

PLANT BEAUMONT
 PROC N° 6482
 A.D. N° LBPC 96764U
 EN N° 5111 7061 /

NOZ	SIZE	TYPE	LOCATION	INSTRUMENT	SCALE	UNIT	STATUS	REMARKS
D1	2	(R)	(R)	6 6	90			
F	4	(R)	(R)	15 24	156			
L1	Δ2"	(R)	(R)	Δ0 6	156			LEVEL
L2	Δ2"	(R)	(R)	1 9	156			LEVEL
M1	24	(R)	(R)	Δ5 6	265 Δ			M HWAY
M2	24	(R)	(R)	Δ6 6	270			M HWAY
P1	2	(R)	(R)	6 6	225			LEVEL Δ
P2	2	(R)	(R)	Δ17 6	225			LEVEL Δ
P3	2	(R)	(R)	Δ5 0	225			PRESSURE
T1	1 1/2"	(R)	(R)	0 6	336			TEMP
T2	1 1/2"	(R)	(R)	7 9 Δ	156			TEMP
T3	1 1/2"	(R)	(R)	10 2 Δ	336			TEMP
T4	1 1/2"	(R)	(R)	11 9 Δ	156			TEMP
T5	1 1/2"	(R)	(R)	13 9 Δ	336			TEMP
T6	1 1/2"	(R)	(R)	17 6	156			TEMP
U	Ø							LIQUID OUT
V	30							VAPOR OUT
X	2	(R)	(R)	15 1' Δ	156			INLET
Y	14	(R)	(R)	Ø 0	Δ575			VAPOR IN
Z	6	(R)	(R)	Ø 0	210 Δ			INSPECTION WITH BLIND FLG
N1	6	(R)	(R)	Ø 2 Δ	30			INSPECTION WITH BLIND FLG
N2	6	(R)	(R)	12 0 Δ	210 Δ			INSPECTION WITH BLIND FLG
N3	6	(R)	(R)	14 0 Δ	210 Δ			INSPECTION WITH BLIND FLG
N4	6	(R)	(R)	16 0 Δ	210 Δ			INSPECTION WITH BLIND FLG
N5	6	(R)	(R)	7 9	225			SPARE
A1	2	(R)	(R)	1 6	135			SPARE
A2	3	(R)	(R)	11 9	90			SPARE/DRAW
P4	2	(R)	(R)		225			Top Head

SEP 28 1990

RF 285559

Sheet # 2

ACH TOPPIN COLLINS
 ORIENTATION
 E I DUPONT DE NEMOURS CO INC
 NEWARK DELAWARE
 227 99 P MERLEY
 JOB NO H 5823
 SHEET 2

AP 1E
 A P 1E AS
 N TE
 I TA VE
 128 80

CHKD. BY *ES* DATE 2/27/89

ST. LOUIS, MO.

JOB NO. H5823

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -956

LETHAL SERVICE

FILE NAME: H5823

DESIGN PRESSURE: INTERNAL = 50. P.S.I.G. EXTERNAL = 15.0 P.S.I.G.

DESIGN TEMPERATURE = 302. DEGREES FAHRENHEIT

SPECIFIC GRAVITY OF CONTENTS = 1.00

SHELL/HEAD CALCULATION JOINT EFFICIENCY: 1.000

CORROSION ALLOWANCE/CLAD THICKNESS: HEADS & SHELLS = .031" NOZZLES = .031"

A.N.S.I. FLANGE RATING CLASS: 150 #

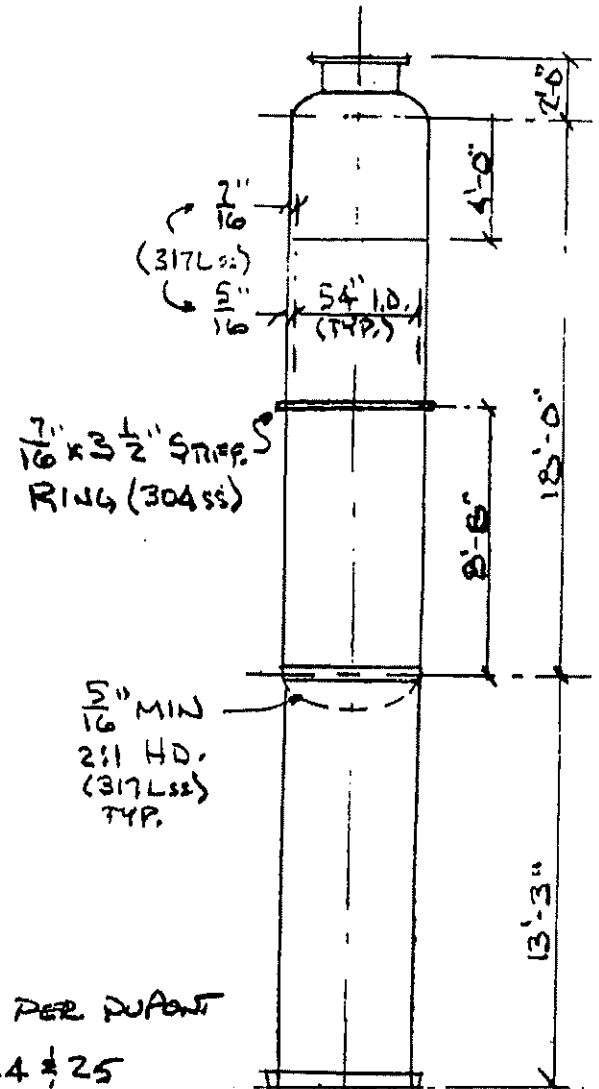
M.D.M.T. = +15° F

NO HEAT TREATMENT

HYDRO TEST Δ

SHOP: 90PSIG @ TOP (HORIZ. POSITION)

FIELD: 90PSIG @ TOP PER DUPONT



Δ REV. HYDRO TEST, FLG. BOLTING, & GASKETS PER DUPONT
 DMP 5/24/89 REV. SH'S. 1, 2, 4, 8, 9, 10, 17, 18, 22, 24 & 25
 ADD SH'S. 16A & 12A

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -956

COMPONENT IDH 2:1 ELLIPSOIDAL HEAD

COMPONENT DESCRIPTION - BOTTOM HEAD

HEAD SKIRT I.D. = 54.00 INCHES
 MATERIAL = SA240317L
 DESIGN TEMPERATURE = 302, DEG F
 DESIGN ALLOWABLE STRESS = 18394. PSI
 AMBIENT ALLOWABLE STRESS = 18000. PSI
 CORR. ALLOW / CLAD = .031 INCHES
 JOINT EFFICIENCY = 1.00
 DESIGN PRESSURE = 50.0 PSIG
 LIQUID HEAD = 21.2 FT
 SPECIFIC GRAVITY = 1.00

REQUIRED THICKNESS FOR INTERNAL PRESSURE (UG-32)

$$P = 50.0 + .433 (1.00) (21.2) = 59.2 \text{ PSIG}$$

$$t = \frac{(59.2) (54.06)}{2 (18394.) (1.00) - (.2) (59.2)} + .031$$

$$= .087 + .031 = .118 \text{ INCHES (}.12 \text{ INCHES)}$$

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

5/16" MIN. 317 LSS (PER DUPONT)

△
 FUTURE HYDROTEST: $P = \frac{2}{3} [90 + 21.2 \times .433] = 66 \text{ PSI}$

O.K. BY INSPECTION

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -656

COMPONENT BH

COMPONENT DESCRIPTION - BOTTOM HEAD

MINIMUM THICKNESS OF VESSEL HEAD FOR A GIVEN
EXTERNAL PRESSURE -- 2:1 ELLIPSOIDAL HEAD (UG-33)

EXTERNAL PRESSURE = 15.0 PSI
DESIGN TEMPERATURE = 302, DEG F
MATERIAL = SA240317L
HEAD I.D. @ TAN. LINE = 54.00 INCHES
CORR. ALLOW / CLAD = .031 INCHES

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

DO = 54.00 + (2) (.313) = 54.63 INCHES

t(corr) = .313 - .031 = .282 INCHES

t(min) = .146 INCHES O.K.

RO = .9(DO) = 49.2 INCHES

A = (.125T) / RO = .000371

FROM FIG. 5-UHA-28.4 B = 5070. PSI

PA = B(T) / RO = 15.0 PSI

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -956

COMPONENT LS

CYLINDRICAL SHELL (PLATE)

COMPONENT DESCRIPTION - LOWER SHELL

I.D. = 54.00 INCHES
 MATERIAL = SA240317L
 DESIGN TEMPERATURE = 302. DEG F
 DESIGN ALLOWABLE STRESS = 18394. PSI
 AMBIENT ALLOWABLE STRESS = 18000. PSI
 CORR. ALLOW / CLAD = .031 INCHES
 JOINT EFFICIENCY = 1.00
 DESIGN PRESSURE = 50.0 PSIG
 LIQUID HEAD = 20.0 FT
 SPECIFIC GRAVITY = 1.00

REQUIRED THICKNESS FOR INTERNAL PRESSURE (UG-27)

$$P = 50.0 + .433 (1.00) (20.0) = 58.7 \text{ PSIG}$$

$$t = \frac{(58.7) (27.03)}{(18394.) (1.00) - (.6) (58.7)} + .031$$

$$= .006 + .031 = .118 \text{ INCHES } (.12 \text{ INCHES})$$

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

5/16" 317L (PER DUPONT)

By INSPECTION 6" STUDDING OUTLETS INHERENTLY
 REINFORCED FOR INT. & EXT. PRESSURE

By INSPECTION D.K. FOR VERT. HYDROTEST

$$\Delta P = \frac{2}{3} [90 + 20 \times .433] = 66 \text{ PSI}$$

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -556

COMPONENT LS

COMPONENT DESCRIPTION - LOWER SHELL (BTM. T.L. TO STIFF.)

MINIMUM THICKNESS OF TUBE OR VESSEL SECTION FOR A GIVEN
EXTERNAL PRESSURE -- CYLINDRICAL SHELL (PLATE) (UG-28)

EXTERNAL PRESSURE = 15.0 PSI
DESIGN TEMPERATURE = 302. DEG F
MATERIAL = SA240317L
SHELL I.D. = 54.00 INCHES
CORR. ALLOW / CLAD = .031 INCHES
UNSUPPORTED LENGTH = 108.5 INCHES

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

DO = 54.00 + (2) (.313) = 54.63 INCHES

t(corr) = .313 - .031 = .282 INCHES

T(MIN) = .238 INCHES

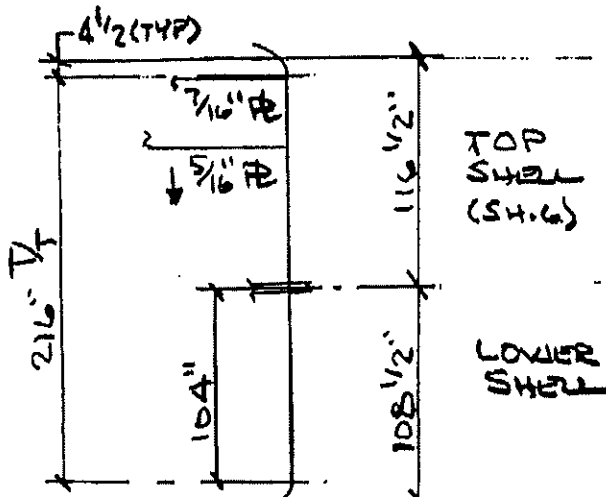
DO / T = 229.9

L / DO = 1.99

FROM FIG. 5-UGO-28.0 A = .000190

FROM FIG. 5-UHA-28.4 B = 2590. PSI

PA = 4B / [3(DO / T)] = 15.0 PSI



CHKD. BY *EB* DATE *4/8/89*

ST. LOUIS, MO.

JOB NO. H5823

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

COMPONENT TS

COMPONENT DESCRIPTION - TOP SHELL (STIFF. RING TO TOP T.I.L.)

MINIMUM THICKNESS OF TUBE OR VESSEL SECTION FOR A GIVEN
EXTERNAL PRESSURE -- CYLINDRICAL SHELL (PLATE) (UG-28)

EXTERNAL PRESSURE	=	15.0 PSI
DESIGN TEMPERATURE	=	302. DEG F
MATERIAL	=	SA240317L
SHELL I.D.	=	54.00 INCHES
CORR. ALLOW / CLAD	=	.031 INCHES
UNSUPPORTED LENGTH	=	116.5 INCHES

{ CONSERVATIVE - 48" OF THIS SECTION IS 1/16" TH'K.

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

DO = 54.00 + (2) (.313) = 54.63 INCHES

t(corr) = .313 - .031 = .282 INCHES

T(MIN) = .244 INCHES

DO / T = 223.9

L / DO = 2.13

FROM FIG. 5-UGO-28.0 A = .000185

FROM FIG. 5-UHA-28.4 B = 2520. PSI

PA = 4B / [3(DO / T)] = 15.0 PSI

COMPANY DUPONT

JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -656

COMPONENT SR

COMPONENT DESCRIPTION - STIFFENING RINGREQUIRED STIFFENER RING FOR CYLINDRICAL SHELL FOR A GIVEN
EXTERNAL PRESSURE -- (UG-29)

EXTERNAL PRESSURE = 15.0 PSI
 DESIGN TEMPERATURE = 302. DEG F
 SHELL MATERIAL = SA240317L
 RING MATERIAL = SA240304
 RING I.D. (SHELL O.D.) = 54.63 INCHES
 SHELL CORR. ALLOW / CLAD = .031 INCHES
 UNSUPPORTED LENGTH = 112.5 INCHES

SHELL NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

TCORR = .313 - .031 = .282 INCHES

B = $3/4 [(PDD) / (T+AS / LS)]$ = 2080. PSI

FROM FIG. 3-UHA-28.1 A = .0001550

IS' = $[(DO**2)LS(T+AS/LS)A] / 10.9$ = 1.4 (IN**4)~~USE : 3.50 X .438 BAR WITH SHELL~~

I' = 4.0 (IN**4)

AS = 1.5 (IN**2)

L STIFF. SIZE PER DUPONT

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

COMPONENT UG CYLINDRICAL SHELL (PLATE)

COMPONENT DESCRIPTION - UPPER SHELL (4'-0" LONG)

I.D. = 54.00 INCHES
 MATERIAL = SA240317L
 DESIGN TEMPERATURE = 302. DEG F
 DESIGN ALLOWABLE STRESS = 18394. PSI
 AMBIENT ALLOWABLE STRESS = 18000. PSI
 CORR. ALLOW / CLAD = .031 INCHES
 JOINT EFFICIENCY = 1.00
 DESIGN PRESSURE = 50.0 PSIG
 LIQUID HEAD = 6.0 FT
 SPECIFIC GRAVITY = 1.00

REQUIRED THICKNESS FOR INTERNAL PRESSURE (UG-27)

$$P = 50.0 + .433 (1.00) (6.0) = 52.6 \text{ PSIG}$$

$$t = \frac{(52.6) (27.03)}{(18394.) (1.00) - (.6) (52.6)} + .031$$

$$= .077 + .031 = .109 \text{ INCHES } (.11 \text{ INCHES})$$

NEW THICKNESS USED IN CALCULATIONS = .438 INCHES

7/16" 317L (PER DUPONT)

BY INSPECTION 6" STUDDING OUTLETS INHERENTLY REINFORCED FOR INT. & EXT. PRESSURE

Δ BY INSPECTION O.K. FOR VERT. HYDROTEST

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

COMPONENT TH 2:1 ELLIPSOIDAL HEAD

COMPONENT DESCRIPTION - TOP HEAD

HEAD SKIRT I.D. = 54.00 INCHES
 MATERIAL = SA240317L
 DESIGN TEMPERATURE = 302. DEG F
 DESIGN ALLOWABLE STRESS = 18394. PSI
 AMBIENT ALLOWABLE STRESS = 18800. PSI
 CORR. ALLOW / CLAD = .031 INCHES
 JOINT EFFICIENCY = 1.00
 DESIGN PRESSURE = 50.0 PSIG
 LIQUID HEAD = 2.0 FT
 SPECIFIC GRAVITY = 1.00

REQUIRED THICKNESS FOR INTERNAL PRESSURE (UG-32)

$$P = 50.0 + .433 (1.00) (2.0) = 50.9 \text{ PSIG}$$

$$t = \frac{(50.9) (54.06)}{2 (18394.) (1.00) - (.2) (50.9)} + .031$$

$$= .075 + .031 = .106 \text{ INCHES } (.11 \text{ INCHES})$$

NEW THICKNESS USED IN CALCULATIONS = .313 INCHES

5/16" MIN. 317L (PER DUPONT)

Δ BY INSPECTION O.K. FOR VERT. HYDROTEST

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -556

DESCRIPTION: NOZZLE Y - 14"

COMPONENT LABEL: Y

PAD REINFORCEMENT FOR EXTERNAL PRESSURE OF
PLATE NOZZLE IN LOWER SHELL (L.S.)
ON LONG. SECTION (CIRCUM. STRESS)

EXTERNAL PRESSURE (PSI) = 15.0 DESIGN TEMPERATURE (F) = 302.

(ITEM)		(NOZZLE)	(PAD)	(VESSEL)
MATERIAL	=	SA240317L	SA51670	SA240317L
ALLOW. STRESS-OPER (PSI)	=	18394.	17500.	18394.
CORROSION ALLOW/CLAD (IN)	=	.031		.031

NOZZLE OD(IN)= 14.000 ID(IN)= 13.500 THK.(IN)= .250 INSERT(IN)= 2.000
 PAD WIDTH (IN)= 2.000 PAD THKS (IN)= .250
 TANGENTIAL OFFSET (IN) = .000 CIRC. ANGLE = .00 LONG. ANGLE = .00
 SPECIAL LIMITS ; NORMAL (IN) = .000 PARALLEL (IN) = .000
 FILLET WELDS ; OUTSIDE NOZ. = .250 INSIDE NOZ. = .250 PAD = .188
 GROOVE WELDS ; OUTSIDE NOZ. = .250 INSIDE NOZ. = .313

P = 15.0 PSI EFFECTIVE SHELL LENGTH AT NOZ. = 108.5 IN.
 T = .313 - .031 = .282 TR = .238
 TN = .250 - .031 = .219 D = (13.500 + 2 X .031) = 13.563
 TRN = .033 IN. EFFECTIVE NOZ. NECK LENGTH = 9.00 IN.

AREA OF REINFORCEMENT REQUIRED: [WHERE: SN/S = 1.000]
 A = .5 X D X TR
 = .5 X 13.563 X .238 = 1.61 SQ. IN.

AREA OF REINFORCEMENT AVAILABLE: [WHERE: SN/S = 1.000 & SP/S = .951]

A1 = (E1 X T - TR)D
 = (1.00 X .282 - .238)13.563 = .599 SQ. IN.

A2 = (TN - TRN)5T
 = (.219 - .038) X 5 X .282 = .255 SQ. IN.

A3 = 2(TN - C)(2.5TN)
 = 2(.219 - .031)(2.5 X .219) = .205 SQ. IN.

A4 = 2 X .5(L1**2 + L2**2)(SP/S) + 2 X .5(L3**2)
 = 2 X .5(.250**2 + .188**2)(.951) + 2 X .5(.250**2) = .155 SQ. IN.

A5 = (DP-D-2TN)TE(SP/S)
 = (18.000 - 13.563 - 2 X .219) .250(.951) = .951 SQ. IN.

AT = A1 + A2 + A3 + A4 + A5 = 2.17 SQ. IN.

OPENING IS ADEQUATELY REINFORCED

BY INSPECTION O.K. FOR INT. PRESS.

" " OK FOR VERT. HYDROTEST
 Δ

1/4" x 2" PAD (SA-516-70) / 10

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -956

COMPONENT (Y) : NOZZLE Y

UNIT STRESSES (PAR. UW-15(C))

PAD TO SHELL FILLET WELD SHEAR = .49 X 17500. = 8575. PSI
PAD TO NOZ. NECK FILLET WELD SHEAR = .49 X 17500. = 8575. PSI
PAD TO NOZ. NECK GROOVE WELD TENSION = .74 X 17500. = 12950. PSI
SHELL TO NOZ. NECK INNER GROOVE WELD TENSION = .74 X 18394. = 13612. PSI
SHELL TO NOZ. NECK INNER FILLET WELD SHEAR = .49 X 18394. = 9013. PSI
NOZZLE NECK SHEAR = .70 X 18394. = 12876. PSI

WELD AND MEAN NOZZLE NECK LENGTHS

C1 = MEAN NOZZLE NECK CIRCUM. = 3.1416 X (14.000 - .219) = 43.30 IN.
C2 = WELD CIRCUM. AT NOZZLE O.D. = 3.1416 X 14.000 = 43.98 IN.
C3 = WELD CIRCUM. AT PAD O.D. = 3.1416 X (14.000 + 2 X 2.000) = 56.55 IN.

STRENGTH OF CONNECTION ELEMENTS

- (A) PAD TO NOZZLE NECK FILLET WELD
1/2 X C2 X WELD LEG X UNIT STRESS
1/2 X 43.98 X .250 X 8575. = 47144. LBS.
- (B) PAD TO NOZZLE NECK GROOVE WELD
1/2 X C2 X WELD DEPTH X UNIT STRESS
1/2 X 43.98 X .250 X 12950. = 71197. LBS.
- (C) SHELL TO NOZZLE NECK INNER GROOVE WELD
1/2 X C2 X (WELD DEPTH - CA) X UNIT STRESS
1/2 X 43.98 X (.313 - .031) X 13612. = 84108. LBS.
- (D) SHELL TO NOZZLE NECK INNER FILLET WELD
1/2 X C2 X WELD LEG X UNIT STRESS
1/2 X 43.98 X .250 X 9013. = 49552. LBS.
- (E) NOZZLE NECK SHEAR
1/2 X C1 X CORRODED THICKNESS X UNIT STRESS
1/2 X 43.30 X .219 X 12876. = 60972. LBS.
- (F) PAD TO SHELL FILLET WELD SHEAR
1/2 X C3 X WELD LEG X UNIT STRESS
1/2 X 56.55 X .188 X 8575. = 45460. LBS.

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -856

COMPONENT (Y) : NOZZLE Y

LOAD TO BE CARRIED BY WELDS (PAR. UG-41(B))

$$\begin{aligned}
 W(1-1) &= (A2 + A5 + A41 + A42) * S &= 23894, \text{ LBS.} \\
 W(2-2) &= (A2 + A3 + A41 + A43 + 2*TN+T*SN/S) * S &= 12968, \text{ LBS.} \\
 W(3-3) &= (A2 + A3 + A4 + A5 + 2*TN*T*SN/S) * S &= 31083, \text{ LBS.} \\
 W &= (A - 2*(LIM-RN-TN)*(E1*T-F*TR)) * S &= 18967, \text{ LBS.}
 \end{aligned}$$

POSSIBLE PATHS OF FAILURE

*** FULL PENETRATION WELDS THRU SHELL (OR HEAD) AND PAD ***

PATH 1 (THRU NOZZLE NECK AND PAD TO SHELL WELD)

$$\begin{aligned}
 &= (E) + (F) \\
 &= 60972. + 45460. \\
 &= 106432, \text{ LBS.} \quad (18967, \text{ LBS. MIN.})
 \end{aligned}$$

PATH 2 (THRU PAD TO NOZ. NECK AND SHELL TO NOZ. NECK WELDS)

$$\begin{aligned}
 &= (A) + (B) + (C) + (D) \\
 &= 47144. + 71197. + 84188. + 49552. \\
 &= 252080, \text{ LBS.} \quad (12968, \text{ LBS. MIN.})
 \end{aligned}$$

PATH 3 (THRU SHELL TO NOZ. NECK AND PAD TO SHELL WELDS)

$$\begin{aligned}
 &= (C) + (D) + (F) \\
 &= 84188. + 49552. + 45460. \\
 &= 179200, \text{ LBS.} \quad (18967, \text{ LBS. MIN.})
 \end{aligned}$$

ALL PATHS ARE STRONGER THAN THE LOAD TO BE CARRIED BY THE WELDS.

PAD TO SHELL WELD STRENGTH (PAR. UG-41(B))

$$\begin{aligned}
 \text{PAD STRENGTH} &= (.951)(18394.) = 17500, \text{ LBS.} \quad (W = 18967, \text{ LBS.}) \\
 \text{FILLET WELD STRENGTH} &= 45460, \text{ LBS.}
 \end{aligned}$$

THE PAD TO SHELL FILLET WELD STRENGTH IS ADEQUATE.

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

DESCRIPTION: NOZZLE V-30"

COMPONENT LABEL: V

PAD REINFORCEMENT FOR EXTERNAL PRESSURE OF
PLATE NOZZLE IN TOP HEAD (TH)
ON MERIDIONAL SECTION (LATITUDINAL STRESS)

EXTERNAL PRESSURE (PSI) = 15.0 DESIGN TEMPERATURE (F) = 302.

(ITEM)	(NOZZLE)	(PAD)	(VESSEL)
MATERIAL =	SA240317L	SA51670	SA240317L
ALLOW. STRESS-OPER (PSI) =	18394.	17500.	18394.
CORROSION ALLOW/CLAD (IN) =	.031		.031

NOZZLE OD(IN)= 30.000 ID(IN)= 29.500 THK.(IN)= .250 INSERT(IN)= .000
PAD WIDTH (IN)= 2.000 PAD THKS (IN)= .250
HILLSIDE OFFSET (IN)= .000 MERID. ANGLE = .00 LATERAL SKEW ANGLE = .00
SPECIAL LIMITS : NORMAL (IN) = .000 PARALLEL (IN) = 21.000
FILLET WELDS : OUTSIDE NOZ. = .250 INSIDE NOZ. = .000 PAD = .188
GROOVE WELDS : OUTSIDE NOZ. = .250 INSIDE NOZ. = .313

P = 15.0 PSI EFFECTIVE SHELL LENGTH AT NOZ. = .0 IN.
T = .313 - .031 = .282 TR = .146 (SPHERICAL SECTION OF HEAD)
TN = .250 - .031 = .219 D = (29.500 + 2 X .031) = 29.563
TRN = .067 IN. EFFECTIVE NOZ. NECK LENGTH = 12.00 IN.

AREA OF REINFORCEMENT REQUIRED: [WHERE: SN/S = 1.000]
A = .5 X D X TR
= .5 X 29.563 X .146 = 2.16 SQ. IN.

AREA OF REINFORCEMENT AVAILABLE: [WHERE: SN/S = 1.000 & SP/S = .951]
A1 = (E1 X T - TR)(2(SPECIAL LIM.) - D)
= (1.00 X .282 - .146)(2(21.00) - 29.563) = 1.691 SQ. IN.

A2 = (TN - TRN)ST
= (.219 - .067) X 5 X .282 = .214 SQ. IN.

A3 = = 0. SQ. IN.

A4 = 2 X .5(L1**2 + L2**2)(SP/S)
= 2 X .5(.250**2 + .188**2)(.951) = .093 SQ. IN.

A5 = (DP-D-2TN)TE(SP/S)
= (34.000 - 29.563 - 2 X .219) .250(.951) = .951 SQ. IN.

AT = A1 + A2 + A3 + A4 + A5 = 2.95 SQ. IN.

OPENING IS ADEQUATELY REINFORCED

ALL REINF. IN SPH. SECT. OF HEAD

1/4" X 2" PAD (SA-516-70)

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

COMPONENT (V) : NOZZLE V

UNIT STRESSES (PAR. UW-15(C))

 PAD TO SHELL FILLET WELD SHEAR = .49 X 17500. = 8575. PSI
 PAD TO NOZ. NECK FILLET WELD SHEAR = .49 X 17500. = 8575. PSI
 PAD TO NOZ. NECK GROOVE WELD TENSION = .74 X 17500. = 12950. PSI
 SHELL TO NOZ. NECK INNER GROOVE WELD TENSION = .74 X 18394. = 13612. PSI
 NOZZLE NECK SHEAR = .70 X 18394. = 12876. PSI

WELD AND MEAN NOZZLE NECK LENGTHS

 C1 = MEAN NOZZLE NECK CIRCUM. = 3.1416 X (30.000 - .219) = 93.56 IN.
 C2 = WELD CIRCUM. AT NOZZLE O.D. = 3.1416 X 30.000 = 94.25 IN.
 C3 = WELD CIRCUM. AT PAD O.D. = 3.1416 X (30.000 + 2 X 2.000) = 106.81 IN.

STRENGTH OF CONNECTION ELEMENTS

- (A) PAD TO NOZZLE NECK FILLET WELD
 1/2 X C2 X WELD LEG X UNIT STRESS
 1/2 X 94.25 X .250 X 8575. = 101022. LBS.
 (B) PAD TO NOZZLE NECK GROOVE WELD
 1/2 X C2 X WELD DEPTH X UNIT STRESS
 1/2 X 94.25 X .250 X 12950. = 152564. LBS.
 (C) SHELL TO NOZZLE NECK INNER GROOVE WELD
 1/2 X C2 X (WELD DEPTH - CA) X UNIT STRESS
 1/2 X 94.25 X (.313 - .031) X 13612. = 180403. LBS.
 (D) SHELL TO NOZZLE NECK INNER FILLET WELD
 1/2 X C2 X WELD LEG X UNIT STRESS
 1/2 X 94.25 X .000 X 0. = 0. LBS.
 (E) NOZZLE NECK SHEAR
 1/2 X C1 X CORRODED THICKNESS X UNIT STRESS
 1/2 X 93.56 X .219 X 12876. = 131761. LBS.
 (F) PAD TO SHELL FILLET WELD SHEAR
 1/2 X C3 X WELD LEG X UNIT STRESS
 1/2 X 106.81 X .188 X 8575. = 85869. LBS.

COMPANY DUPONT
 JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -556

COMPONENT (V) : NOZZLE V

LOAD TO BE CARRIED BY WELDS (PAR. UG-41(B))

$$\begin{aligned} W(1-1) &= (A2 + A5 + A41 + A42) * S &= 23142. \text{ LBS.} \\ W(2-2) &= (A2 + A3 + A41 + A43 + 2*TN+T*SN/S) * S &= 7294. \text{ LBS.} \\ W(3-3) &= (A2 + A3 + A4 + A5 + 2*TN*T*SN/S) * S &= 25409. \text{ LBS.} \\ W &= (A - 2*(LIM-RN-TN)*(E1*T-F*TR)) * S &= 9639. \text{ LBS.} \end{aligned}$$

POSSIBLE PATHS OF FAILURE

*** FULL PENETRATION WELDS THRU SHELL (OR HEAD) AND PAD ***

PATH 1 (THRU NOZZLE NECK AND PAD TO SHELL WELD)

$$\begin{aligned} &= (E) + (F) \\ &= 131761. + 85869. \\ &= 217630. \text{ LBS.} \quad (9639. \text{ LBS. MIN.}) \end{aligned}$$

PATH 2 (THRU PAD TO NOZ. NECK AND SHELL TO NOZ. NECK WELDS)

$$\begin{aligned} &= (A) + (B) + (C) + (D) \\ &= 101022. + 152564. + 180403. + 0. \\ &= 433989. \text{ LBS.} \quad (7294. \text{ LBS. MIN.}) \end{aligned}$$

PATH 3 (THRU SHELL TO NOZ. NECK AND PAD TO SHELL WELDS)

$$\begin{aligned} &= (C) + (D) + (F) \\ &= 180403. + 0. + 85869. \\ &= 266271. \text{ LBS.} \quad (9639. \text{ LBS. MIN.}) \end{aligned}$$

ALL PATHS ARE STRONGER THAN THE LOAD TO BE CARRIED BY THE WELDS.

PAD TO SHELL WELD STRENGTH (PAR. UG-41(B))

$$\begin{aligned} \text{PAD STRENGTH} &= (.951)(18394.) = 17500. \text{ LBS.} \quad (W = 9639. \text{ LBS.}) \\ \text{FILLET WELD STRENGTH} &= 85869. \text{ LBS.} \end{aligned}$$

THE PAD TO SHELL FILLET WELD STRENGTH IS ADEQUATE.

COMPANY DUPONT
JOB DESCRIPTION ACH TOPPING COLUMN

BASIC VESSEL DES. -S56

DESCRIPTION: NOZZLE V-30'

COMPONENT LABEL: V

PAD REINFORCEMENT FOR INTERNAL PRESSURE OF
PLATE NOZZLE IN TOP HEAD (TH)
ON MERIDIONAL SECTION (LATITUDINAL STRESS)

DESIGN PRESSURE (PSI) = 50.0
LIQUID HEAD (FT.) = 1.0

DESIGN TEMPERATURE (F) = 302.
SPECIFIC GRAVITY = 1.00

(ITEM)	(NOZZLE)	(PAD)	(VESSEL)
MATERIAL	SA240317L	SA51670	SA240317L
ALLOW. STRESS-OPER (PSI)	18394.	17500.	18394.
CORROSION ALLOW/CLAD (IN)	.031		.031

NOZZLE OD(IN)= 30.000 ID(IN)= 29.500 THK.(IN)= .250 INSERT(IN)= .000
 PAD WIDTH (IN)= 2.000 PAD THKS (IN)= .250
 HILLSIDE OFFSET (IN)= .000 MERID. ANGLE = .00 LATERAL SKEW ANGLE = .00
 SPECIAL LIMITS ; NORMAL (IN) = .000 PARALLEL (IN) = 21.000
 FILLET WELDS ; OUTSIDE NOZ. = .250 INSIDE NOZ. = .000 PAD = .188
 GROOVE WELDS ; OUTSIDE NOZ. = .250 INSIDE NOZ. = .313

$P = 50.0 + .433 (1.00) (1.0) = 50.4 \text{ PSI}$
 $T = .313 - .031 = .282$ TR = .067 (SPHERICAL SECTION OF HEAD)
 $TN = .250 - .031 = .219$ D = (29.500 + 2 X .031) = 29.563
 $TRN = (50.4 X 14.781) / (18394. X 1.00 - .6 X 50.4) = .041 \text{ IN.}$

AREA OF REINFORCEMENT REQUIRED: [WHERE: SN/S = 1.000]
 $A = D X TR X F$
 $= 29.563 X .067 X 1.0 = 1.98 \text{ SQ. IN.}$

AREA OF REINFORCEMENT AVAILABLE: [WHERE: SN/S = 1.000 & SP/S = .951]
 $A1 = (E1 X T - F X TR) (2(SPECIAL LIM.) - D)$
 $= (1.00 X .282 - 1.0 X .067) (2(21.00) - 29.563) = 2.671 \text{ SQ. IN.}$

$A2 = (TN - TRN) 5T$
 $= (.219 - .041) X 5 X .282 = .251 \text{ SQ. IN.}$

$A3 = 0. \text{ SQ. IN.}$

$A4 = 2 X .5(L1**2 + L2**2)(SP/S)$
 $= 2 X .5(.250**2 + .188**2) (.951) = .093 \text{ SQ. IN.}$

$A5 = (DP-D-2TN)TE(SP/S)$
 $= (34.000 - 29.563 - 2 X .219) .250 (.951) = .951 \text{ SQ. IN.}$

$AT = A1 + A2 + A3 + A4 + A5 = 3.97 \text{ SQ. IN.}$

OPENING IS ADEQUATELY REINFORCED

PATH OF FAILURE CALC'S. NOT RECD.

ALL REINF. IN SPH. SECT. OF HEAD

1/4" X 2" PAD OK /16