gate is slid open), as did the photos taken on-site in Houston, TX at Z&J. The report from Z&J also indicated erosion of the spent slide valve; therefore, from the evidences found it is logical to assume that deficiencies found in the spent slide valve attributed to the incident that occurred on 4/26/18 in which circumstances were right for a reversal situation, in which air was able to get into the reactor from the regenerator. Internal wear of the slide valve potentially allowed catalyst to flow through the valve even though the valve was in a closed position, thus removing the protective catalyst barrier seal.

The Z&J Clearance Inspection Report – (Superior Spent Slide Valve 235726888_1; PMI Inspection Report - Superior Spent Slide Valve 235726942_1), dated July 20, 2018, indicated the following based on the HRT review of the information provided:

(b)(4) [redacted]

Photos of the spent slide valve, taken by the refinery when the valve was removed on-site in Superior, showed significant erosion to the gate seat at both sides of the leading edges (i.e., edges first exposed when the gate is slid open), as did the photos taken on-site in Houston, TX at Zimmermann & Jensen (Z&J) Engineering. The Clearance report from Z&J also indicated erosion of the spent slide valve; therefore, from the evidences found it logical to assume that deficiencies found in the spent slide valve attributed to the incident that occurred on 4/26/18 in which circumstances were right for a reversal situation in which air was able to get into the reactor.

Despite the identified erosion of the spent slide valves in the 2008 and 2013 turnarounds; the employer continued the same 5-year repair and/or replacement frequency. Additionally, the refinery did not follow their own written PSM Policy and Procedure, ADM-0010, Mechanical Integrity (SUPERIOR005277), (b)(4) [redacted] which requires a fitness-for-service analysis per API Standard 579-1/ASME FFS-1, Fitness-For-Service (2016); this assessment indicates methods that should have been followed for erosion damage to the spent slide valve gate and gate seat ring (see specifically Figure 2.1 - FFS Assessment Procedures for Various Damage Classes) prior to commencement and continued use of the spent slide valve put in during the last turnaround in 2013. See programmatic information below. The employer should have determined the need to increase frequency of inspections as well as the need to decrease the duration of time in which the spent slide valve was being utilized; therefore, potentially increasing replacement on the spent slide valve to less than the determined 5 years.

Incident information related to the spent slide valve and its use:

It was indicated based on documentation and interviews that factors leading up to the incident that occurred on 4/26/18, in which the primary and sponge absorber blew up, was related to a reversal situation due to loss of the catalyst barrier. Documentation showed the spent catalyst slide valve had severe erosion which could have contributed to the loss of catalyst barrier above the spent catalyst slide valve in the reactor stripper, and/or the catalyst was dumped prematurely due to confusion in the new operating procedure (OPP0563), see below. With no catalyst above the spent catalyst slide valve a reversal situation in which air was able to get into the reactor from the regenerator (differential pressure was not maintained, there was higher pressure in the regenerator and lower pressure in the reactor) occurred; moreover, the main auxiliary air blower and one compressor was running at the time of the incident. This allowed air to travel from the regenerator to the reactor into the main column (as the blind had not yet been installed) eventually ending up in the primary and sponge absorber, finding an ignition source along the way. DCS data showed the spent slide valve was in the closed position.

A known potential ignition source found in the FCCU equipment could have been iron sulfide. Iron sulfide has pyrophoric properties and can ignite spontaneously when exposed to air. It was noted in the V8 Scale Analysis (Vessel V8 Scale Analysis Results 235953800_1 (2)) that, "(b)(4) [redacted] (dated September 12, 2018)