

Materials and Fabrication Requirements for Carbon Steel Pressure Vessels in Petroleum Refining Wet H₂S Environments

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Foreword

Many petroleum refining and oil and gas production services contain liquid water and hydrogen sulfide (H₂S). Depending on the H₂S concentration and various other process conditions, the following damage mechanisms can become active:

- a) Sulfide stress cracking (SSC) of carbon steel welds or base materials that exceed certain strength or hardness levels
- b) Blistering
- c) Hydrogen Induced Cracking (HIC)
- d) Stress-oriented Hydrogen Induced Cracking (SOHIC)

Complementary AMPP standards with which this document is intended to comply, and which are referenced in specific sections, include:

- 1) ANSI/NACE MR0103/ISO 17945, "Petroleum, Petrochemical, and Natural Gas Industries – Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments"
- 2) NACE SP0472, "Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments."

ANSI/NACE MR0103/ISO 17945 provides product form heat treating requirements and hardness limits for preventing SSC in numerous alloys, but its scope does not address blistering, HIC, or SOHIC. NACE SP0472 provides guidance on controls to prevent hydrogen stress cracking (including SSC) and alkane cracking mechanisms at carbon steel (CS) weldments.

Many practices discussed in the precursor to this standard, NACE Publication 8X194, were identified through informal industry surveys of petroleum refiners, process licensors, and engineering contractors conducted in 1991 by NACE Work Group (WG) T-8-16g and in 2004 by NACE Task Group (TG) 301. This information has been supplemented by the experiences of the work group and task group members and their colleagues and other industry publications like EEMUA Publication 179. The first edition of NACE Publication 8X194 was issued in June 1994, and a revision was issued in December 2006. TCRs are more tutorial in format, and present numerous options and experiences, and therefore are not intended to provide recommendations. The intent of issuing this document as an SP is to provide a tool for the procurement and fabrication of new equipment for petroleum refining wet H₂S services. The requirements outlined in the main body of the SP are in a specification format to allow direct use as a standard specification by users/owners.

Although this SP is specific to wet H₂S services, the requirements outlined herein may also be applicable to other hydrogen charging services (e.g., hydrofluoric acid services). It is then the owner's responsibility to define which specific requirements they will apply to these other hydrogen charging environments and the additional requirements for these other services.

Scope

This AMPP standard defines standard practices for new carbon steel (CS) pressure vessels to be used in petroleum refining wet hydrogen sulfide (H₂S)-containing environments, with the recommended steps for resisting the damage mechanisms listed below. It covers materials, welding, testing, and other fabrication requirements. It is intended to be used by refiners, equipment fabricators, engineering contractors, and construction contractors.

Rationale

This Standard Practice (SP) was developed as a result of a previous Technical Committee Report (TCR), NACE Publication 8X194, which was titled "Materials and Fabrication Practices for New Pressure Vessels Used in Wet H₂S Refinery Service." The objective of that TCR was to provide a state-of-the-art overview of the options for materials selection, fabrication, post-weld heat treatment (PWHT), inspection, and testing practices that have been applied to new pressure vessels (referred to in this document as equipment) intended for use in wet H₂S refinery service.