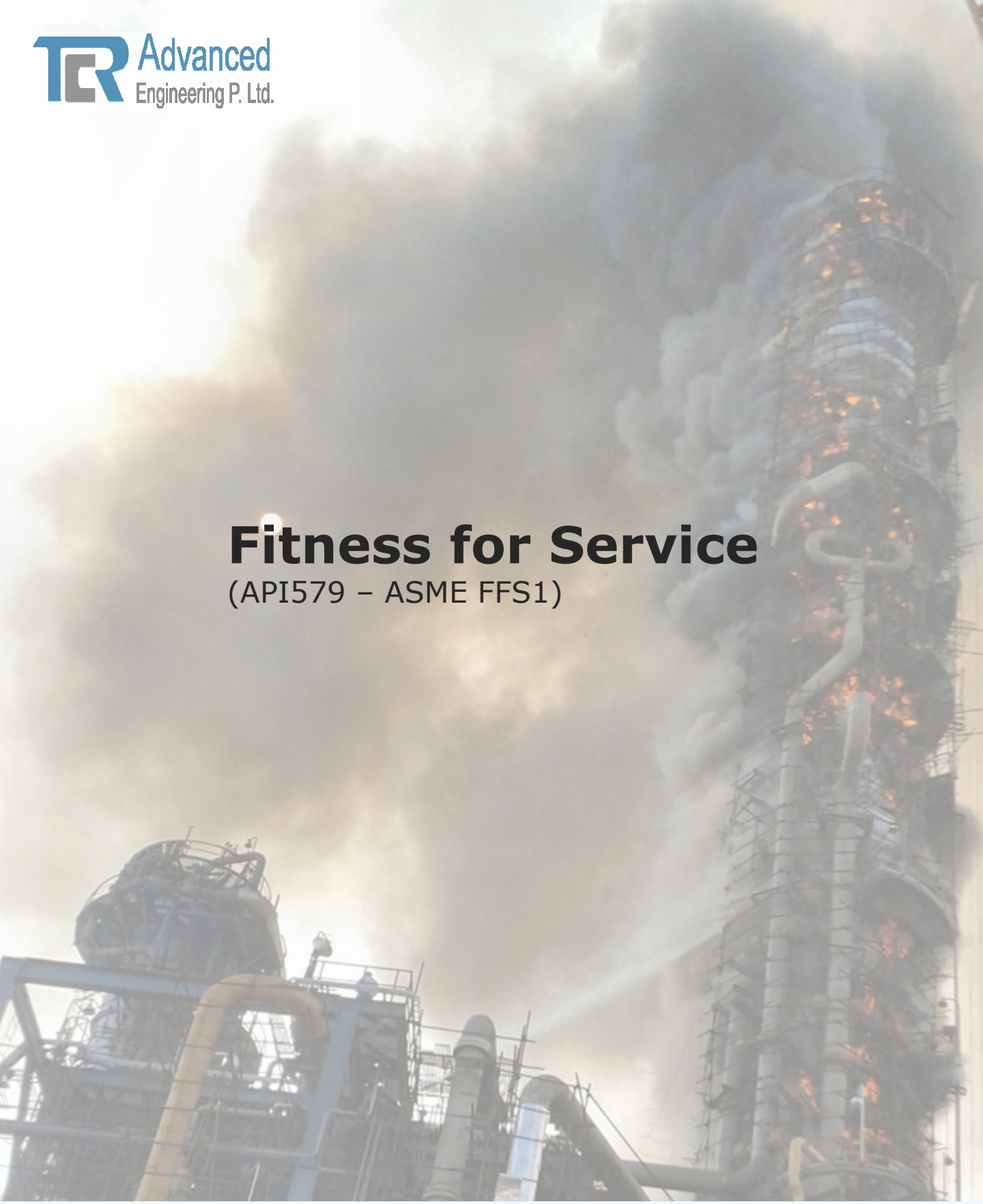
TCR Advanced Engineering P. Ltd.



Fitness for Service

(API579 – ASME FFS1)

TCR Advanced Engineering P. Ltd

A service partner company of TCR Engineering P. Ltd.

Why would you require FFS assessment?

Fitness-for-service ensures utilization of full potential concerning present damage assessment. It is required because the equipment has either seen some serious operational miss happenings or faced more severe conditions than the equipment was originally designed for. Besides, it may have flaws such as localized corrosion, cracks or unforeseen temperature shoot up in view of process overrun, fire like incident and other design limiting factors.

Steps involved:

The FFS procedures are complex and require state-of-the-art analytical, metallurgical, mechanical tests that involve multidisciplinary engineering analyses.

A combination of physical testing and interpretation thereof, identifies a principally affecting damage mechanism under the prevailing operating conditions. The test results further can be employed for theoretical calculation of component's fitness for prescribed design specifications.

Any irreversible damages to the equipment would call for alteration in original design and production specifications; for example- lower rate of production or reduced stress condition, as per the feasibility of running the equipment.

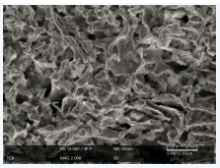
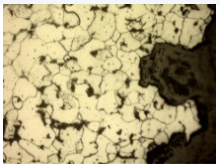
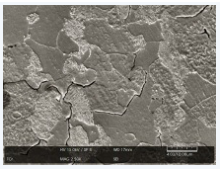
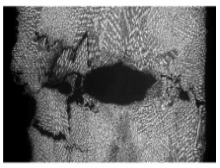
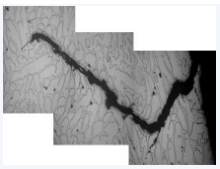
FFS deliverables

FFS report culminates having analysis providing solutions with expected returns on investments, safe and reliable continual operation. It points mechanisms highlighting probability of impending damages. FFS output helps in setting up proper inspection schedules, modified maintenance procedures and more of online monitoring systems. Deliverable includes judgment on whether (a) equipment is fit for service or not or (b) equipment is fit for service in de-rated design condition.

FFS team of experts at TCR:

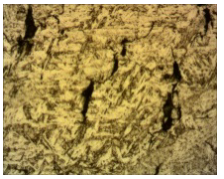
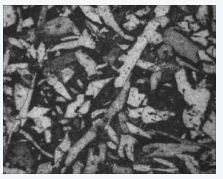
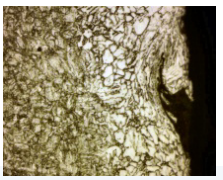
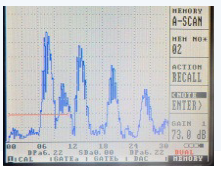
- ❑Specialist in failure investigation with more than 2000 root cause analyses
- ❑Specialist in corrosion with 30 years of experience in Fertilizer and Petrochemical industries
- ❑Specialist with inspection expertise of more then 35 years in refinery and petrochemical
- ❑Specialists in mechanical design and component integrity with 35+ years of experience
- ❑Specialists in foundry and steel making practice with 30+ years of experience
- ❑Specialists in metallurgical characterization
- ❑Specialist NDT expert ASNT level III (UT, PT, MP,VE,ECT,LT)

API 579 ASME FFS1: Part numbers and related damages

Assessment of metal loss	Thinning and metal loss are resulted from corrosion, erosion, or both corrosion and erosion, under deposit corrosion, corrosion under insulation. Thinning limits the structural strength and requires FFS assessment.	
Assessment of pitting corrosion	Pitting is metal loss associated with diameter of the order of the plate thickness or less. Continued pitting can result in puncture of section and requires FFS assessment.	
Assessment of hydrogen damage, HIC and SOHIC	Ferritic steel, pressure components operating at elevated temperature in H_2 service may get damaged by hydrogen attack where pearlite degradation and metallurgical degradation that requires FFS assessment.	
Assessment of weld misalignment and shell distortions	Weld misalignment can lead to shell distortion, out-of-roundness and bulges. Over a period internal locked up flaws such as porosity endanger the weld integrity. Result during manufacturing may require FFS assessment.	
Assessment of crack-like flaws	Internal crack like flaws at sites of pre-existing (minor) weld porosities or inclusions are not easier to rectify. Along with, in-service degradation of material would require FFS assessment for run/repair decision.	

Team efforts for engineering judgement

API 579 ASME FFS1: Part numbers and related damages

Assessment of components operating in the creep range	Metallurgical degradation because of elevated temperature exposure of pressure components undergo creep damage that requires remaining life assessment (RLA). For components with and without a crack-like flaw subject to steady state and cyclic operating conditions, the remaining life assessment would require FFS approach.	
Assessment of fire damage	Pressurized vessel, piping and tanks subjected to fire accident, either by flame impingement or radiant heat may undergo visually observable structural damage and degradation of mechanical and metallurgical properties, such as strength, ductility, and toughness ; that requires FFS assessment.	
Assessment of dents, gouges, and dent-gouge combinations	Pressure components containing dents, gouges, or dent-gouge combinations resulting from mechanical damage would produce localized stress concentration and becomes susceptible to crack initiation would require FFS assessment.	
Assessment of laminations	Refinery pressure equipment containing laminations are susceptible to HIC/SHOHIC and hydrogen blistering. Approach for FFS may be required to determine adequate strength of material with laminations for run / de-rate decision.	

Team efforts for engineering judgement

Reactor I Tank I Piping I Heat exchanger I Heater I Column I Spheres

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