d = SHORT SPAN OF A FLAT HEAD (THE RADIUS) = 6.750 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 13.500 INCHES  
C = HEAD ATTACHMENT FACTOR WHICH = .33m PER FIGURE UG-34(E)  
m =  $t_r/t_s$  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 = 40. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 6.750/13.500) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQARE ROOT OF} (Z \cdot .33 \cdot P/SE) = 0.341 \text{ INCHES}$$

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 / Review date:

MAR 29 2005

MINIMUM ASME THICKNESS REQUIREMENTS FOR ALUMINUM FLATENDS:

FLATEND DESIGN FOR G OUT HEADER 18.000 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:

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

WHERE:

d = SHORT SPAN OF A FLAT HEAD (THE RADIUS) = 8.750 INCHES  
D = LONG SPAN OF A FLAT HEAD (THE DIAMETER) = 17.500 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 = 40. PSIG  
S = MAXIMUM ALLOWABLE ASME STRESS VALUE (PSI)

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

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

$$\text{HENCE } Z = 3.4 - (2.4 \cdot 8.750/17.500) = 2.20$$

THEREFORE, TMIN, BASED ON THE ABOVE CRITERIA IS:

$$T_{\text{MIN}} = d \cdot \text{SQRT OF } (Z \cdot .33 \cdot P/SE) = 0.442 \text{ INCHES}$$

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.

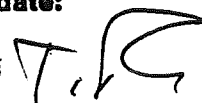
THEREFORE THE MINIMUM NOMINAL PLATE THICKNESS IS:

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

THE MINIMUM FLATEND THICKNESS 0.468 IN. (0.500 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:

MAR 29 2005



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

Customer: AL-DEUTSCHLAND  
Sales Order: 509.8  
Assembly drawing: 15770A REV A  
ITEM: W20000

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.
F	PNEU	29.	X	1.50/1.1	=	40.	X	1.10	X	1.000	=	44.
G	PNEU	29.	X	1.50/1.1	=	40.	X	1.10	X	1.000	=	44.

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.

Stream	Test Method	Test Factor		MAWP PSIG		S test/S design		Test Pressure PSIG
B	HYDRO	1.50	X	914.	X	1.000	=	1371.
C	HYDRO	1.50	X	914.	X	1.000	=	1371.
D	HYDRO	1.50	X	580.	X	1.000	=	870.
E	HYDRO	1.50	X	435.	X	1.000	=	653.

Hydro test factors 1.5 and less will not exceed material yield strengths.

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.

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

MAR 29 2005

*T.R.*



Section 1 :

Stream A INACT	30. layers, 0.380" high at	0. psig =	0. lb/in
Stream B	18. layers, 0.201" high at	914. psig =	3307. lb/in
Stream D	9. layers, 0.201" high at	580. psig =	1049. lb/in
Stream E	6. layers, 0.201" high at	435. psig =	525. lb/in
Stream F	30. layers, 0.380" high at	40. psig =	456. lb/in
Stream G	36. layers, 0.380" high at	40. psig =	547. lb/in
sum	129. layers		5884. lb/in

$$\text{min sheet} = \frac{5884. \text{ lb/in}}{129. * 3400. \text{ psi}} = 0.013 \text{ in} < 0.055 \text{ in}$$

$$\text{Ave thk} = \frac{(62 \text{ shts} * .039") + (30 \text{ shts} * .059") + (36 \text{ shts} * .079")}{(62 + 30 + 36)} = .055 \text{ in.}$$

Section 2 :

Stream A	30. layers, 0.380" high at	149. psig =	1699. lb/in
Stream B	18. layers, 0.201" high at	914. psig =	3307. lb/in
Stream D	9. layers, 0.201" high at	580. psig =	1049. lb/in
Stream E	6. layers, 0.201" high at	435. psig =	525. lb/in
Stream F	30. layers, 0.380" high at	40. psig =	456. lb/in
Stream G	36. layers, 0.380" high at	40. psig =	547. lb/in
sum	129. layers		7582. lb/in

$$\text{min sheet} = \frac{7582. \text{ lb/in}}{129. * 3400. \text{ psi}} = 0.017 \text{ in} < 0.055 \text{ in}$$

Section 3 :

Stream A	30. layers, 0.380" high at	149. psig =	1699. lb/in
Stream C	18. layers, 0.201" high at	914. psig =	3307. lb/in
Stream D	9. layers, 0.201" high at	580. psig =	1049. lb/in
Stream E	6. layers, 0.201" high at	435. psig =	525. lb/in
Stream F	30. layers, 0.380" high at	40. psig =	456. lb/in
Stream G	36. layers, 0.380" high at	40. psig =	547. lb/in
sum	129. layers		7582. lb/in

$$\text{min sheet} = \frac{7582. \text{ lb/in}}{129. * 3400. \text{ psi}} = 0.017 \text{ in} < 0.055 \text{ in}$$

Section 4 :

Stream A	30. layers, 0.380" high at	149. psig =	1699. lb/in
Stream C INACT	18. layers, 0.201" high at	0. psig =	0. lb/in
Stream D	9. layers, 0.201" high at	580. psig =	1049. lb/in
Stream E INACT	6. layers, 0.201" high at	0. psig =	0. lb/in
Stream F	30. layers, 0.380" high at	40. psig =	456. lb/in
Stream G	36. layers, 0.380" high at	40. psig =	547. lb/in
sum	129. layers		3751. lb/in

$$\text{min sheet} = \frac{3751. \text{ lb/in}}{129. * 3400. \text{ psi}} = 0.009 \text{ in} < 0.055 \text{ in}$$

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

MAR 29 2005

