ASSESSMENT OF PITTING CORROSION

Pitting is defined as localized regions of metal loss that can be characterized by a pit diameter on the order of the plate thickness or less, and a pit depth that is less than the plate thickness. Pitting Corrosion consist of both widespread and localized pitting in a component with or without a region of local metal loss.

Four Types of Pitting Corrosion

- Widely scattered pitting that occurs over a significant region of the component
- Local thin area (LTA) located in a region of widely scattered pitting
- Localized regions of pitting
- Pitting confined within a region of a LTA

Applicability of the Level Assessment Procedures

- The original design criteria were in accordance with a recognized code or standard
- The material is considered to have sufficient material toughness.
- The component is not in cyclic service.
- Type A Components (see Part 4, paragraph 4.2.5) subject to internal pressure.
- The pitting corrosion is located on only one surface of the component, i.e. inside or outside diameter.
- The pitting corrosion is composed of many pits; individual pits or isolated pairs of pits should be evaluated as LTAs using the assessment procedures in Part 5.
- For a Level 1 Assessment, the pitting corrosion is arrested.

Required Data/Measurements for a FFS Assessment

- Level 1 Assessment, a measure of the surface damage in terms of pitted area and the maximum pit depth are used to quantify the extent of pitting corrosion.
- The depth of a pit should be carefully measured because of the variety of pit types that can occur in service.
- The measure of surface area damage is determined using standard pit charts by comparing the actual damage on the component to the damage represented on the pit chart (see Figures 6.6 through 6.13).
- A pit chart is found by comparing the surface damage (black areas) to the surface damage on the actual component. This chart along with an estimate of the corresponding maximum pit depth is used to directly determine acceptability.
- Therefore, the data required for an assessment should include a photograph (with a reference scale) and/or rubbing of the surface of the damaged component with an estimate of the maximum pit depth.
- A cross-sectional UT thickness scan can also be performed to determine the pitting profile.

Assessment Techniques and Acceptance Criteria

- If the depth of all of the pits is less than the specified corrosion/erosion allowance and adequate thickness is available for future pitting corrosion no further action is required other than to record the data; otherwise, an assessment is required.
- Level 1 Assessments are limited to Type A components with one-sided, widespread pitting corrosion that are designed to a recognized code or standard. The only load considered is internal pressure.

Level 1 Assessment

- The Level 1 Assessment technique utilizes standard pit charts and the maximum pit depth in the area being evaluated to estimate a Remaining Strength Factor, *RSF* .
- The surface damage of the pitted region is characterized by making a visual comparison between the actual damage and a standard pit chart.
- Based on the pit chart that best approximates the present damage, the remaining strength factor can be determined using the measured maximum pit depth.

CALCULATION

- Design Conditions – 280 psi @700 Fahrenheit
- Inside Diameter – 120 inch
- Wall Thickness – 1.375 inch
- Uniform Metal Loss – 0.03 inch
- Future Corrosion Allowance – 0.06 inch
- Material – SA 285 Gr C
- Weld Joint Efficiency – 1.0
- Allowable Stress – 14300 psi
- There are no supplemental loads on the section.

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- Perform a Level 1 Assessment
- STEP 1 **-** Determine the following parameters: D, $T_{nom,}$ Loss, and FCA.
- D – 120 inch
- T_{Nom} - 1.375 inch
- Loss – 0.03 inch
- FCA – 0.06 inch
- STEP 2 - Determine the wall thickness to be used in the assessment
- **$T_c = T_{nom} – Loss – FCA$** = 1.375-0.03-0.06 = 1.285 inch
- STEP 3 **-** Locate the area on the component that has the highest density of pitting damage based on the number of pits. Get photograph to compare with Pitting Chart.
- STEP 4 - Determine the maximum pit depth W_{Max} in the region of pitting damage being evaluated.
- W_{Max} = 0.5528 inch

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- STEP 5 - Determine the ratio of the remaining wall thickness to the future wall thickness in the pitted region.
- **$R_{wt} = T_{rd} - W_{max} / T_C$**
- Where
- **$T_{rd} = T_{Nom} - Loss$** = 1.375 – 0.03 = 1.345 inch
- R_{wt} = (1.345- 0.5528)/1.285 = 0.616 ≈ 0.6 approx.
- **$T_{mm} = T_{rd} - W_{max}$** = 1.345 -0.5528 = 0.7922 inch > 0.1 inch for Vessels
- If the T_{mm} criterion is satisfied and $R_{wt} \geq 0.2$
- Both criteria satisfied.

- STEP 6 - Determine the *MAWP* for the component.
- R = D/2 = 120/2 = 60 inch
- Radius to be used in Calculation is R_C **= R + Loss + FCA**
- = 60 + 0.03 +0.06
- = 60.09 inch
- **$MAWP = (S*E*T_C) / (R_C + 0.6 * T_C)$**
- = (14300 * 1* 1.285) / (60.09 + 0.6 *1.285)
- = 301.92 psi ≈ 302 psi approx.

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STEP 7 – Compare the surface damage from the photographs or rubbings to the standard pit charts shown in Figures 6.6 through 6.13. Select a pit chart that has a measure of surface damage that approximates the actual damage on the component.

STEP 8 – Determine the *RSF* from the table shown at the bottom of the pit chart that was chosen in STEP 7 using the value of $R_{wt.}$

$RSF = 0.93 \geq RSF_a\ (0.9)$

STEP 9 - Since the ***RSF ≥ RSF$_a$***, then the pitting damage is acceptable for operation at the MAWP determined in STEP 6.

The Design Pressure is 280 psi, and the MAWP = 302 *psi.T*herefore, the vessel passes the Level 1 assessment and is acceptable for the design pressure.

Pitting Chart - Grade 3	
R_{wt}	Level 1 RSF - Cylinder
0.8	0.96
0.6	0.93
0.4	0.89
0.2	0.86

Let See One another example with Pitting Chart Grade 6.

STEP 7 – Compare the surface damage from the photographs or rubbings to the standard pit charts shown in Figures 6.6 through 6.13. Select a pit chart that has a measure of surface damage that approximates the actual damage on the component

STEP 8 – Determine the *RSF* from the table shown at the bottom of the pit chart that was chosen in STEP 7 using the value of $R_{wt.}$

RSF = 0.82 < RSFa *(0.9)*

STEP 9 - Since the ***RSF < RSF_a***, then the pitting damage is not acceptable for operation at the MAWP determined in STEP 6.

Calculate the $MAWP_r$ as applicable using the equations below.

$MAWP_r$ = MAWP (RSF/RSF_a)

= 302 *(0.82 * 0.9) = 275.15 psi.

The Design Pressure is 280 psi, and the MAWP = 275.15 *psi.T*herefore, the vessel fails the Level 1 assessment and is not acceptable for the design pressure.

Pitting Chart - Grade 6	
R_{wt}	Level 1 RSF - Cylinder
0.8	0.91
0.6	0.82
0.4	0.73
0.2	0.64