Kern Oil & Refining Co.
Incident Investigation of the
January 18, 2018 KHT Charge Heater Fire

1 BACKGROUND

1.1 Introduction and Overview

On January 18, 2018, just after 9:00 p.m., a heater tube in the radiant section of the Kern Oil & Refining Co.'s (Refinery's) Kerosene Hydrotreater ("KHT") Charge Heater failed ("Incident"), releasing naphtha and vacuum gas oil ("VGO") range feed into the heater, resulting in immediate ignition and fire. The fire was extinguished within one hour and 18 minutes. No reportable substances were released to atmosphere, and there were no off-site impact or injuries as a result of the Incident.

Response Actions: The Refinery's Operators and Shift Supervisor immediately took response actions, including shutting down the KHT and later the Platformer. Personnel assumed their emergency response duties to secure the unit, removed fuel gas from the heater, eliminated charge to the unit, and shut down/blocked in pumps and compressors.

During the fire, operators activated fire monitors and pointed them towards the heater. Once they were able, additional personnel took action to control the fire by applying snuffing steam to the heater firebox, and confirming operation of the emergency firewater engine for boosting pressure to the system.

Agency Notification and Response: The Kern County Fire Department ("KCFD") arrived at 9:10 p.m., and remained onsite for precautionary monitoring. Kern County Environmental Health Department also responded to the Incident.

1.2 Investigation Team Composition

The Incident investigation was initiated on January 19, 2018, at approximately 8:30 a.m. Investigation team members included representatives from Kern's Safety, Engineering, Operations, and Maintenance departments.

1.3 Root Cause Analysis Methodology and Materials Reviewed

The investigation team applied a Root Cause methodology. In connection with its investigation, the team reviewed the KHT Unit 2018 Damage Mechanism Review ("DMR") Report, KHT Unit 2018 Hazard Controls Analysis ("HCA") Report, and the November 8, 2016 KHT Process Hazards Analysis ("PHA").

2 ROOT CAUSE ANALYSIS, CONCLUSIONS, AND RECOMMENDATIONS

2.1 Analysis and Findings

Metallurgical failure analysis of a KHT heater tube indicated internal sulfidation, carburization, and oxidation, which led to high temperature creep and stress rupture. An in-service infrared ("IR") tube scan of coked sections of the Charge Heater showed skin temperatures in the radiant section were consistently approximately 1,200 °F, which was above recommended the KHT heater tube design maximum tube wall temperature of 804 °F. Charge Heater ultrasonic testing ("UT") data also showed variations in loss of wall thickness and increasing high corrosion rates.

2.2 Conclusion and Root Causes

The KHT tube failure was caused by progressive creep due to high temperature exposure, which initiated at the inside diameter tube surface. There were no injuries, illnesses, or fatalities associated with the Incident. The investigation team identified aspects of the Refinery's preventative maintenance program as a root cause of the incident and an improvement opportunity. Specifically, the team recommended that the Refinery enhance method(s) to detect and correct tube overheating and tube decoking.

2.3 Interim Measures and Recommendations

Interim Measures: Heater repairs were completed. This work included installation of in-kind replacement tubing and instrumentation. New radiant and convection section tubes were also installed. All peripheral heater equipment and controls were inspected and repaired / replaced as needed.

Recommendations:

- Review KHT UT program's short and long-term corrosion rates with special emphasis on locations where more severe corrosion may occur; perform targeted UT inspections during planned unit shutdowns. [Completed on June 19, 2018]

- Establish a KHT decoking program to prevent tube temperature excursions above 1,000 °F. [Completed on June 19, 2018]

- Confirm that KHT tube remaining life calculations are based on most severe short or long-term corrosion rates and Rupture Allowable Stresses per American Petroleum Institute ("API") Standard 530. [Completed on June 19, 2018]

- Consider installing tubeskin thermocouples to detect localized temperature excursions or develop a temperature monitoring program to include periodic analysis intervals to help support timely execution of corrective actions. Kern installed tubeskin thermocouples on the KHT Charge Heater tubes [Completed on June 19, 2018].