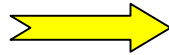
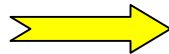


**Gas Composition**



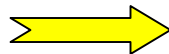
**Hydrogen Compatibility Test  
B1**

**Temperature**



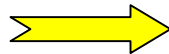
**Test Temperatures  
-40°C, 85°C/ 120°C in  
B5, B6, B7**

**NWP/ MAWP**



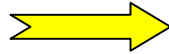
**???**

**Service Life/  
Cycles**



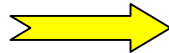
**Corrosion/ Endurance Test  
B3, B5  
Pressure Cycles ???**

**NWP/ MAWP**

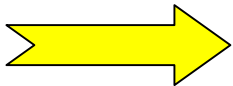


**Verification of safe function  
at NWP/ MAWP**

**Service Life/  
Cycles**



**Verification of suitability for  
Pressure Cycles**



**Correlation of NWP/ MAWP relative to burst pressure**  
**Small and local deformation  
under service conditions, only (shake down)**

**Calculational**

**Experimental**

**EN 12516-2**

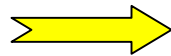
**Define qualified test plan**

**Safety margins individually  
defined depending on  
material and construction**

**Covers suitability for NWP/ MAWP  
and pressure cycles**

**NWP/ MAWP**

**Burst Test**



**ASME Sec. VIII, Div. 1, UG 101**

**For components where the strength cannot be computed by formulae**

**Based on component yield**

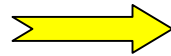
**Minimum wall thickness**

**Factor  $\geq 4$**

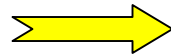
**$(4 R_{p \text{ act}} / R_{p \text{ spec}})$**

**NWP/ MAWP**

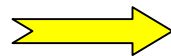
**Why 4?**



**Consider tolerances for  
manufacturing process**



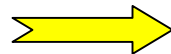
**Consider bending moments**



**Consider service life/ cycles**

**Service life/ cycles**

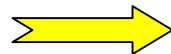
**Cycle Test**



**Change B5 (Endurance test)**

**Include pressure cycles  
during duty cycles**

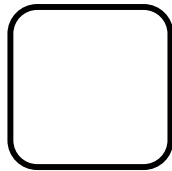
**OR**



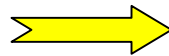
**B4 (Pressure cycle test)  
for all components**

## Service life/ cycles

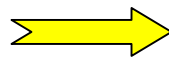
**Example**



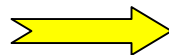
rectangular steel tube  
180 mm x 6 mm  
S3551RG3:  $R_p$  355 Mpa,  $R_m$  490 MPa



**Burst pressure: 95 bar**



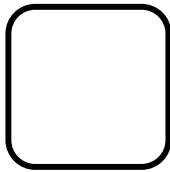
**MAWP: 8,5 bar**



**Stresses at 8,5 bar in the angle:  
 $\sigma_{tot} = 286$  MPa**



## Service life/ cycles



rectangular steel tube  
180 mm x 6 mm  
S3551RG3:  $R_p$  355 Mpa,  $R_m$  490 MPa

### Number of Cycles N:

$N = 94.000$  for MAWP 8,5 bar

$N = 6.600$  for MAWP 19 bar  
( $p_{burst} / 5$ )

$N = 1.000$  for MAWP 32 bar  
( $p_{burst} / 3$ )

**Note:** probability of failure is 0,1% for N cycles  
probability of failure is **50%** for 10 x N cycles