API 579 - LOCAL METAL LOSS AND PITTING CORROSION ASSESSMENT COMPARISON

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INTRODUCTION

Fitness for Service (FFS) is an engineering practice to assess the pressure equipment with damage or defect. FFS is often performed on in-service equipment to clearly understand the condition of the asset and determine a course of future actions. API 579/ASME FFS is an industry recognized code used for FFS assessment.

Metal loss resulted due to either corrosion, erosion and mechanical damage is common type of defect that often require FFS assessment. If the metal loss is locally concentrated, API 579 Part 5 for Local Metal Loss and API 579 Part 6 for Pitting Corrosion is used for the assessment.

Figure 1. External Pitting Corrosion

Pitting corrosion 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.[1] Pitting with higher grade and intensity or larger pit diameter maybe classified as Local Metal Loss and maybe assessed using API 579 Part 5.

This article compares Level 1 Assessment of Part 5 and Part 6. Relationship between size of the defect, radius of the pressure equipment, and the deviation between the acceptance criteria of each assessment are determined.

METHODOLOGY

Variable inputs required for API 579 Part 5 and Part 6 Level 1 Assessments are listed as below:

- Outer diameter of the equipment
- Nominal wall thickness
- Measured wall thickness of the equipment
- Corrosion Allowance
- MAWP (Maximum Allowable Working Pressure)
- Flaw characteristic (Longitudinal and circumferential length)

The output of API 579 Part 5 and Part 6 Level 1 Assessment is RSF (remaining strength factor). If the computed RSF is lower than RSFa (Allowable remaining strength factor) of 0.90, the assessment fails and requires a repair, change in operating conditions or a Level 2 Assessment.

With outer diameter, nominal wall thickness, corrosion allowance and MAWP as controlled variables, the measured wall thickness required for RSF to equal RSFa at varying longitudinal flaw length were computed using Part 5 and Part 6 Level 1 Assessment. These data were plotted on a smooth line graph.
The procedure was repeated for varying outer diameter of the pipe with constant MAWP and nominal wall thickness. NPS 4 and NPS 24 was chosen.

RESULTS

In Figure 1 and Figure 2, the smooth curve plots indicate the measure wall thickness and longitudinal length of the defect at RSF = 0.90. The area below smooth curve plots have RSF lower than 0.90 and fails Part 5 or Part 6 Level 1 Assessment. The area above smooth curve plots have RSF higher than 0.90 and passes Part 5 or Part 6 Level 1 Assessment.

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ABSTRACT:
Two commonly assessed defects, Local Metal Loss (API 579 Part 5) and Pitting Corrosion (API 579 Part 6) are compared in this report. Pitting with higher grade and intensity or larger pit diameter are often classified as Local Metal Loss and maybe assessed using API 579 Part 5. Acceptance criteria of API 579 Part 5 and Part 6 Level 1 assessments are plotted and analyzed for their sensitivity and standard deviation for assessment on small and large NPS pipe.

The result indicate that Part 6 Level 1 Assessment for pitting corrosion yields more conservative result than Part 5 Level 1 Assessment for both small and larger NPS piping. High standard deviation between Part 5 and Part 6 Level 1 Assessment was observed for defects of smaller longitudinal dimension.

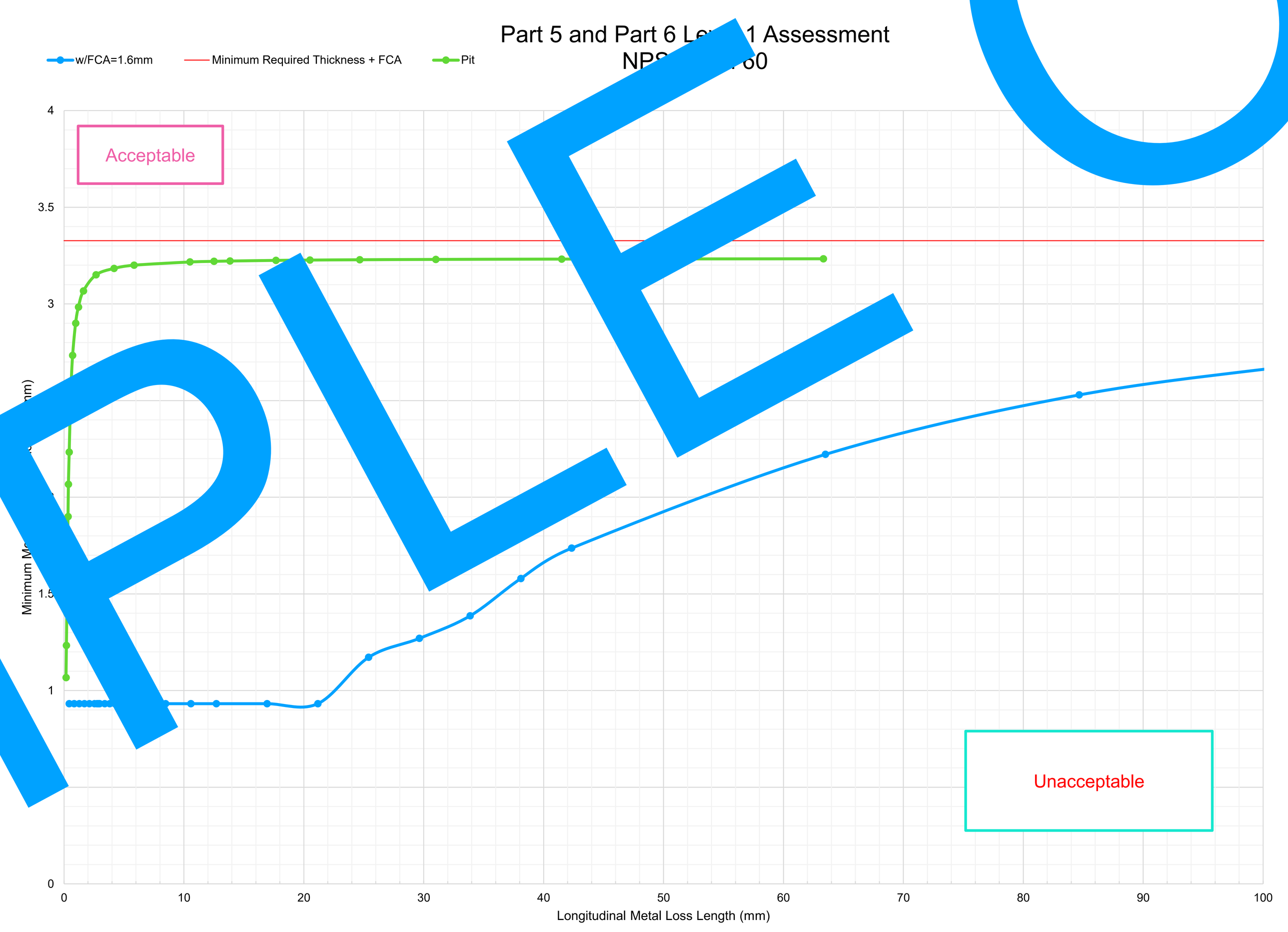

Figure 1. Acceptance Criteria of API 579 Part 5 and Part 6 Level 1 Assessment on NPS 4 pipe

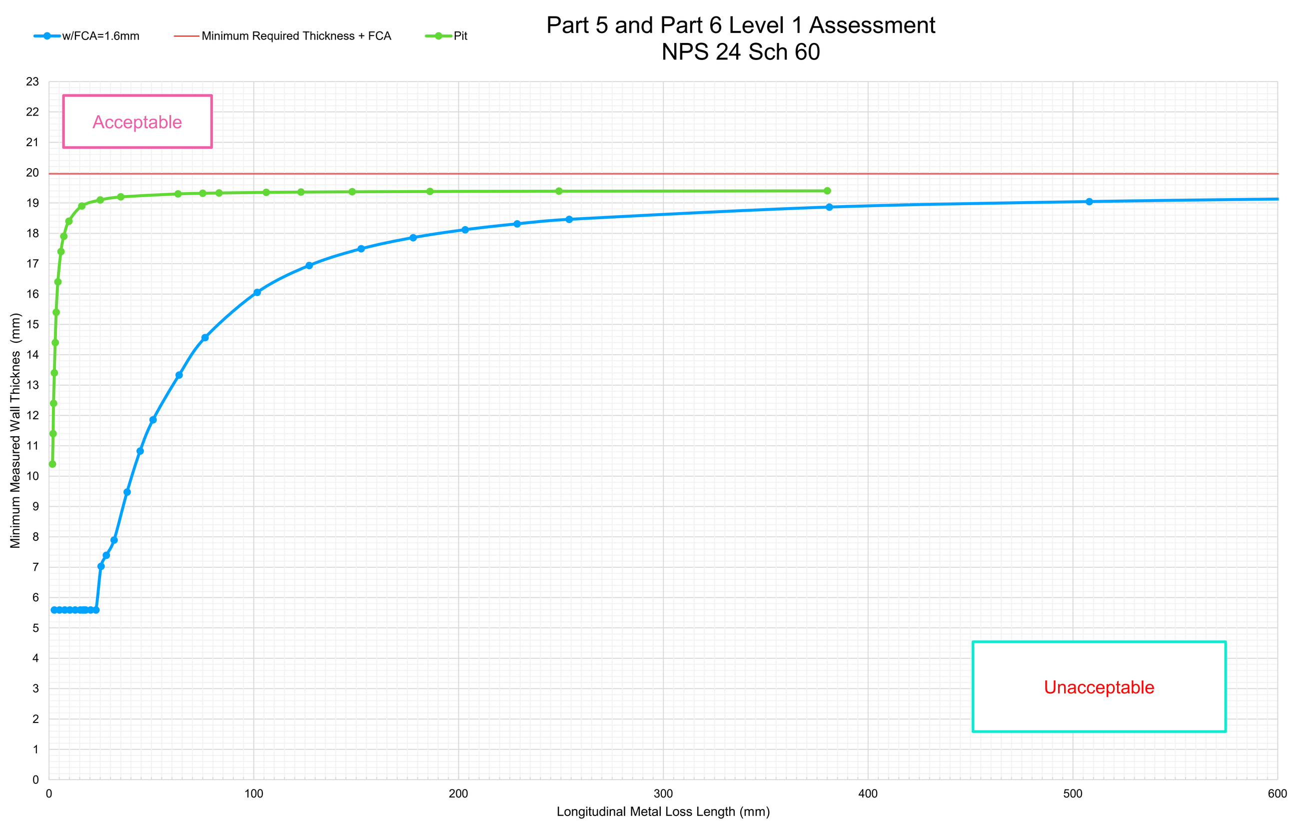

Figure 2. Acceptance Criteria of API 579 Part 5 and Part 6 Level 1 Assessment on NPS 24 pipe

DISCUSSION

Standard deviation between Part 5 and Part 6 were calculated for all effective pitting diameter, as restricted in Part 6 by RSF = 0.90.

NPS	Standard Deviation (σ)		
	Mean	Highest	Lowest
NPS 4	17.6	89.4	2.1
NPS 24	26.9	52.3	2.7

Table 1. Standard Deviation between API 579 Part 5 and Part 6 Assessment of NPS 4 and NPS 24 pipe

Size of the Defect (mm)		NPS 4	NPS 24
Pit Diameter Longitudinal Length of Metal Loss		21	68
Minimum Measured Thickness	Part 5, Local Metal Loss	3.2	19.3
	Part 6, Nominal Wall Thickness - Pit depth	0.8	5.8

Table 2. Size of the Defect at the Greatest Standard Deviation of Measured Wall Thickness between API 579 Part 5 and Part 6 Assessment on NPS 4 and NPS 24 pipe

Part 6 Assessment for pitting corrosion is dimed to be more conservative than Part 5 Level 1 Assessment. Part 6 Level 1 Assessment is more sensitive to the depth of the corrosion than Part 5 Level 1 Assessment. Thus, a metal loss is more likely to fail when assessed using Part 6 Level 1 assessment than when using Part 5 Level 1 Assessment.

For both NPS 4 and NPS 24, higher standard deviation is observed at the smaller longitudinal length of metal loss or pit diameter. The slope of Part 6 plot is steeper, reaching 90% of the maximum possible wall thickness at 10mm of the corrosion length for both NPS 4 and NPS 24 pipe. The slope of Part 5 plot reaches 90% of the maximum possible wall thickness at 300mm of the longitudinal defect length for NPS 24 pipe.

At the larger longitudinal length of metal loss or pit diameter, the standard deviation decreases, and both plots extents toward the minimum required wall thickness for the given MAWP. However, Part 5 plot of NPS 4 pipe does not reach 90% of the maximum possible wall thickness. The behaviour of the slope indicates that the pipes of smaller diameter are less tolerable to metal loss than pipes of larger diameter.

The average standard deviation is greater for the pipes of smaller NPS. Thus, when assessing pipe of small NPS, defect types must be explicitly distinguished to gain accurate assessment results.

CONCLUSIONS

The results conclude that Part 6 Level 1 Assessment for pitting corrosion yields more conservative result than Part 5 Level 1 Assessment for both small and larger NPS piping. High standard deviation between Part 5 and Part 6 Level 1 Assessment was observed for defects of smaller longitudinal dimension. The pipes of smaller NPS were found to have higher average standard deviation between Part 5 and Part 6 Assessment.

REFERENCES

[1] API 579, Fitness for Service (2016)
[2] ASME 31.3, Pressure Piping (2016)

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