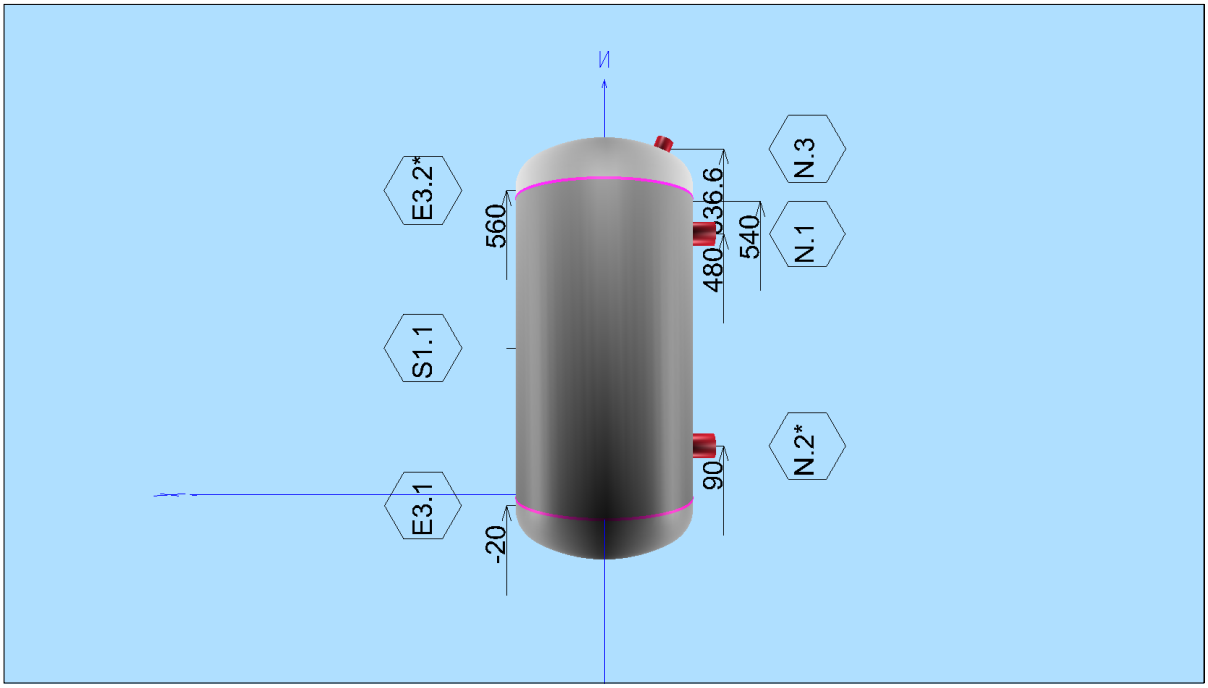
(0) Drawing

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

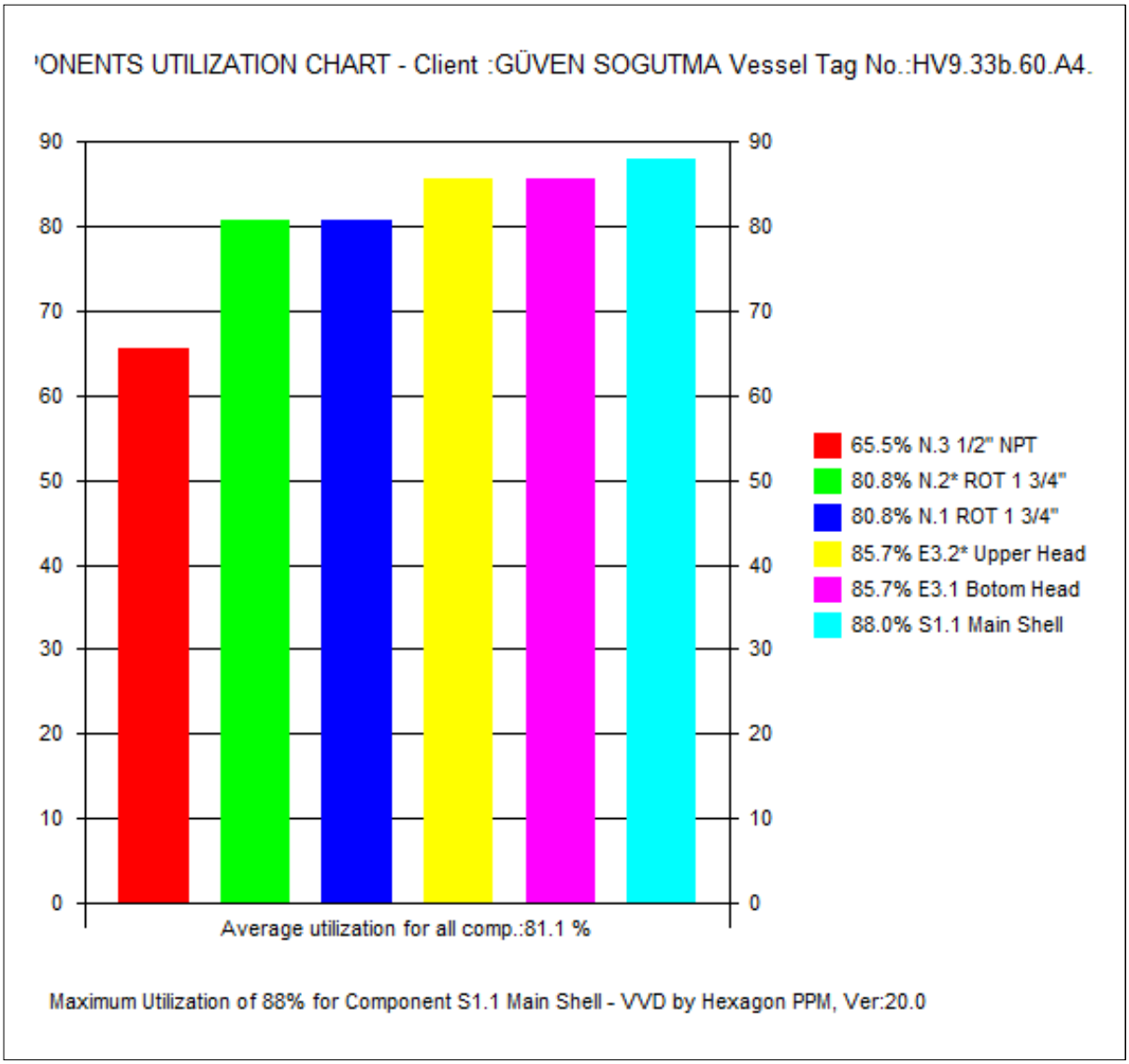


Design Data & Process Information

Description	Units	Design Data
Process Card		General Design Data
Design Code & Specifications		EN13445 TG = 3b
Internal Design Pressure (MPa)	MPa	3.3
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=3.3000 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  2   (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        324.00 mm
LENGTH OF CYLINDRICAL PART OF SHELL.................:Lcyl      540.00 mm
NOMINAL WALL THICKNESS (uncorroded).................:en        4.0000 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)
=324*3.3/(2*194.67*1+3.3)=                                  2.7231 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =2.72+0.5+0.3=                     3.5231 mm

Analysis Thickness
ea = en - c - NegDev =4-0.5-0.3=                             3.2000 mm
```

»7.4.1 Cond.of Applicabilty emin/De=0.0084 <= 0.16« » OK«

Internal Pressure emina=3.52 <= en=4[mm]	88.0%	OK

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :

```
Inside Diameter of Shell
Di = De - 2 * ea =324-2*3.2=                                 317.60 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(324+317.6)/2=                           320.80 mm
MAWP HOT & CORR. (Corroded condition at design temp.)
MAWPHC = 2 * f * z * ea / Dm =2*194.67*1*3.2/320.8=          3.8837 MPa

MAWP NEW & COLD (Uncorroded condition at ambient temp.)
MAWPNC = 2 * f20 * z * (ea + c) / Dm
=2*204.17*1*(3.2+0.5)/320.8=                                4.7097 MPa
```

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

```
Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(3.2+0.5)/320.8=                                 7.7991 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*3.3*204.17/194.67= 4.3263 MPa

Ptmin = 1.43 * Pd =1.43*3.3= 4.7190 MPa

Test Pressure Ptmin=4.72 <= Ptmax=7.8[MPa]	60.5%	OK

MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Inside Radius of Shell
ris = Di / 2 (9.5-3) =317.6/2= 158.80 mm
Length of Shell Contributing to Reinforcement
Is = Sqr((2 * ris + ea) * ea) (9.5-2)
=Sqr((2*158.8+3.2)*3.2)= 32.04 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*317.6,(3.2*32.04*(194.67-0.5*3.3)/3.3-158.8*32.04)/(0.5*158.8+0.5*3.2))= = 11.22 mm

Maximum diameter of Opening Not Requiring Reinforcement Check
dmax2 = 0.15 * Sqr((2 * ris + ea) * ea) (9.5-18)
=0.15*Sqr((2*158.8+3.2)*3.2)= 4.8060 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(11.22,4.81)= 11.22 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)
=324*3.3/(2*194.67*1+3.3)= 2.7231 mm

Required Minimum Shell Thickness Incl.Allow. :
emina = emin + c + NegDev =2.72+0.5+0.3= 3.5231 mm

Internal Pressure emina=3.52 <= en=4[mm]	88.0%	OK

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

Ptmax = 2 * ftest * ztest * (ea + c) / Dm
=2*338.1*1*(3.2+0.5)/320.8= 7.7991 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*3.3*204.17/194.67= 4.3263 MPa

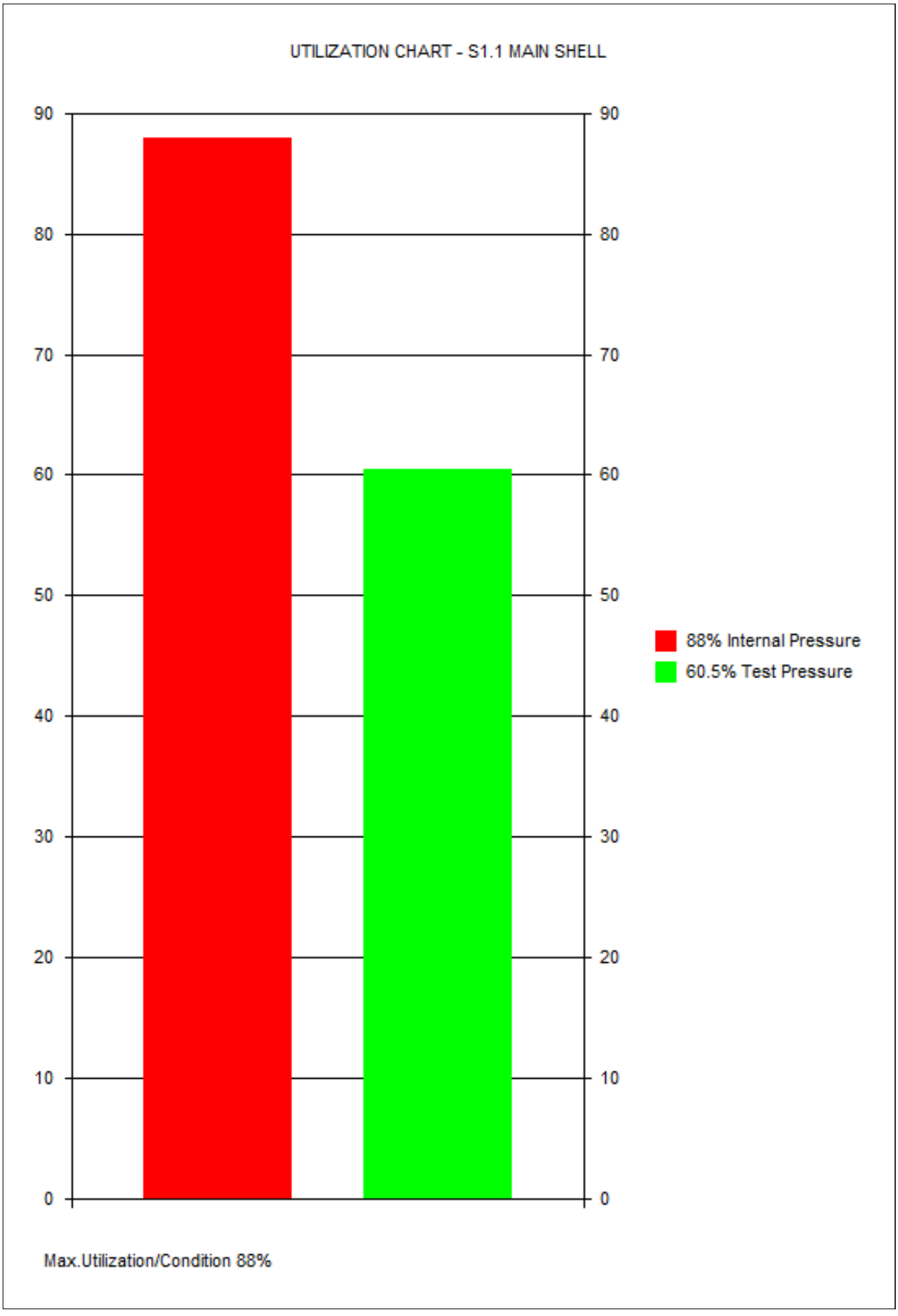
Ptmin = 1.43 * Pd =1.43*3.3= 4.7190 MPa

Test Pressure Ptmin=4.72 <= Ptmax=7.8[MPa]	60.5%	OK

MAXIMUM DIAMETER OF UNREINFORCED OPENING IN SHELL

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(11.22,4.81)= 11.22 mm

Volume:0.0428 m3 Weight:17 kg (SG= 7.85)


UTILIZATION CHART - S1.1 MAIN SHELL
90
80
70
60
50
40
30
20
10
0
88% Internal Pressure
60.5% Test Pressure
Max.Utilization/Condition 88%

INPUT DATA

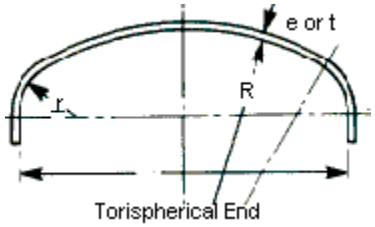
COMPONENT ATTACHMENT/LOCATION

```
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=3.3000 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        324.00 mm
LENGTH OF CYLINDRICAL FLANGE OF END.................:Lcyl       20.00 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE...............:th        0.3000 mm
NOMINAL THICKNESS OF HEAD/END (uncorroded)..........:en        4.0000 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)
=3.3*259.2/(2*205.73*1-0.5*3.3)=                              2.0872 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*259.2+0.2*317)*((3.3/(111*205.73)*(317/49.896)^0.825)^(0.667)
=   1.9579 mm

7.5.3.5 Formulas for Calculation of Factor Beta
Y = MIN( emin / R, 0.04) (7.5-9) =MIN(2.6201/259.2,0.04)=     0.0101
Z = LOG( 1 / Y) (7.5-10) =LOG(1/0.0101)=                      1.9953
X = r / Di (7.5-11) =49.896/318.76=                           0.1565
```

```
N = 1.006 - 1 / (6.2 + (90 * Y) ^ 4)                                  (7.5-12)
=1.006-1/(6.2+(90*0.0101)^4)=                              0.8608
Beta01 = N*(-0.1833*Z^3+1.0383*Z^2-1.2943*Z+0.837)                    (7.5-15)
=0.8608*(-0.1833*2.^3+1.0383*2.^2-1.2943*2.+0.837)=        0.8023
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*0.0101-82.5*0.0101^2))=           0.5054
beta = 10 * ((0.2 - X) * Beta01 + (X - 0.1) * Beta02)                 (7.5-16)
=10*((0.2-0.1565)*0.8023+(0.1565-0.1)*0.5054)=             0.6344
Required Thickness of Knuckle to Avoid Axisymmetric Yielding
ey = beta * P * (0.75 * R + 0.2 * Di) / f                             (7.5-2)
=0.6344*3.3*(0.75*259.2+0.2*318.76)/205.73=                2.6272 mm
```

NOTE 3, since ey(2.6) > 0.005*Di(1.6) it is NOT necessary to calculate/consider eb.

```
Required Minimum End Thickness Excl.Allow. emin :
emin = emin =2.63=                                          2.6272 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =2.63+0.5+0.3=                        3.4300 mm
```

Internal Pressure emina=3.43 <= en=4[mm]	85.7%	OK

```
Analysis Thickness
ea = en - c - th =4-0.5-0.3=                                3.2000 mm
Inside Diameter of Shell
Di = De - 2 * (en - c) =324-2*(4-0.5)=                      317.00 mm
Mean Diameter of Shell
Dm = (De + Di) / 2 =(324+317)/2=                            320.50 mm
```

7.5.3.4 - Required Minimum Thickness of Straight Cylindrical Flange

```
Llim = 0.2 * SQR( Di * emin) =0.2*SQR(317*2.63)=            5.7717 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)
=3.3*317/(2*205.73*1-3.3)=                                 2.5630 mm

Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =2.56+0.5=                                 3.0600 mm
```

7.5.3.1 Conditions of Applicability - Torispherical Ends

»Geometry Check r=49.896 <= 0.2 * Di=63.4[mm] « » OK«
»Geometry Check r=49.896 >= 0.06 * Di=19.02[mm] « » OK«
»Geometry Check r=49.896 >= 2*e=5.25[mm] « » OK«
»Geometry Check e=2.63 <= 0.08*De=25.92[mm] « » OK«
»Geometry Check ea=3.2 >= 0.001*De=0.324[mm] « » OK«
»Geometry Check R=259.2 <= De=324[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*3.7/(258.7+0.5*3.7)=                            6.0353 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                        (7.5-7)
=212.5*3.7/(0.604*(0.75*258.7+0.2*317))=                   5.0565 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                     (7.5-8)
=111*236.67*(3.7/(0.75*258.7+0.2*317))^1.5*(49.896/317)^0.825=   9.8473 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*3.7*212.5*1/(317+3.7)=                                  4.9033 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=4.9=                                                      4.9033 MPa
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

```
Ps = 2 * f * z * ea / (R + 0.5 * ea)                                  (7.5-6)
=2*205.73*1*3.2/(259.2+0.5*3.2)=                           5.0486 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                        (7.5-7)
=205.73*3.2/(0.6135*(0.75*259.2+0.2*317))=                 4.1622 MPa
```

```
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                    (7.5-8)
=111*205.73*(3.2/(0.75*259.2+0.2*317))^1.5*(49.896/317)^0.825=   6.8700 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*3.2*205.73*1/(317+3.2)=                                       4.1120 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=4.11=                                                           4.1120 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*3.7/(258.7+0.5*3.7)=                                  9.6025 MPa
Py = f * ea / ( beta * ( 0.75 * R + 0.2 * Di))                       (7.5-7)
=338.1*3.7/(0.604*(0.75*258.7+0.2*317))=                         8.0452 MPa
PB = 111*fb*(ea/(0.75*R+0.2*Di))^1.5*(r/Di)^0.825                    (7.5-8)
=111*338.1*(3.7/(0.75*258.7+0.2*317))^1.5*(49.896/317)^0.825=    14.07 MPa
Pcyl = 2 * ea * f * z / (Di + ea)
=2*3.7*338.1*1/(317+3.7)=                                        7.8015 MPa
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=7.8=                                                            7.8015 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*3.3*212.5/205.73=               4.2607 MPa

Ptmin = 1.43 * Pd =1.43*3.3=                                      4.7190 MPa
```

Test Pressure Ptmin=4.72 <= Ptmax=7.8[MPa]	60.4%	OK

Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

```
ris = R (9.5-4) =259.2=                                          259.20 mm
Length of Shell Contributing to Reinforcement
Is = Sqr(( 2 * ris + ea) * ea)                                       (9.5-2)
=Sqr((2*259.2+3.2)*3.2)=                                        40.85 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*317,(3.2*40.85*(205.73-0.5*3.3)/3.3-259.2*40.85)/(0.5*259.2+0.5*3.
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*259.2+3.2)*3.2)=                                    6.1282 mm

Maximum Diameter of Unreinforced Opening
dmax = MAX( dmax1, dmax2) =MAX(0,6.13)=                          6.1282 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 =2.63=                                               2.6272 mm

Required Minimum End Thickness Incl.Allow. :
emina = emin + c + th =2.63+0.5+0.3=                             3.4300 mm
```

Internal Pressure emina=3.43 <= en=4[mm]	85.7%	OK

```
Minimum Thickness of Straight Flange Incl.Corr. :
ecyla = ecyl + c =2.56+0.5=                                      3.0600 mm
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :NEW & COLD

```
Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=4.9=                                                            4.9033 MPa
```

MAXIMUM ALLOWABLE WORKING PRESSURE MAWP :HOT & CORR

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=4.11= 4.1120 MPa

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

Pmax (is the least of Ps, Py, Pb and Pcyl) = Pmax
=7.8= 7.8015 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*3.3*212.5/205.73= 4.2607 MPa

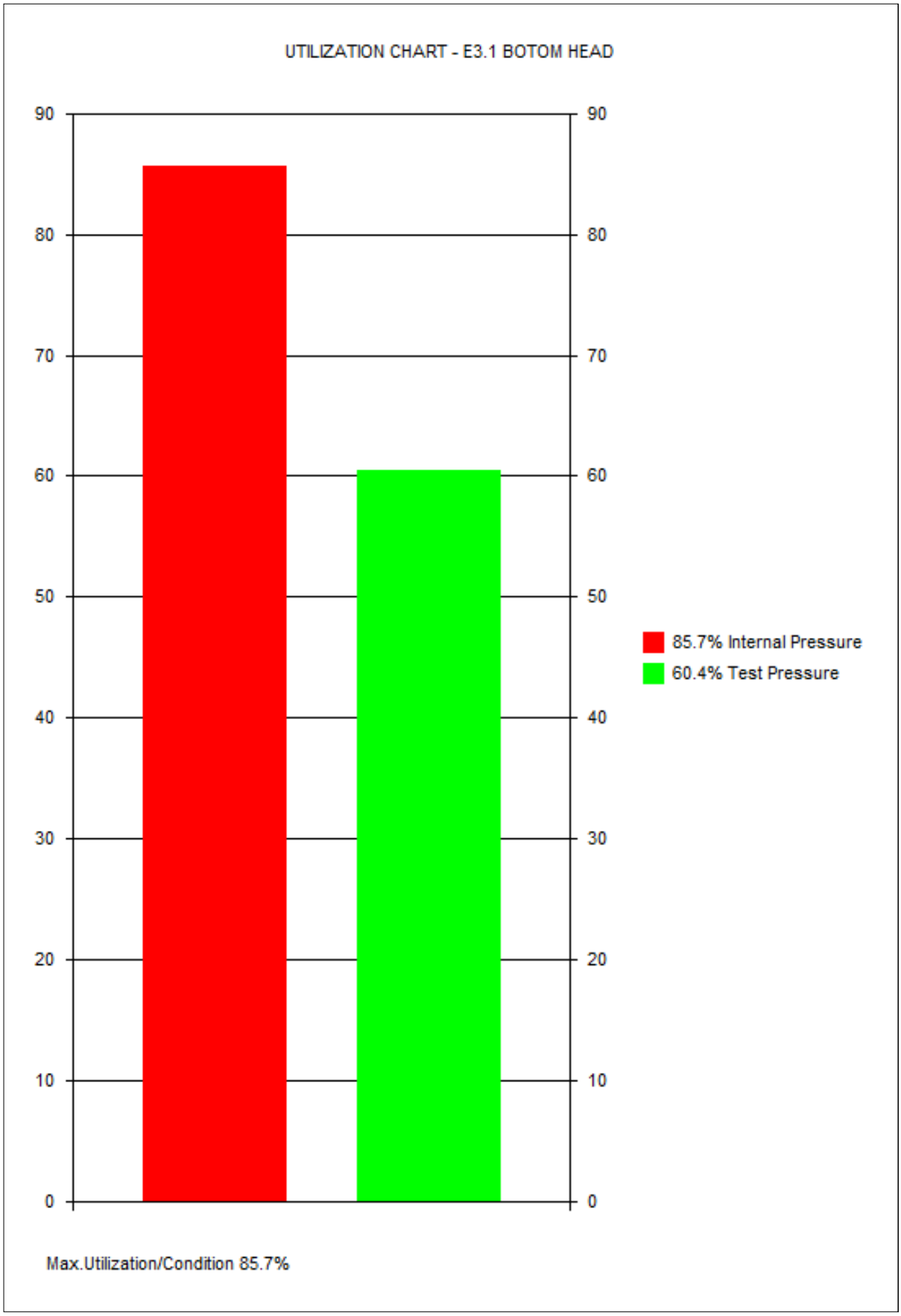
Ptmin = 1.43 * Pd =1.43*3.3= 4.7190 MPa

Test Pressure Ptmin=4.72 <= Ptmax=7.8[MPa]	60.4%	OK

Maximum diameter of Opening Not Requiring Reinforcement Check , dmax

Maximum Diameter of Unreinforced Opening
dmax = MAX(dmax1, dmax2) =MAX(0,6.13)= 6.1282 mm

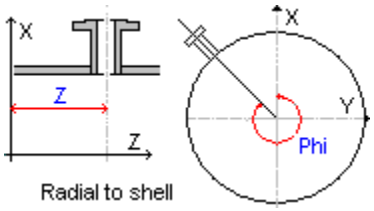
Volume:0.0058 m3 Weight:4.2 kg (SG= 7.85)


UTILIZATION CHART - E3.1 BOTOM HEAD
90
80
70
60
50
40
30
20
10
0
85.7% Internal Pressure
60.4% Test Pressure
Max.Utilization/Condition 85.7%

INPUT DATA

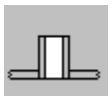
COMPONENT ATTACHMENT/LOCATION

```
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         480.00 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=3.3000 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        324.00 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        4.0000 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        44.50 mm
NOMINAL NOZZLE THICKNESS (uncorroded)...............:enb       8.4000 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 =4-0.5-0.3=                                3.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =8.4-0.5-1.05=                       6.8500 mm
Inside Radius of Curvature
ris = De / 2 - eas (9.5-3) =324/2-3.2=                       158.80 mm
dib = deb - 2 * eab =44.5-2*6.85=                             30.80 mm
Min.Nozzle Thk.Based on Internal Pressure ebp
ebp = P * deb / (2 * fb * z + P)
=3.3*44.5/(2*127.6*1+3.3)=                                  0.5700 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)=0.097 <= 1.00=1[mm] «» OK«

Min.Nozzle Thk. ebp=0.57 <= eab=6.85[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*158.8+3.2)*3.2)=                                  32.04 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =3.2*32.04=                       102.53 mm2
```

Area of Nozzle Afb

```
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                            (9.5-76)
=MIN(Sqr((44.5-6.85)*6.85,)40)=                           16.06 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =6.85*(16.06+0+3.2)=  131.93 mm2
```

Calculation of Pressure Loaded Areas

```
In the Nozzle Apb
Apb = 0.5 * dib * (Ibo + eas) (9.5-84) =0.5*30.8*(16.06+3.2)=   296.59 mm2

Cyl.Shell in the Longitudinal Section Aps
ApsL = ris * (Is + a) (9.5-94) =158.8*(32.04+22.25)=       8621.25 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*158.8^2*(32.04+22.32)/(0.5*3.2+158.8)=              4273.28 mm2

Aps = MAX( ApsL ApsT) =MAX(8621.25,4273.28)=               8621.25 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                         (9.5-7)
=3.3*(8621.25+296.59+0.5*0)=                              29.43 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                          (9.5-7)
=3.3*(4273.28+296.59+0.5*0)=                              15.08 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(29428.88,15080.6)=        29.43 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)
=(102.53+0)*(194.67-0.5*3.3)+0*(0-0.5*3.3)+131.93*(127.6-0.5*3.3)=   36.41 kN
```

Nozzle Reinforcement pAAval=36.41 >= pAReq=29.43[kN]	80.8%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))    (9.5-10)
=(102.53+0)*194.67+131.93*127.6/((8621.25+296.59)+0.5*(102.53+0+131.93+0))
=   4.0722 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                               7.9314 MPa

Weight of Nozzle: .3408kg
```

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.57 <= eab=6.85[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*158.8+3.2)*3.2)=                                  32.04 mm
Limit of Reinforcement Along Nozzle (outside shell)
Ibo = MIN( Sqr(( deb - eb) * eb), ho)                            (9.5-76)
```

```
=MIN(Sqr((44.5-6.85)*6.85,)40)=                                  16.06 mm
```

Pressure Area Required pA(req.)

```
pAReqL = P * (ApsL + Apb + 0.5 * ApphiL)                              (9.5-7)
=3.3*(8621.25+296.59+0.5*0)=                                     29.43 kN

pAReqT = P * (ApsT + Apb + 0.5 * Apphi)                               (9.5-7)
=3.3*(4273.28+296.59+0.5*0)=                                     15.08 kN

pAReq = MAX( pAReqL, pAReqT) =MAX(29428.88,15080.6)=               29.43 kN
```

Pressure Area Available pA(aval.)

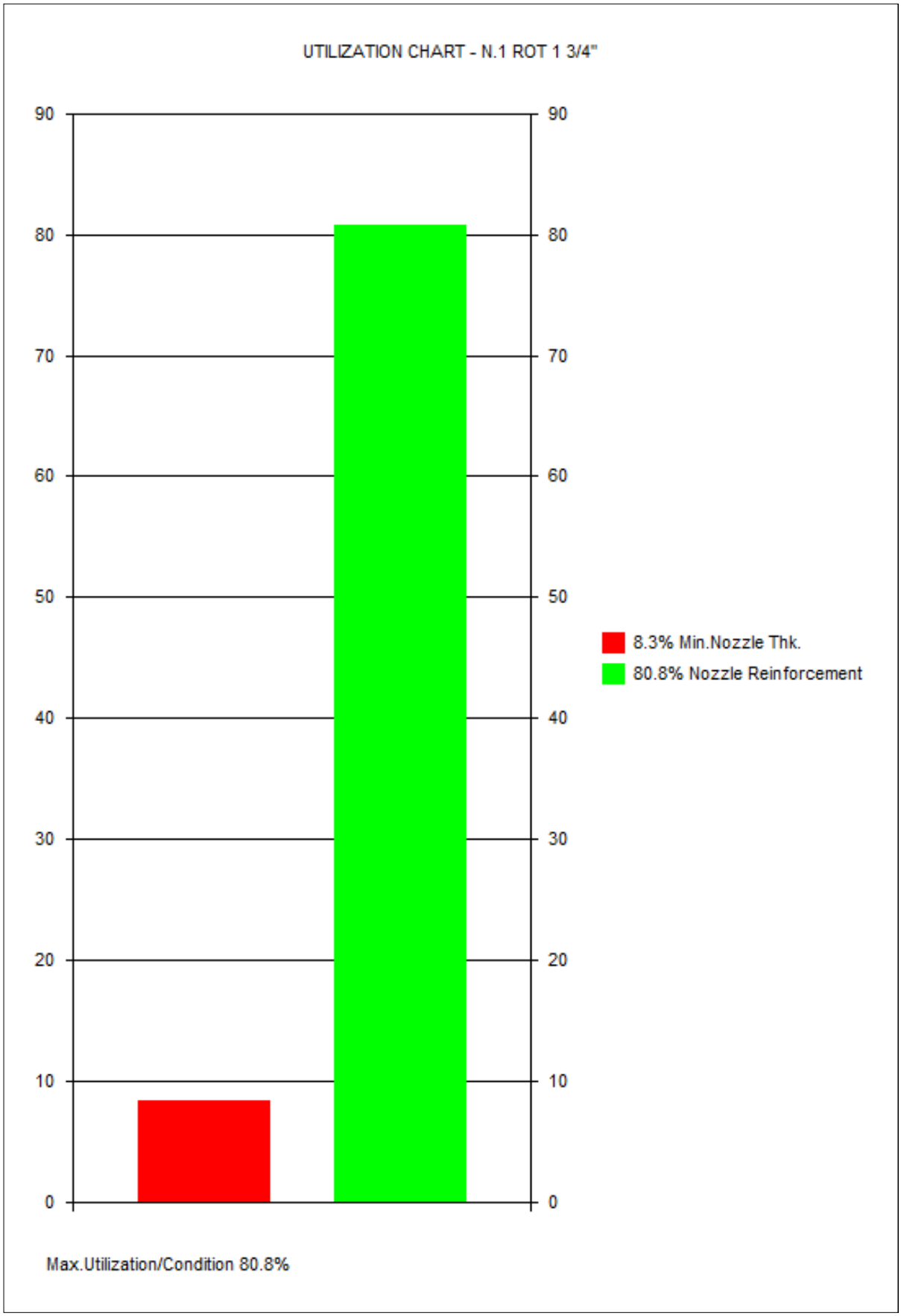
```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)          (9.5-7)
=(102.53+0)*(194.67-0.5*3.3)+0*(0-0.5*3.3)+131.93*(127.6-0.5*3.3)=    36.41 kN
```

Nozzle Reinforcement pAAval=36.41 >= pAReq=29.43[kN]	80.8%	OK

Maximum Allowable Pressure Pmax

```
Pmax = (Afs+Afw)*fs+Afb*fob/((ApsL+Apb)+0.5*(Afs+Afw+Afb+Afp))         (9.5-10)
=(102.53+0)*194.67+131.93*127.6/((8621.25+296.59)+0.5*(102.53+0+131.93+0))
=   4.0722 MPa
```

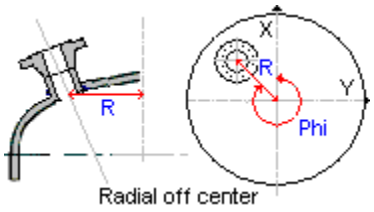
Volume:0.00 m3 Weight:0.3 kg (SG= 7.85)


UTILIZATION CHART - N.1 ROT 1 3/4"
90
80
70
60
50
40
30
20
10
0
8.3% Min.Nozzle Thk.
80.8% Nozzle Reinforcement
Max.Utilization/Condition 80.8%

INPUT DATA

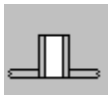
COMPONENT ATTACHMENT/LOCATION

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




```
Orientation & Location of Nozzle: Radial to End (Off Center)
Angle of Rotation of nozzle axis projected in the x-y plane:Phi   180.00 Degr.
Distance between Center of End and Center of Nozzle.:R         100.00 mm
```

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=3.3000 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        324.00 mm
NOMINAL WALL THICKNESS (uncorroded)..................:en        4.0000 mm
NEGATIVE TOLERANCE/THINNING ALLOWANCE................:th        0.3000 mm
INSIDE SPHERICAL RADIUS (corroded)...................:R         259.20 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        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         30.00 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 =4-0.5-0.3=                              3.2000 mm
Nozzle Analysis Thickness eab
eab = enb - cn - NegDev =7.05-0.5-0.8813=                  5.6688 mm
ris = R (9.5-4) =100=                                      259.20 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)
=3.3*31.5/(2*127.6*1+3.3)=                               0.4000 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=0.0622 <= 0.60=0.6[mm] (9.4.5.3)«» OK«

Min.Nozzle Thk. ebp=0.4 <= eab=5.67[mm]	7.0%	OK

»Location in End to Fig.9.5-4 L=47.02 >= De/10=32.4[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 Reduced by Location in Dished End
Iso =  ==                                                    17.04 mm
Set In Nozzle
Afs = eas * Is (9.5-79) =3.2*17.04=                          54.53 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,)30)=                              12.10 mm
Set In Nozzle
Afb = eb * (Ibo + Ibi + eas) (9.5-78) =5.67*(12.1+0+3.2)=    86.74 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+3.2)=   154.25 mm2

Spherical Shell/End on any Section Aps
Aps = 0.5 * ris ^ 2 * (Is + a) / (0.5 * eas + ris)                   (9.5-105)
=0.5*259.2^2*(17.04+15.76)/(0.5*3.2+259.2)=                 4224.84 mm2
```

9.5.2 Reinforcement Rules

Pressure Area Required pA(req.)

```
pAReq = P * (Aps + Apb + 0.5 * Apphi)                                (9.5-7)
=3.3*(4224.84+154.25+0.5*0)=                                 14.45 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)
=(54.53+0)*(205.73-0.5*3.3)+0*(0-0.5*3.3)+86.74*(127.6-0.5*3.3)=    22.05 kN
```

Nozzle Reinforcement pAAval=22.05 >= pAReq=14.45[kN]	65.5%	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)
=(54.53+0)*205.73+86.74*127.6/((4224.84+154.25+0.5*0)+0.5*(54.53+0+86.74+0)
)=                                                           =   5.0084 MPa
```

Max.Allowable Test Pressure Ptmax

```
Ptmax =  ==                                                  9.5209 MPa
```

Weight of Nozzle: .1466kg

CALCULATION SUMMARY

Min.Nozzle Thk. ebp=0.4 <= eab=5.67[mm]	7.0%	OK

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

```
Limit of Reinforcement Along Shell Reduced by Location in Dished End
Iso =  ==                                                    17.04 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,)30)=                              12.10 mm
```

Pressure Area Required pA(req.)

```
pAReq = P * (Aps + Apb + 0.5 * Apphi)                                (9.5-7)
=3.3*(4224.84+154.25+0.5*0)=                                 14.45 kN
```

Pressure Area Available pA(aval.)

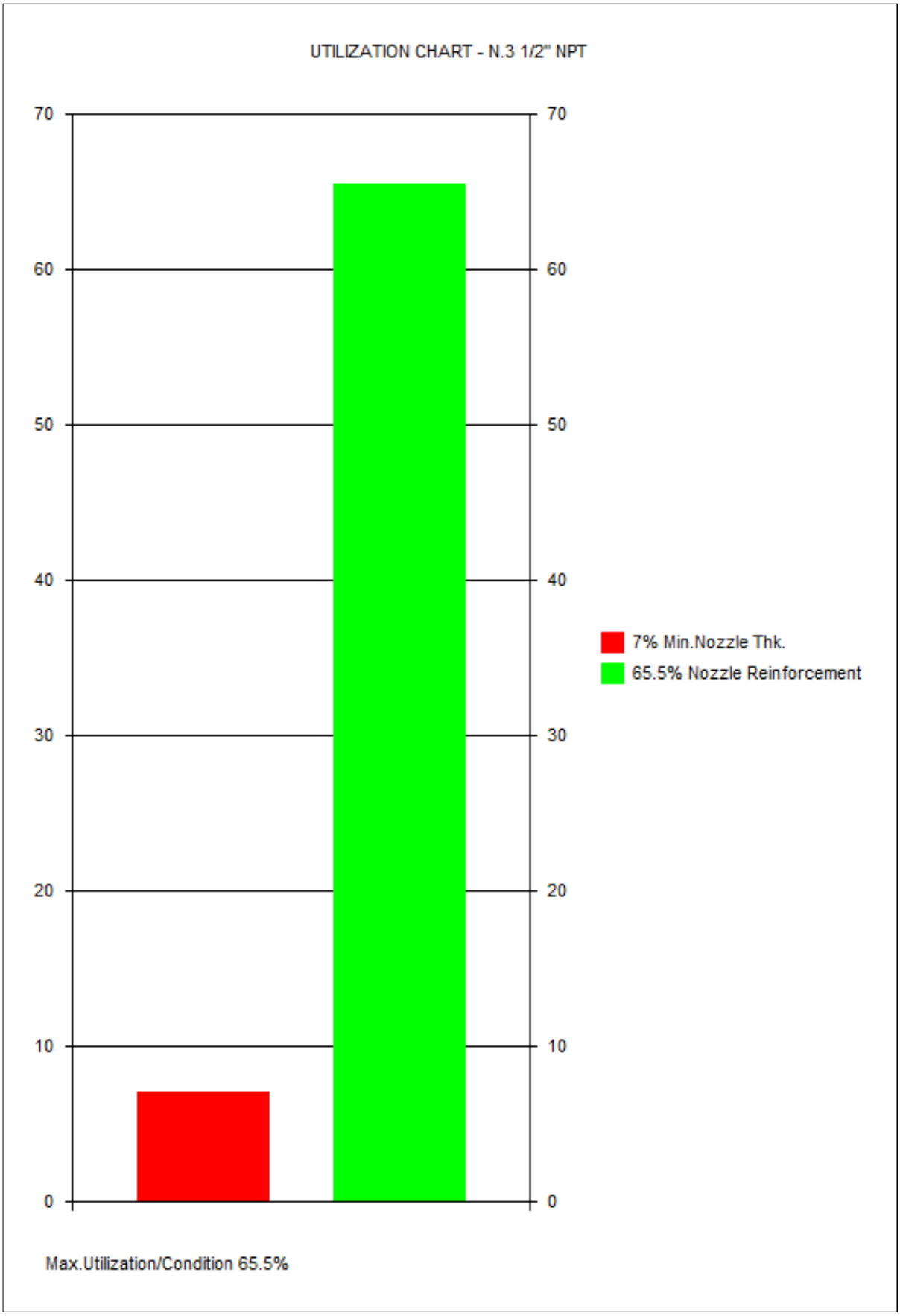
```
pAAval = (Afs+Afw)*(fs-0.5*P)+Afp*(fop-0.5*P)+Afb*(fob-0.5*P)      (9.5-7)
=(54.53+0)*(205.73-0.5*3.3)+0*(0-0.5*3.3)+86.74*(127.6-0.5*3.3)=    22.05 kN
```

Nozzle Reinforcement pAAval=22.05 >= pAReq=14.45[kN]	65.5%	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)
=(54.53+0)*205.73+86.74*127.6/((4224.84+154.25+0.5*0)+0.5*(54.53+0+86.74+0)
)=                                                          =   5.0084 MPa
```

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


UTILIZATION CHART - N.3 1/2" NPT
70
60
50
40
30
20
10
0
7% Min.Nozzle Thk.
65.5% Nozzle Reinforcement
Max.Utilization/Condition 65.5%