



Valero Benicia Refinery

December 11, 2021 FCC Startup Release Root Cause Analysis

Report Completion Date: February 7, 2022

I. OVERVIEW

On the morning of December 11, 2021 while in the process of restarting the Fluid Catalytic Cracking (FCC) unit following maintenance activities (Turnaround), a block valve began to leak. The valve is on a line supplying vacuum gas oil feed to the preheat furnace that was installed as part of an energy recovery project installed in 2008. The refinery immediately isolated the line and the leaking valve was removed from service.

Valero promptly convened an investigation team to identify the cause of the incident and determined there were two causes that contributed to the event:

1. Internal gasket damage that was discovered when a third-party valve was disassembled.
2. Overpressure protection for the piping system was inadequate, as the operating procedure did not specify time-sensitive steps which led to a pressure increase from thermal expansion.

II. RESPONSE ACTIONS

Consistent with the Company's commitment to transparency, Valero made the required and courtesy notifications to relevant agencies in connection with the Incident, including the City of Benicia, Solano County CUPA, Bay Area Air Quality Management District (BAAQMD) and the California Office of Emergency Services (CA OES). In response, the City of Benicia issued a Level 2 public notification.

Community air monitoring was conducted by Valero using portable equipment and did not detect any readings for hydrogen sulfide (H₂S) or hydrocarbons. Additionally, Valero's fence-line monitoring system continued to measure Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) below the method detection limit (MDL) and sulfur dioxide was detected in the parts per billion (ppb) level but well below the reference exposure level (REL).

Based on the results of the investigation, Valero has kept the system out of service until a review of the overpressure protection can be completed and recommendations from that analysis are implemented.

III. INVESTIGATION METHOD AND TEAM

On December 13, 2021, Valero convened a team to investigate the root cause of the Incident using a casual analysis method consistent with applicable state and federal

regulations and the refinery's incident investigation reporting procedures. The investigation team included refinery personnel with expertise in mechanical engineering, operations, process engineering, process safety management and environmental. The team reviewed materials in connection with the incident, including, but not limited to: process data, management of change (MOC) documentation, unit process hazard analysis (PHA) information, operating procedures, inspection/maintenance records, valve manufacturer QA/QC procedures.

IV. PROCESS OVERVIEW

The refinery uses a Fluid Catalytic Cracker Unit (FCCU) to upgrade heavy oils and convert them into gasoline and diesel fuel using a catalytic cracking process. The unit requires a preheat furnace to heat the feed up to the temperature required for the catalytic reaction to occur. After vacuum gas oil feed was introduced and the unit was at the proper operating temperature, the line supplying feed to the preheat furnace for energy recovery was put into service and subsequently developed a leak.

V. CAUSAL ANALYSIS

First contributing cause – gasket damage: From the valve disassembly photographs, the valve bonnet gasket showed signs of damage. The exact reason for the damage could not be determined but could have been from an incorrect gasket size or misalignment from third-party manufacturing of the valve.

Second contributing cause – inadequate overpressure protection: The energy recovery project installed in 2008 determined that over-pressure protection was not required on this piping system. The project determined that the only scenario of over-pressure would occur during a maintenance activity and could be properly managed by operating procedures. The operating procedure did not state time sensitivity while the valve was closed which allowed the liquid to thermally expand and the resulting leak at the damaged gasket occurred.

VI. FINDINGS AND RECOMMENDATIONS

December 11, 2021 FCC Startup Release: Findings and Recommendations			
Ref	Finding	Recommendation	Target Date
1	Internal bonnet gasket damage	Review on-site valve bonnet assembly practices and implementation of current piping flange assembly practices for valve bonnets	September 30, 2022
2a	Overpressure protection for the piping system was inadequate	Consider design of a safety relief system to provide over-pressure protection for the piping system	July 30, 2022
2b		Review of additional over-pressurization scenarios with all piping systems installed from the 2008 FCC Energy Recovery Project	July 30, 2022
2c	The operating procedure did not specify time-sensitive steps which led to a pressure increase from thermal expansion	Following completion of 2a, review operating procedures associated with the FCC Energy Recovery Project from 2008 for thermal relief requirements, and make necessary updates to ensure over-pressure protection is addressed	December 30, 2022