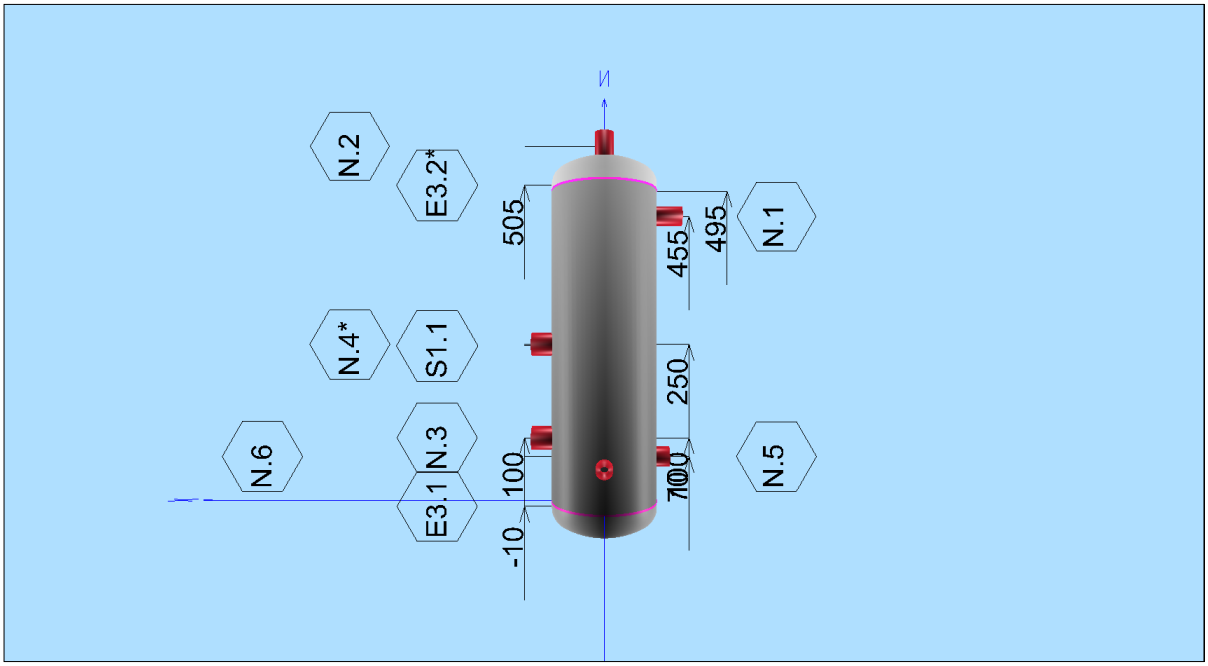
Company Name -

Client :GÜVEN SOGUTMA Vessel Tag No.:OS.HR.45b.22.1

Visual Vessel Design by Hexagon PPM,Ver:20.0 Operator : Rev.:A

(0) Drawing

3D View of Vessel (alter by using the Save User Specified View command)

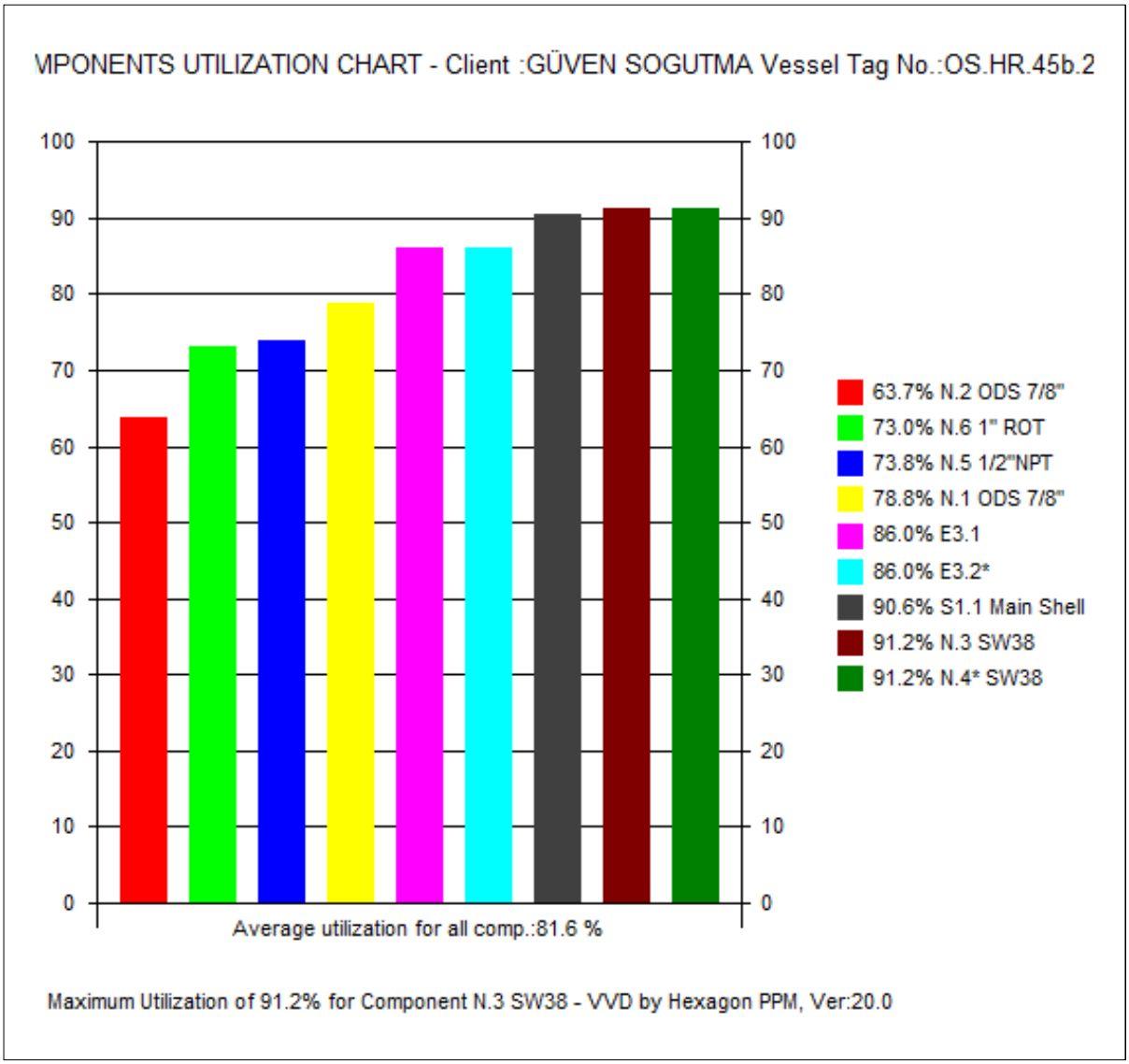


Design Data & Process Information

Description	Units	Design Data
Process Card		General Design Data
Design Code & Specifications		EN13445 TG = 2b
Internal Design Pressure (MPa)	MPa	4.5
External Design Pressure (MPa)	MPa	
Hydrotest Pressure (MPa)	MPa	
Maximum Design Temperature ('C)	'C	130
Minimum Design Temperature ('C)	'C	-20
Operating Temperature ('C)	'C	
Corrosion Allowance (mm)	mm	0.5
Content of Vessel		
Specific Density of Oper.Liq		
Normal Liquid Level NLL (mm)	mm	

Utilization Chart

Utilization Chart



Welding Information

EN1708-1 Welding Requirements for Pressurized Components
NOTE: No welding information has been specified by the user.

INPUT DATA

COMPONENT ATTACHMENT/LOCATION

```
Distance from end of cylinder to ref. DATUM LINE....:mm          0.00 mm
```

GENERAL DESIGN DATA

```
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
```

SHELL DATA

```
CYLINDER FABRICATION: Welded Pipe
WELD JOINT COEFFICIENT: Testing Group  1   (z=1.0)
NEGATIVE TOLERANCE: Negative tolerance specified in mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 f=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
OUTSIDE DIAMETER OF SHELL...........................:De        168.00 mm
LENGTH OF CYLINDRICAL PART OF SHELL.................:Lcyl      495.00 mm
NOMINAL WALL THICKNESS (uncorroded).................:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:th        0.3000 mm
Split shell into several shell courses and include welding information: NO
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

7.4.2 - CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE

```
Required Minimum Shell Thickness Excl.Allow. emin :
emin = De * P / (2 * f * z + P)                                  (7.4-2)
=168*4.5/(2*194.67*1+4.5)=                                  1.9196 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =1.92+0.5+0.3=                    2.7196 mm

Analysis Thickness
ea = en - c - NegDev =3-0.5-0.3=                            2.2000 mm
```

»7.4.1 Cond.of Applicabilty emin/De=0.0114 <= 0.16« » OK«

Internal Pressure emina=2.72 <= en=3[mm]	90.6%	OK

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :

```
Inside Diameter of Shell
Di = De - 2 * ea =168-2*2.2=                                163.60 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(168+163.6)/2=                          165.80 mm
MAWP HOT & CORR. (Corroded condition at design temp.)
MAWPHC = 2 * f * z * ea / Dm =2*194.67*1*2.2/165.8=         5.1662 MPa

MAWP NEW & COLD (Uncorroded condition at ambient temp.)
MAWPNC = 2 * f20 * z * (ea + c) / Dm
=2*204.17*1*(2.2+0.5)/165.8=                                6.6497 MPa
```

MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)

```
Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(2.2+0.5)/165.8=                                 11.01 MPa
```

EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*204.17/194.67= 5.8995 MPa

Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

Test Pressure Ptmin=6.435 <= Ptmax=11.01[MPa]	58.4%	OK

MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Inside Radius of Shell
ris = Di / 2 (9.5-3) =163.6/2= 81.80 mm
Length of Shell Contributing to Reinforcement
Is = Sqr((2 * ris + ea) * ea) (9.5-2) =Sqr((2*81.8+2.2)*2.2)= 19.10 mm
Maximum Diameter of Unreinforced Opening in Shell Checked to Rules in Section 9
dmax1 = MIN(0.5*Di,(ea*Is*(f-0.5*P)/P-ris*Is)/(0.5*ris+0.5*ea)) (9.5-7,22,23)
=MIN(0.5*163.6,(2.2*19.1*(194.67-0.5*4.5)/4.5-81.8*19.1)/(0.5*81.8+0.5*2.2)
)= = 5.5805 mm

Maximum diameter of Opening Not Requiring Reinforcement Check
dmax2 = 0.15 * Sqr((2 * ris + ea) * ea) (9.5-18)
=0.15*Sqr((2*81.8+2.2)*2.2)= 2.8648 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(5.58,2.86)= 5.5805 mm

CALCULATION SUMMARY

7.4.2 - CYLINDRICAL SHELLS UNDER INTERNAL PRESSURE

Required Minimum Shell Thickness Excl.Allow. emin :
emin = De * P / (2 * f * z + P) (7.4-2)
=168*4.5/(2*194.67*1+4.5)= 1.9196 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =1.92+0.5+0.3= 2.7196 mm

Internal Pressure emina=2.72 <= en=3[mm]	90.6%	OK

MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)

Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(2.2+0.5)/165.8= 11.01 MPa

EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*204.17/194.67= 5.8995 MPa

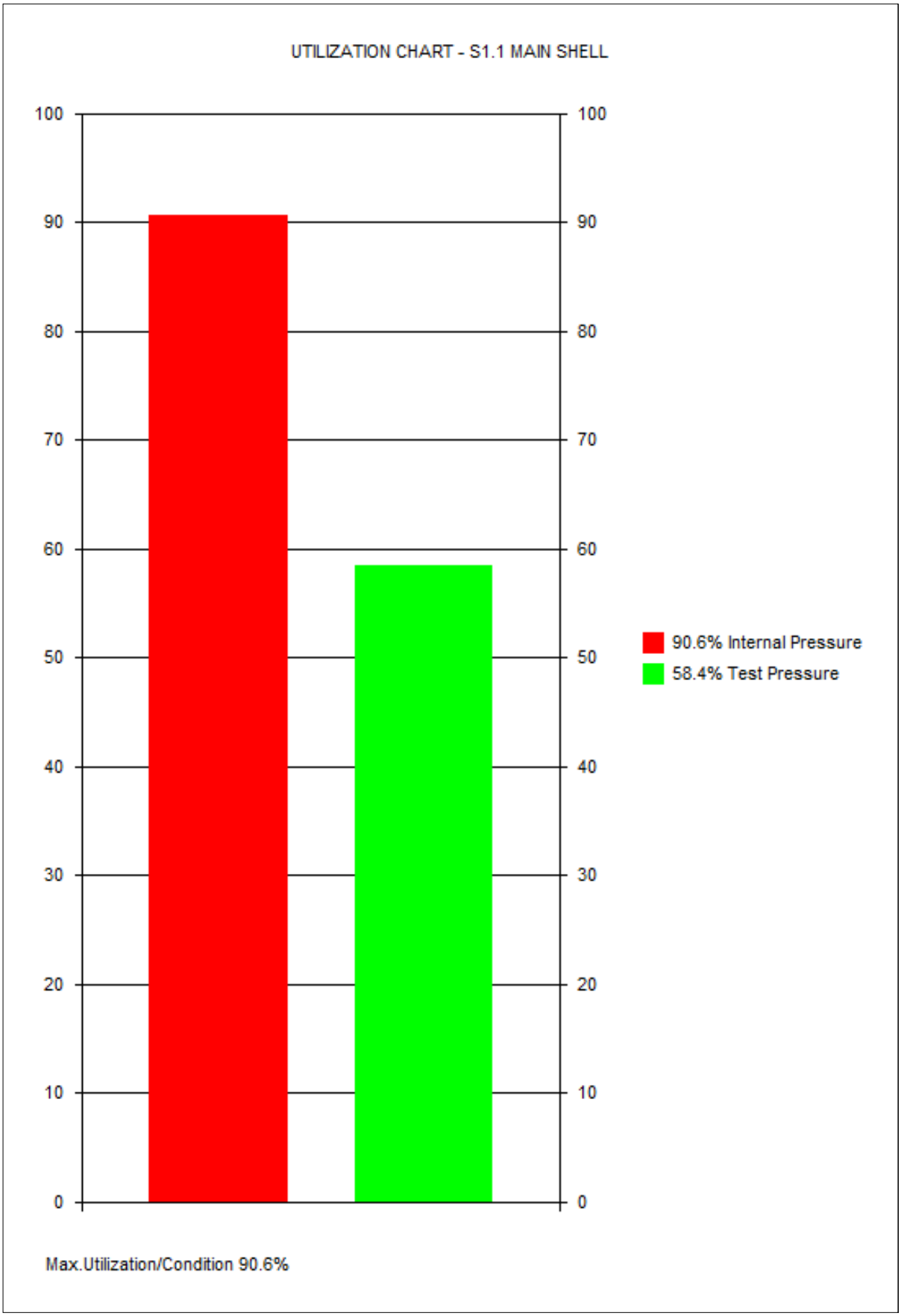
Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

Test Pressure Ptmin=6.435 <= Ptmax=11.01[MPa]	58.4%	OK

MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(5.58,2.86)= 5.5805 mm

Volume:0.0104 m3 Weight:6 kg (SG= 7.85)


UTILIZATION CHART - S1.1 MAIN SHELL
100
90
80
70
60
50
40
30
20
10
0
90.6% Internal Pressure
58.4% Test Pressure
Max.Utilization/Condition 90.6%

INPUT DATA

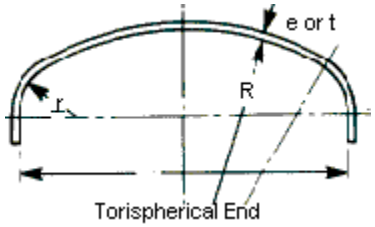
COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Location: Along z-axis zo=  0
```

GENERAL DESIGN DATA

```
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD..........................................:LH          0.00 mm
```

DIMENSIONS OF END




```
Type of Torispherical End: Dished End KORBBOGEN DIN 28013-28014/SMS 482
WELD JOINT COEFFICIENT: Unwelded Component(z=1.0)
OUTSIDE DIAMETER OF CYLINDRICAL FLANGE OF END.......:De        168.00 mm
LENGTH OF CYLINDRICAL FLANGE OF END.................:Lcyl       10.00 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:th        0.3000 mm
NOMINAL THICKNESS OF HEAD/END (uncorroded)..........:en        3.0000 mm
Include calculation of forming during fabrication to EN13445-4 Section 9.: NO
```

MATERIAL DATA FOR END

```
EN 10028-2:2017, 1.0473 P355GH plate and strip, HT:N THK<=16mm 130'C
Rm=510 Rp=355 Rpt=308.6 f=205.73 f20=212.5 ftest=338.1 E=203868(N/mm2) ro=7.85
Material & Delivery Form: NOT Cold Spun Seamless Austenitic Stainless Steel
```

NOZZLES IN KNUCKLE REGION TO SECTION 7.7

```
Nozzles In Knuckle Region: NO
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

7.5.3 - TORISPHERICAL ENDS UNDER INTERNAL PRESSURE

7.5.3.2 Required Minimum End Thickness

```
Required Thickness of End to Limit Membrane Stress in Central Part
es = P * R / (2 * f * z - 0.5 * P)                                  (7.5-1)
=4.5*134.4/(2*205.73*1-0.5*4.5)=                          1.4780 mm

fb = Rpt / 1.5 (7.5-4) =308.6/1.5=                          205.73 N/mm2
Required Thickness of Knuckle to Avoid Plastic Buckling
eb = (0.75*R+0.2*Di)*((P/(111*fb)*(Di/r)^0.825)^(0.667)             (7.5-3)
=(0.75*134.4+0.2*163)*((4.5/(111*205.73)*(163/25.872)^0.825)^(0.667)
=   1.2403 mm

7.5.3.5 Formulas for Calculation of Factor Beta
Y = MIN( emin / R, 0.04) (7.5-9) =MIN(1.78/134.4,0.04)=       0.0132
Z = LOG( 1 / Y) (7.5-10) =LOG(1/0.0132)=                     1.8789
X = r / Di (7.5-11) =25.872/164.45=                          0.1573
```

```
N = 1.006 - 1 / (6.2 + (90 * Y) ^ 4)                              (7.5-12)
=1.006-1/(6.2+(90*0.0132)^4)=                          0.8841
Beta01 = N*(-0.1833*Z^3+1.0383*Z^2-1.2943*Z+0.837)                (7.5-15)
=0.8841*(-0.1833*1.88^3+1.0383*1.88^2-1.2943*1.88+0.837)=   0.7557
Beta02 = MAX( 0.5, 0.95 * (0.56 - 1.94 * Y - 82.5 * Y ^ 2))       (7.5-17)
=MAX(0.5,0.95*(0.56-1.94*0.0132-82.5*0.0132^2))=           0.5000
beta = 10 * ((0.2 - X) * Beta01 + (X - 0.1) * Beta02)             (7.5-16)
=10*((0.2-0.1573)*0.7557+(0.1573-0.1)*0.5)=                0.6091
Required Thickness of Knuckle to Avoid Axisymmetric Yielding
ey = beta * P * (0.75 * R + 0.2 * Di) / f                         (7.5-2)
=0.6091*4.5*(0.75*134.4+0.2*164.45)/205.73=                1.7812 mm
```

NOTE 3, since ey(1.8) > 0.005*Di(0.8) it is NOT necessary to calculate/consider eb.

```
Required Minimum End Thickness Excl.Allow. emin :
emin = emin =1.78=                                          1.7812 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =1.78+0.5+0.3=                        2.5800 mm
```

Internal Pressure emina=2.58 <= en=3[mm]	86.0%	OK

```
Analysis Thickness
ea = en - c - th =3-0.5-0.3=                                2.2000 mm
Inside Diameter of Shell
Di = De - 2 * (en - c) =168-2*(3-0.5)=                      163.00 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(168+163)/2=                            165.50 mm
```

7.5.3.4 - Required Minimum Thickness of Straight Cylindrical Flange

```
Llim = 0.2 * SQR( Di * emin) =0.2*SQR(163*1.78)=            3.4078 mm
Since Lcyl > Llim, Required Thickness of Straight Cylindrical Flange to 7.4.2
Minimum Thickness of Straight Flange Excl. Allow.
ecyl = P * Di / (2 * f * z - P)                                   (7.4-1)
=4.5*163/(2*205.73*1-4.5)=                                 1.8024 mm

Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =1.8+0.5=                                  2.3000 mm
```

7.5.3.1 Conditions of Applicability - Torispherical Ends

»Geometry Check r=25.872 <= 0.2 * Di=32.6[mm] « » OK«
»Geometry Check r=25.872 >= 0.06 * Di=9.78[mm] « » OK«
»Geometry Check r=25.872 >= 2*e[mm] « » OK«
»Geometry Check e=1.78 <= 0.08*De=13.44[mm] « » OK«
»Geometry Check ea=2.2 >= 0.001*De=0.168[mm] « » OK«
»Geometry Check R=134.4 <= De=168[mm] « » OK«

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                              (7.5-6)
=2*212.5*1*2.7/(133.9+0.5*2.7)=                            8.4843 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                    (7.5-7)
=212.5*2.7/(0.5808*(0.75*133.9+0.2*163))=                  7.4259 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                 (7.5-8)
=111*236.67*(2.7/(0.75*133.9+0.2*163))^1.5*(25.872/163)^0.825=    16.64 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.7*212.5*1/(163+2.7)=                                  6.9252 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=6.93=                                                     6.9252 MPa
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                              (7.5-6)
=2*205.73*1*2.2/(134.4+0.5*2.2)=                           6.6805 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                    (7.5-7)
=205.73*2.2/(0.5929*(0.75*134.4+0.2*163))=                 5.7222 MPa
```

```
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                    (7.5-8)
=111*205.73*(2.2/(0.75*134.4+0.2*163))^1.5*(25.872/163)^0.825=    10.59 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.2*205.73*1/(163+2.2)=                                  5.4795 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=5.48=                                                      5.4795 MPa
```

MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                                 (7.5-6)
=2*338.1*1*2.7/(133.9+0.5*2.7)=                             13.50 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                       (7.5-7)
=338.1*2.7/(0.5808*(0.75*133.9+0.2*163))=                   11.82 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                    (7.5-8)
=111*338.1*(2.7/(0.75*133.9+0.2*163))^1.5*(25.872/163)^0.825=    23.77 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*2.7*338.1*1/(163+2.7)=                                   11.02 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=11.02=                                                     11.02 MPa
```

EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

```
NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*212.5/205.73=           5.8101 MPa

Ptmin = 1.43 * Pd =1.43*4.5=                                  6.4350 MPa
```

Test Pressure Ptmin=6.435 <= Ptmax=11.02[MPa]	58.4%	OK

Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

```
ris = R (9.5-4) =134.4=                                      134.40 mm
Length of Shell Contributing to Reinforcement
Is = Sqr(( 2 * ris + ea) * ea)                                       (9.5-2)
=Sqr((2*134.4+2.2)*2.2)=                                    24.42 mm
Maximum Diameter of Unreinforced Opening in Shell Checked to Rules in Section 9
dmax1 = MIN(0.5*Di,(ea*Is*(f-0.5*P)/P-ris*Is)/(0.5*ris+0.5*ea))    (9.5-7,22,23)
=MIN(0.5*163,(2.2*24.42*(205.73-0.5*4.5)/4.5-134.4*24.42)/(0.5*134.4+0.5*2.
2))=                                                        =     0.00 mm

Maximum diameter of Opening Not Requiring Reinforcement Check
dmax2 = 0.15 * Sqr(( 2 * ris + ea) * ea)                             (9.5-18)
=0.15*Sqr((2*134.4+2.2)*2.2)=                               3.6626 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(0,3.66)=                      3.6626 mm
```

CALCULATION SUMMARY

7.5.3 - TORISPHERICAL ENDS UNDER INTERNAL PRESSURE

7.5.3.2 Required Minimum End Thickness

```
Required Minimum End Thickness Excl.Allow. emin :
emin = emin =1.78=                                           1.7812 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =1.78+0.5+0.3=                         2.5800 mm
```

Internal Pressure emina=2.58 <= en=3[mm]	86.0%	OK

```
Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =1.8+0.5=                                   2.3000 mm
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD

```
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=6.93=                                                      6.9252 MPa
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=5.48= 5.4795 MPa

MAX TEST PRESSURE (Uncorroded cond.at ambient temp.)

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=11.02= 11.02 MPa

EN13445-5;10.2.3.3 REQUIRED MIN.HYDROSTATIC TEST PRESSURE:Ptmin

NEW AT AMBIENT TEMP. FOR TEST GROUPS 1, 2 and 3
Ptmin = 1.25 * Pd * f20 / f =1.25*4.5*212.5/205.73= 5.8101 MPa

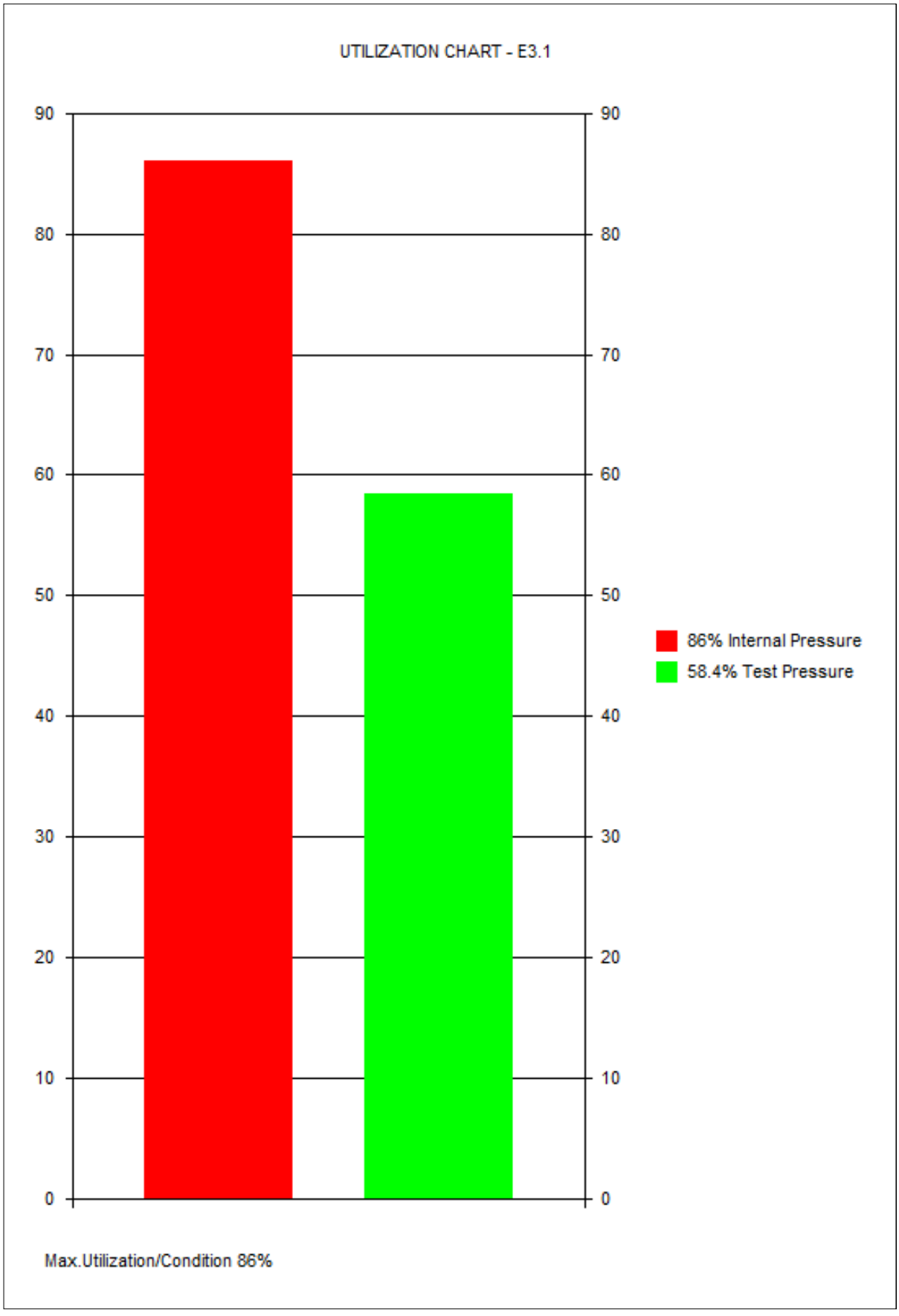
Ptmin = 1.43 * Pd =1.43*4.5= 6.4350 MPa

Test Pressure Ptmin=6.435 <= Ptmax=11.02[MPa]	58.4%	OK

Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(0,3.66)= 3.6626 mm

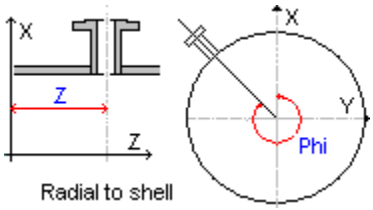
Volume:0.0007700 m3 Weight:0.8 kg (SG= 7.85)


UTILIZATION CHART - E3.1
90
80
70
60
50
40
30
20
10
0
86% Internal Pressure
58.4% Test Pressure
Max.Utilization/Condition 86%

INPUT DATA

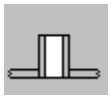
COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Radial to Shell
z-location of nozzle along axis of attacment.....:z         455.00 mm
Angle of Rotation of nozzle axis projected in the x-y plane:Phi   180.00 Degr.
```

GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.....:SG          0.00
LIQUID HEAD.....:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

SHELL DATA (S1.1)

```
Shell Type: Cylindrical Shell
OUTSIDE DIAMETER OF SHELL.....:De        168.00 mm
NOMINAL WALL THICKNESS (uncorroded).....:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE.....:th        0.3000 mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 fs=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
```

NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER.............................:deb        30.90 mm
NOMINAL NOZZLE THICKNESS (uncorroded)...............:enb       6.4500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD.............:ho         40.00 mm
```

WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE PhiC(OBLIQUE IN TRANSVERSE.CROSS SECT.)Fig.9.5-2:PhiC      0.00 Degr.
ANGLE PhiL(OBLIQUE IN LONG.CROSS SECT.)Fig.9.5-1....:PhiL       0.00 Degr.
```

DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                              2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =6.45-0.5-0.8063=                  5.1438 mm
Inside Radius of Curvature
ris = De / 2 - eas (9.5-3) =168/2-2.2=                      81.80 mm
dib = deb - 2 * eab =30.9-2*5.14=                           20.61 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*30.9/(2*127.6*1+4.5)=                               0.5400 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(194.67,127.6)=              127.60 N/mm2
```

GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/(2*ris)=0.126 <= 1.00=1[mm] «» OK«

Min.Nozzle Thk. ebp=0.54 <= eab=5.14[mm]	10.4%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Calculation of Stress Loaded Areas Effective as Reinforcement

Area of Shell Afs

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*19.1=                        42.02 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
=MIN(Sqr((30.9-5.14)*5.14,)40)=                          11.51 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =5.14*(11.51+0+2.2)=  70.52 mm2
```

Calculation of Pressure Loaded Areas

```
In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*20.61*(11.51+2.2)=  141.30 mm2

Cyl.Shell in the Longitudinal Section Aps
ApsL = ris * (Is + a) (9.5-94) =81.8*(19.1+15.45)=        2826.08 mm2

Cyl.Shell in the Transverse Cross Section Aps
ApsT = 0.5 * ris ^ 2 * (Is + a ) / (0.5 * eas + ris)               (9.5-105)
=0.5*81.8^2*(19.1+15.54)/(0.5*2.2+81.8)=                 1397.96 mm2

Aps = MAX( ApsL ApsT) =MAX(2826.08,1397.96)=              2826.08 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                           (9.5-7)
=4.5*(2826.08+141.3+0.5*0)=                              13.35 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                            (9.5-7)
=4.5*(1397.96+141.3+0.5*0)=                             6.9267 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(13353.23,6926.67)=       13.35 kN
```

Pressure Area Available pA(aval.)

```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)       (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+70.52*(127.6-0.5*4.5)=    16.92 kN
```

Nozzle Reinforcement pAAval=16.92 >= pAReq=13.35[kN]	78.8%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))      (9.5-10)
=(42.02+0)*194.67+70.52*127.6/((2826.08+141.3)+0.5*(42.02+0+70.52+0))
=   5.6812 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                               11.46 MPa

Weight of Nozzle: .173kg
```

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.54 <= eab=5.14[mm]	10.4%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
```

```
=MIN(Sqr((30.9-5.14)*5.14,)40)=                                  11.51 mm
```

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                              (9.5-7)
=4.5*(2826.08+141.3+0.5*0)=                                      13.35 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                               (9.5-7)
=4.5*(1397.96+141.3+0.5*0)=                                     6.9267 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(13353.23,6926.67)=              13.35 kN
```

Pressure Area Available pA(aval.)

```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)          (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+70.52*(127.6-0.5*4.5)=    16.92 kN
```

Nozzle Reinforcement pAAval=16.92 >= pAReq=13.35[kN]	78.8%	OK

Maximum Allowable Pressure Pmax

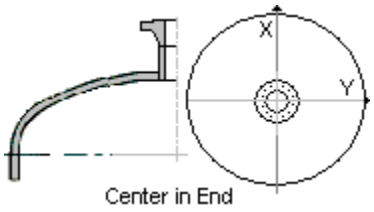
```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))         (9.5-10)
=(42.02+0)*194.67+70.52*127.6/((2826.08+141.3)+0.5*(42.02+0+70.52+0))
=   5.6812 MPa
```

Volume:0.00 m3 Weight:0.2 kg (SG= 7.85)

INPUT DATA

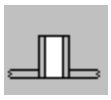
COMPONENT ATTACHMENT/LOCATION

```
Attachment: E3.2*   Torispherical End                                    S1.1
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Center in End
```

GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

SHELL DATA (E3.2*)

```
Shell Type: Torispherical End
OUTSIDE DIAMETER OF SHELL............................:De        168.00 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th        0.3000 mm
INSIDE SPHERICAL RADIUS (corroded)...................:R         134.40 mm
EN 10028-2:2017, 1.0473 P355GH plate and strip, HT:N THK<=16mm 130'C
Rm=510 Rp=355 Rpt=308.6 fs=205.73 f20=212.5 ftest=338.1 E=203868(N/mm2) ro=7.85
```

NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER..............................:deb        30.90 mm
NOMINAL NOZZLE THICKNESS (uncorroded)................:enb       6.4500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD..............:ho         40.00 mm
```

WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE BETWN.BRANCH AXIS AND A LINE NORMAL TO MAIN BODY:Phi       0.00 Degr.
```

DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                                  2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =6.45-0.5-0.8063=                      5.1438 mm
ris = R (9.5-4) =134.4=                                        134.40 mm
dib = deb - 2 * eab =30.9-2*5.14=                               20.61 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*30.9/(2*127.6*1+4.5)=                                   0.5400 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(205.73,127.6)=                 127.60 N/mm2
```

GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/De=0.1227 <= 0.60=0.6[mm] (9.4.5.3)«» OK«

Min.Nozzle Thk. ebp=0.54 <= eab=5.14[mm]	10.4%	OK

»Location in End to Fig.9.5-4 L=68.55 >= De/10=16.8[mm] « » OK«

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Calculation of Stress Loaded Areas Effective as Reinforcement

Area of Shell Afs

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*134.4+2.2)*2.2)=                                    24.42 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*24.42=                          53.72 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
=MIN(Sqr((30.9-5.14)*5.14,)40)=                             11.51 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =5.14*(11.51+0+2.2)=   70.52 mm2
```

Calculation of Pressure Loaded Areas

In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*20.61*(11.51+2.2)= 141.30 mm2

Spherical Shell/End on any Section Aps
Aps = 0.5 * ris ^ 2 * (Is + a) / (0.5 * eas + ris) (9.5-105)
=0.5*134.4^2*(24.42+15.48)/(0.5*2.2+134.4)= 2659.57 mm2

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(2659.57+141.3+0.5*0)= 12.60 kN

Pressure Area Available pA(aval.)

pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(53.72+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+70.52*(127.6-0.5*4.5)= 19.77 kN

Nozzle Reinforcement pAAval=19.77 >= pAReq=12.6[kN]	63.7%	OK

Maximum Allowable Pressure Pmax

Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(53.72+0)*205.73+70.52*127.6/((2659.57+141.3+0.5*0)+0.5*(53.72+0+70.52+0))
= 7.0031 MPa

Max.Allowable Test Pressure Ptmax

Ptmax = == 13.79 MPa

Weight of Nozzle: .1707kg

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.54 <= eab=5.14[mm]	10.4%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Limit of Reinforcement Along Shell
Iso = Sqr((2 * ris + eas) * eas)
=Sqr((2*134.4+2.2)*2.2)= 24.42 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN(Sqr((deb - eb) * eb), ho) (9.5-76)
=MIN(Sqr((30.9-5.14)*5.14,)40)= 11.51 mm

Pressure Area Required pA(req.)

pAReq = P * (Aps + Apb + 0.5 * Apphi) (9.5-7)
=4.5*(2659.57+141.3+0.5*0)= 12.60 kN

Pressure Area Available pA(aval.)

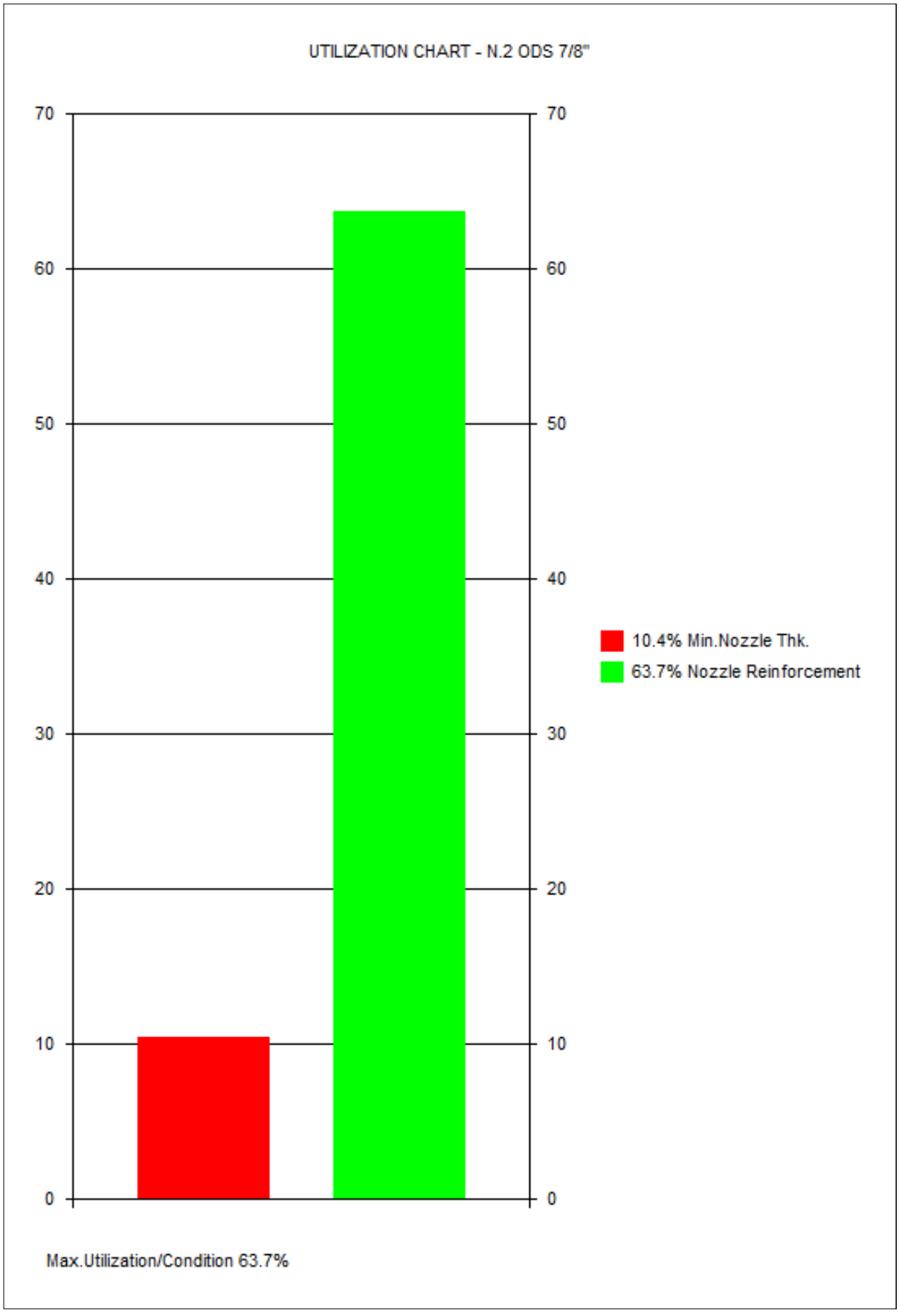
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P) (9.5-7)
=(53.72+0)*(205.73-0.5*4.5)+0*(0-0.5*4.5)+70.52*(127.6-0.5*4.5)= 19.77 kN

Nozzle Reinforcement pAAval=19.77 >= pAReq=12.6[kN]	63.7%	OK

Maximum Allowable Pressure Pmax

Pmax = (Afs+Afw)*fs+Afb*fob/((Aps+Apb+0.5*Apphi)+0.5*(Afs+Afw+Afb+Afp)) (9.5-10)
=(53.72+0)*205.73+70.52*127.6/((2659.57+141.3+0.5*0)+0.5*(53.72+0+70.52+0))
= 7.0031 MPa

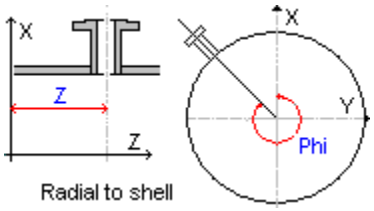
Volume:0.00 m3 Weight:0.2 kg (SG= 7.85)


UTILIZATION CHART - N.2 ODS 7/8"
70
60
50
40
30
20
10
0
10.4% Min.Nozzle Thk.
63.7% Nozzle Reinforcement
Max.Utilization/Condition 63.7%

INPUT DATA

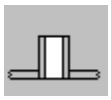
COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Radial to Shell
z-location of nozzle along axis of attacment........:z         100.00 mm
Angle of Rotation of nozzle axis projected in the x-y plane:Phi     0.00 Degr.
```

GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.................:SG          0.00
LIQUID HEAD.........................................:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

SHELL DATA (S1.1)

```
Shell Type: Cylindrical Shell
OUTSIDE DIAMETER OF SHELL............................:De        168.00 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th        0.3000 mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 fs=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
```

NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER.............................:deb        37.50 mm
NOMINAL NOZZLE THICKNESS (uncorroded)...............:enb       5.7500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD.............:ho         32.00 mm
```

WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE PhiC(OBLIQUE IN TRANSVERSE.CROSS SECT.)Fig.9.5-2:PhiC      0.00 Degr.
ANGLE PhiL(OBLIQUE IN LONG.CROSS SECT.)Fig.9.5-1....:PhiL       0.00 Degr.
```

DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                              2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =5.75-0.5-0.7188=                  4.5313 mm
Inside Radius of Curvature
ris = De / 2 - eas (9.5-3) =168/2-2.2=                      81.80 mm
dib = deb - 2 * eab =37.5-2*4.53=                           28.44 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*37.5/(2*127.6*1+4.5)=                               0.6500 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(194.67,127.6)=              127.60 N/mm2
```

GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/(2*ris)=0.1738 <= 1.00=1[mm] «» OK«

Min.Nozzle Thk. ebp=0.65 <= eab=4.53[mm]	14.3%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Calculation of Stress Loaded Areas Effective as Reinforcement

Area of Shell Afs

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*19.1=                        42.02 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
=MIN(Sqr((37.5-4.53)*4.53,)32)=                          12.22 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =4.53*(12.22+0+2.2)=  65.35 mm2
```

Calculation of Pressure Loaded Areas

```
In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*28.44*(12.22+2.2)=  205.07 mm2

Cyl.Shell in the Longitudinal Section Aps
ApsL = ris * (Is + a) (9.5-94) =81.8*(19.1+18.75)=        3096.02 mm2

Cyl.Shell in the Transverse Cross Section Aps
ApsT = 0.5 * ris ^ 2 * (Is + a ) / (0.5 * eas + ris)               (9.5-105)
=0.5*81.8^2*(19.1+18.91)/(0.5*2.2+81.8)=                1534.08 mm2

Aps = MAX( ApsL ApsT) =MAX(3096.02,1534.08)=              3096.02 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                           (9.5-7)
=4.5*(3096.02+205.07+0.5*0)=                              14.85 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                            (9.5-7)
=4.5*(1534.08+205.07+0.5*0)=                             7.8262 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(14854.92,7826.16)=        14.85 kN
```

Pressure Area Available pA(aval.)

```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)       (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+65.35*(127.6-0.5*4.5)=    16.28 kN
```

Nozzle Reinforcement pAAval=16.28 >= pAReq=14.85[kN]	91.2%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))      (9.5-10)
=(42.02+0)*194.67+65.35*127.6/((3096.02+205.07)+0.5*(42.02+0+65.35+0))
=   4.9238 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                               10.01 MPa

Weight of Nozzle: .1675kg
```

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.65 <= eab=4.53[mm]	14.3%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
```

```
=MIN(Sqr((37.5-4.53)*4.53,)32)=                                  12.22 mm
```

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                          (9.5-7)
=4.5*(3096.02+205.07+0.5*0)=                                     14.85 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                           (9.5-7)
=4.5*(1534.08+205.07+0.5*0)=                                    7.8262 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(14854.92,7826.16)=              14.85 kN
```

Pressure Area Available pA(aval.)

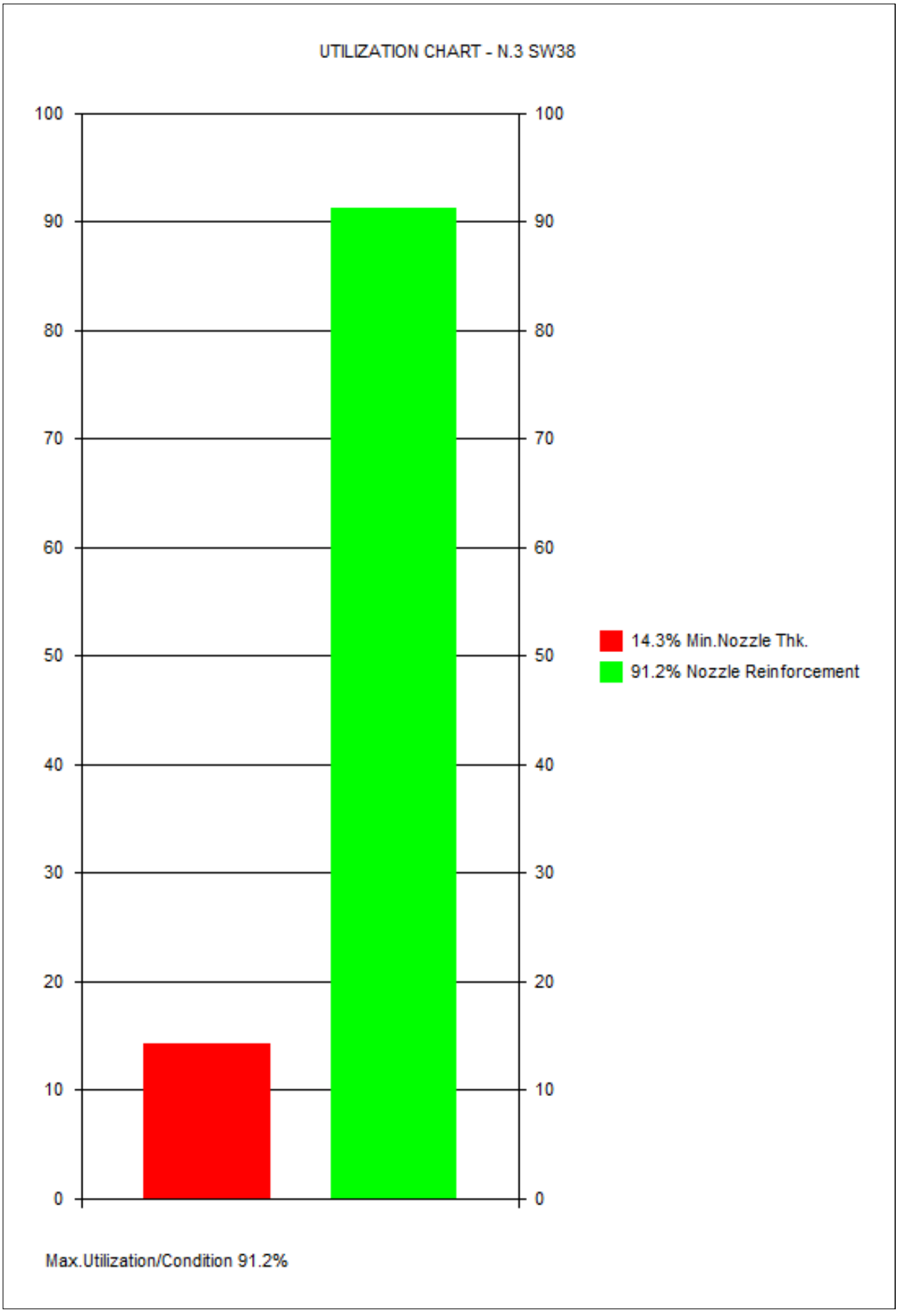
```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)      (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+65.35*(127.6-0.5*4.5)=   16.28 kN
```

Nozzle Reinforcement pAAval=16.28 >= pAReq=14.85[kN]	91.2%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))     (9.5-10)
=(42.02+0)*194.67+65.35*127.6/((3096.02+205.07)+0.5*(42.02+0+65.35+0))
=   4.9238 MPa
```

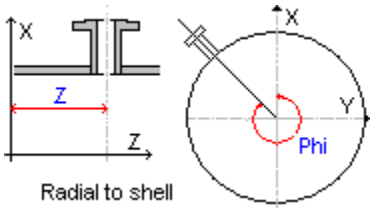
Volume:0.00 m3 Weight:0.2 kg (SG= 7.85)


UTILIZATION CHART - N.3 SW38
100
90
80
70
60
50
40
30
20
10
0
14.3% Min.Nozzle Thk.
91.2% Nozzle Reinforcement
Max.Utilization/Condition 91.2%

INPUT DATA

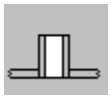
COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Radial to Shell
z-location of nozzle along axis of attacment.....:z          70.00 mm
Angle of Rotation of nozzle axis projected in the x-y plane:Phi   180.00 Degr.
```

GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.....:SG          0.00
LIQUID HEAD.....:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

SHELL DATA (S1.1)

```
Shell Type: Cylindrical Shell
OUTSIDE DIAMETER OF SHELL.....:De        168.00 mm
NOMINAL WALL THICKNESS (uncorroded).....:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE.....:th        0.3000 mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 fs=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
```

NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER.............................:deb        31.50 mm
NOMINAL NOZZLE THICKNESS (uncorroded)...............:enb       7.0500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD.............:ho         20.00 mm
```

WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE PhiC(OBLIQUE IN TRANSVERSE.CROSS SECT.)Fig.9.5-2:PhiC      0.00 Degr.
ANGLE PhiL(OBLIQUE IN LONG.CROSS SECT.)Fig.9.5-1....:PhiL       0.00 Degr.
```

DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                              2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =7.05-0.5-0.8813=                  5.6688 mm
Inside Radius of Curvature
ris = De / 2 - eas (9.5-3) =168/2-2.2=                      81.80 mm
dib = deb - 2 * eab =31.5-2*5.67=                           20.16 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*31.5/(2*127.6*1+4.5)=                               0.5500 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(194.67,127.6)=               127.60 N/mm2
```

GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/(2*ris)=0.1232 <= 1.00=1[mm] «» OK«

Min.Nozzle Thk. ebp=0.55 <= eab=5.67[mm]	9.7%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Calculation of Stress Loaded Areas Effective as Reinforcement

Area of Shell Afs

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*19.1=                        42.02 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
=MIN(Sqr((31.5-5.67)*5.67,)20)=                          12.10 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =5.67*(12.1+0+2.2)=  81.07 mm2
```

Calculation of Pressure Loaded Areas

```
In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*20.16*(12.1+2.2)=  144.17 mm2

Cyl.Shell in the Longitudinal Section Aps
ApsL = ris * (Is + a) (9.5-94) =81.8*(19.1+15.75)=        2850.62 mm2

Cyl.Shell in the Transverse Cross Section Aps
ApsT = 0.5 * ris ^ 2 * (Is + a ) / (0.5 * eas + ris)               (9.5-105)
=0.5*81.8^2*(19.1+15.85)/(0.5*2.2+81.8)=                1410.29 mm2

Aps = MAX( ApsL ApsT) =MAX(2850.62,1410.29)=              2850.62 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                           (9.5-7)
=4.5*(2850.62+144.17+0.5*0)=                              13.48 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                            (9.5-7)
=4.5*(1410.29+144.17+0.5*0)=                             6.9951 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(13476.57,6995.06)=        13.48 kN
```

Pressure Area Available pA(aval.)

```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)       (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+81.07*(127.6-0.5*4.5)=    18.25 kN
```

Nozzle Reinforcement pAAval=18.25 >= pAReq=13.48[kN]	73.8%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))      (9.5-10)
=(42.02+0)*194.67+81.07*127.6/((2850.62+144.17)+0.5*(42.02+0+81.07+0))
=   6.0608 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                               12.13 MPa

Weight of Nozzle: .1043kg
```

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.55 <= eab=5.67[mm]	9.7%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
```

```
=MIN(Sqr((31.5-5.67)*5.67,)20)=                                  12.10 mm
```

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                              (9.5-7)
=4.5*(2850.62+144.17+0.5*0)=                                     13.48 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                               (9.5-7)
=4.5*(1410.29+144.17+0.5*0)=                                     6.9951 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(13476.57,6995.06)=               13.48 kN
```

Pressure Area Available pA(aval.)

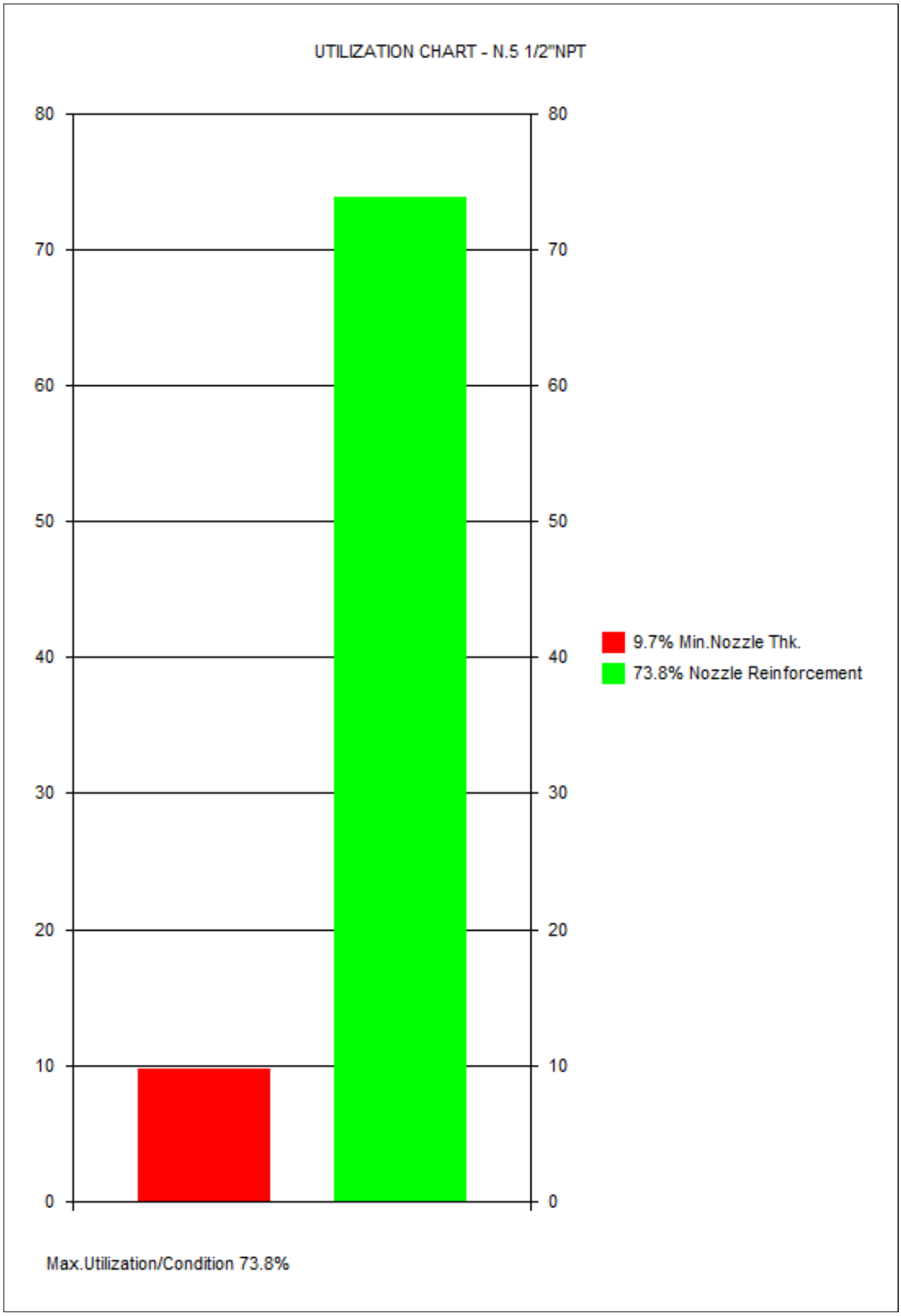
```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)          (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+81.07*(127.6-0.5*4.5)=     18.25 kN
```

Nozzle Reinforcement pAAval=18.25 >= pAReq=13.48[kN]	73.8%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))         (9.5-10)
=(42.02+0)*194.67+81.07*127.6/((2850.62+144.17)+0.5*(42.02+0+81.07+0))
=   6.0608 MPa
```

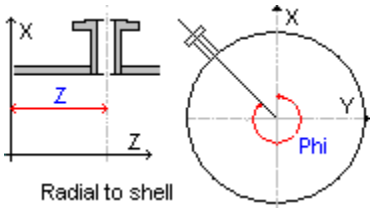
Volume:0.00 m3 Weight:0.1 kg (SG= 7.85)


UTILIZATION CHART - N.5 1/2"NPT
80
70
60
50
40
30
20
10
0
9.7% Min.Nozzle Thk.
73.8% Nozzle Reinforcement
Max.Utilization/Condition 73.8%

INPUT DATA

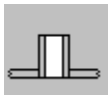
COMPONENT ATTACHMENT/LOCATION

```
Attachment: S1.1    Cylindrical Shell    Main Shell
Connect this nozzle to the nozzle neck of another nozzle: NO
```




```
Orientation & Location of Nozzle: Radial to Shell
z-location of nozzle along axis of attacment.....:z          70.00 mm
Angle of Rotation of nozzle axis projected in the x-y plane:Phi    90.00 Degr.
```

GENERAL DESIGN DATA



```
Type of Opening: Nozzle Without Standard ASME or DIN/EN Flange Attachment
PRESSURE LOADING: Design Component for Internal Pressure Only
PROCESS CARD:
General Design Data : Temp= 130°C, P=4.5000 MPa, c=0.5 mm, Pext=0.0000 MPa
SPECIFIC DENSITY OF OPERATING LIQUID.....:SG          0.00
LIQUID HEAD.....:LH          0.00 mm
Apply a different corrosion allowance to nozzle neck than the shell thickness.: NO
Include Nozzle Load Calculation: NO
```

SHELL DATA (S1.1)

```
Shell Type: Cylindrical Shell
OUTSIDE DIAMETER OF SHELL.....:De        168.00 mm
NOMINAL WALL THICKNESS (uncorroded).....:en        3.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE.....:th        0.3000 mm
EN 10217-3:2019, 1.0565 P355NH welded tube, HT:N THK<=20mm 130'C
Rm=490 Rp=355 Rpt=292 fs=194.67 f20=204.17 ftest=338.1 E=203868(N/mm2) ro=7.85
```

NOZZLE MATERIAL DATA

```
Delivery Form: Seamless Pipe
EN 10216-2:2013, 1.0345 P235GH seamless tube, HT:N THK<=16mm 130'C
Rm=360 Rp=235 Rpt=191.4 fb=127.6 f20=150 ftest=223.81 E=203868(N/mm2) ro=7.85
```

NOZZLE DIMENSIONAL DATA

```
Attachment: Set In Flush Nozzle
Shape of Nozzle/Opening: Circular
Application:
9.4.6.3 NOT a critical fatigue area, and calc.temp.is outside creep range.
OUTSIDE NOZZLE DIAMETER.............................:deb        25.70 mm
NOMINAL NOZZLE THICKNESS (uncorroded)...............:enb       6.7500 mm
Size of Flange and Nozzle:
Comment (Optional):
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:           12.50 %
NOZZLE STANDOUT MEASURED FROM VESSEL OD.............:ho         20.00 mm
```

WELDING DATA

```
Nozzle/Pad to Shell Welding Area: Exclude Area of Nozzle to Shell Weld
Nozzle Weld Intersect: Nozzle Does NOT Intersect with a Welded Shell Seam
ANGLE PhiC(OBLIQUE IN TRANSVERSE.CROSS SECT.)Fig.9.5-2:PhiC      0.00 Degr.
ANGLE PhiL(OBLIQUE IN LONG.CROSS SECT.)Fig.9.5-1....:PhiL       0.00 Degr.
```

DATA FOR REINFORCEMENT PAD

```
Type of Pad: No Pad
```

LIMITS OF REINFORCEMENT

```
Reduction of Limits of Reinforcement: No Reduction Required
```

WELDING REQUIREMENTS TO EN 1708-1:2010

```
Comment(Optional):
Type of welded connection: Not Applicable
```

CALCULATION DATA

PRELIMINARY CALCULATIONS

```
Shell Analysis Thickness eas
eas = en - c - th =3-0.5-0.3=                              2.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =6.75-0.5-0.8438=                  5.4063 mm
Inside Radius of Curvature
ris = De / 2 - eas (9.5-3) =168/2-2.2=                      81.80 mm
dib = deb - 2 * eab =25.7-2*5.41=                           14.89 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=4.5*25.7/(2*127.6*1+4.5)=                               0.4500 mm
Allowable Stresses
fob = Min( fs, fb) (9.5-8) =Min(194.67,127.6)=              127.60 N/mm2
```

GEOMETRIC LIMITATIONS

»Check Max.Diameter of Nozzle dib/(2*ris)=0.091 <= 1.00=1[mm] «» OK«

Min.Nozzle Thk. ebp=0.45 <= eab=5.41[mm]	8.3%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

Calculation of Stress Loaded Areas Effective as Reinforcement

Area of Shell Afs

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =2.2*19.1=                        42.02 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
=MIN(Sqr((25.7-5.41)*5.41,)20)=                          10.47 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =5.41*(10.47+0+2.2)=  68.52 mm2
```

Calculation of Pressure Loaded Areas

```
In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*14.89*(10.47+2.2)=   94.35 mm2

Cyl.Shell in the Longitudinal Section Aps
ApsL = ris * (Is + a) (9.5-94) =81.8*(19.1+12.85)=       2613.40 mm2

Cyl.Shell in the Transverse Cross Section Aps
ApsT = 0.5 * ris ^ 2 * (Is + a ) / (0.5 * eas + ris)               (9.5-105)
=0.5*81.8^2*(19.1+12.9)/(0.5*2.2+81.8)=                 1291.46 mm2

Aps = MAX( ApsL ApsT) =MAX(2613.4,1291.46)=              2613.40 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                           (9.5-7)
=4.5*(2613.4+94.35+0.5*0)=                               12.18 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                            (9.5-7)
=4.5*(1291.46+94.35+0.5*0)=                             6.2361 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(12184.87,6236.13)=       12.18 kN
```

Pressure Area Available pA(aval.)

```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)       (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+68.52*(127.6-0.5*4.5)=   16.67 kN
```

Nozzle Reinforcement pAAval=16.67 >= pAReq=12.18[kN]	73.0%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))      (9.5-10)
=(42.02+0)*194.67+68.52*127.6/((2613.4+94.35)+0.5*(42.02+0+68.52+0))
=   6.1247 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                               12.34 MPa

Weight of Nozzle: .0758kg
```

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.45 <= eab=5.41[mm]	8.3%	OK

9.5.2.4.4 Nozzles normal to the shell, with or without reinforcement pads.

```
Limit of Reinforcement Along Shell
Iso = Sqr(( 2 * ris + eas) * eas)
=Sqr((2*81.8+2.2)*2.2)=                                  19.10 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                              (9.5-76)
```

```
=MIN(Sqr((25.7-5.41)*5.41,)20)=                                  10.47 mm
```

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                              (9.5-7)
=4.5*(2613.4+94.35+0.5*0)=                                       12.18 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                               (9.5-7)
=4.5*(1291.46+94.35+0.5*0)=                                     6.2361 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(12184.87,6236.13)=              12.18 kN
```

Pressure Area Available pA(aval.)

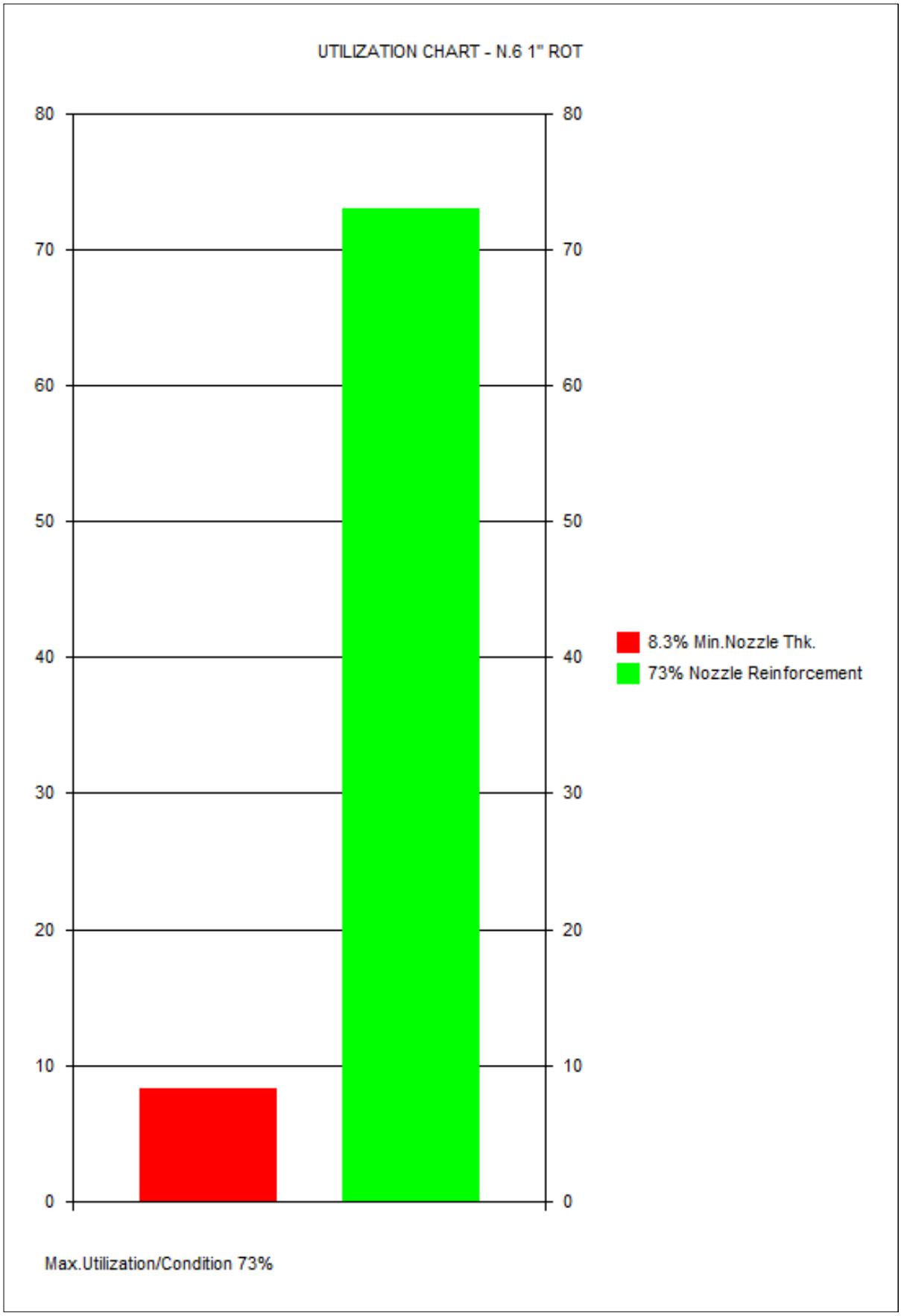
```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)          (9.5-7)
=(42.02+0)*(194.67-0.5*4.5)+0*(0-0.5*4.5)+68.52*(127.6-0.5*4.5)=    16.67 kN
```

Nozzle Reinforcement pAAval=16.67 >= pAReq=12.18[kN]	73.0%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))         (9.5-10)
=(42.02+0)*194.67+68.52*127.6/((2613.4+94.35)+0.5*(42.02+0+68.52+0))
=   6.1247 MPa
```

Volume:0.00 m3 Weight:0.1 kg (SG= 7.85)


UTILIZATION CHART - N.6 1" ROT
80
70
60
50
40
30
20
10
0
8.3% Min.Nozzle Thk.
73% Nozzle Reinforcement
Max.Utilization/Condition 73%