

INVESTIGATION REPORT

August 13, 2012

Shell Oil Products US Martinez, California Refinery Fire at Hydrocracker J-97 Hydrogen Compressor

EXECUTIVE SUMMARY

This report documents the investigation team findings and mitigation recommendations regarding the incident at Shell Oil Products US's Martinez, California Refinery (Shell) in which a fire occurred at the J-97 Hydrogen Compressor in the Hydrocracker unit.

The fire resulted in equipment damage and temporary shutdown of the 1st stage hydrocracker unit.

The investigation process began the same day the incident occurred, August 13, 2012. Interviews and pictures were obtained to preserve evidence.

The investigation team included an experienced RCA facilitator/team leader and an Operations team leader for the Hydrocracker unit. The team was chartered with identifying the mechanism(s) that led to the fire. This included identifying the functional causes of the fire and Human Factors, Latent Conditions or Management Systems as causal factors.

The team concluded that the cause of the event was ignition of lubricating oil on the turbine case or 650 psig steam line. The oil escaped from the turbine bearing seals after the gravity drain from the turbine to the oil reservoir became restricted. The restriction was caused by overfill of the reservoir, which occurred when the manual reservoir filling valve was left open.

This report is based on information available to the team at the time of the investigation. The times and quantities referenced in this report are approximations, and are based on a variety of information sources. All times are reported in a 24-hour format.

DESCRIPTION OF THE FACILITY/EQUIPMENT INVOLVED IN THE INCIDENT

The J-97 compressor provides high pressure hydrogen to the hydrocracker unit at the refinery. Lubrication oil is delivered to the compressor bearings from the lube oil reservoir via a pump. The oil is recovered and returned to the reservoir at atmospheric pressure through a gravity drain line. Due to normal oil consumption, the level in the reservoir will decrease over time. The rate of decrease varies depending on compressor and seal condition. Field operators check the oil level via a sight glass (also called a gauge glass). If the oil level is found to be lower than target, the operator will manually open a valve that allows oil from a central tank to flow into the reservoir. The valve is equipped with a spring return that closes when the operator is not holding it open. The reservoir is also equipped with a vapor vent that allows pressure to equalize between the reservoir and the atmosphere.

NARRATIVE TIMELINE

Up until the time of the incident, the hydrocracker unit and the J-97 compressor were running normally. At 13:58 on August 13, 2012, multiple common trouble alarms were received in the

Control Center from a local panel near the compressor. Operations personnel were notified of the alarm and went to the compressor deck to investigate the cause of the alarms. The responding operator found a fire at J-97 in progress. The Shell Emergency Response crew was called and a Level 2 Community Warning was issued. The fire was extinguished within approximately 10 minutes. No injuries were reported as a result of the fire. Within one minute of the first alarm, the automatic safety systems activated and shut down the compressor and the Hydrocracker processing unit.

The fire is most likely to have developed when Turbo 32 lubricating oil from the compressor contacted the hot case of the compressor or 650 psig steam line leading to the turbine, igniting the lubricating oil. These elements of the compressor are typically found at 700 degF, which is above the Turbo 32 auto-ignition temperature of 608 degF.

Although hydrogen is present at the compressor, it was ruled out as the initial fuel source because the compressor did not show signs of a hydrogen leak. Also the hydrogen would have been in vapor form, and the damage was not consistent with ignition of hydrogen. Other steam lines in the area were ruled out as the ignition heat sources because they do not operate at temperatures above the Turbo 32 oil auto-ignition temperature. The instrument panels in the area were examined and found to have external fire damage only, indicating that the source of ignition was not inside these panels.

The source of the oil was the compressor lubrication system. The lube oil reservoir fill valve has a spring return-to-close mechanism, but that device had been defeated so that the valve was in the open position. The open valve was left unattended while the reservoir was filling. The reservoir began to overflow out the vent valve on top of the reservoir, and then flowed to the ground. This created a pool of oil near the compressor, but is not believed to have ignited because there are no heat sources close enough to grade. After the initial fire broke out, this oil ignited and caused a secondary pool fire beneath the compressor.

Once the reservoir was full, the liquid flow out the vapor vent was less than the flow of oil being pumped to the compressor and returned in the gravity drain line. This created an imbalance in flows that resulted in buildup of oil inside the compressor. The excess lubricating oil escaped the compressor, most likely from the bearing seal at the end of the turbine shaft. A small section of shaft is exposed, and fire damage evidence suggests that the excess oil was sprayed by the rapidly rotating shaft onto the nearby case and 650 psig steam piping. The required oxygen, fuel and heat were all present at that point to start the fire.

ROOT CAUSE INVESTIGATION METHODOLOGY

Shell Oil Products US, Martinez Refinery used a Cause and Effect Analysis method to conduct the Root Cause Analysis (RCA) investigation. This method includes features that ‘test for cause’ and examine data quality. In addition, the team used the Latent Conditions checklist¹ as an aid to the investigation.

¹ Latent conditions are the hidden causes that may contribute to human errors. The Latent Conditions Checklist used is based upon the Contra Costa County Health Services Department Human Factors Program Guidance Document.

The investigation team conducted interviews, reviewed documentation, and visited the incident site as part of the investigation.

INCIDENT INVESTIGATION TEAM FINDINGS

Root Causes

The root cause of the incident is that the operator left the oil reservoir while it was filling, which led to overfilling the oil reservoir and restricting of the oil return line.

Contributing Causes

LCC-1: Workers understood the general hazards of materials and conditions, but were not aware that overfilling the lube oil reservoir could lead to a fire.

LCC-2: Some physical discomfort may be experienced while refilling the lube oil reservoir because the valve must be manually held in the open position for a variable amount of time, typically 30 seconds to 10 minutes. This discomfort may lead to operators using auxiliary means to keep the valve open, which negates the purpose of the spring return mechanism.

LCC-3: The system was not designed to include a liquid vent, only vapor vent. This contributed to a restriction, preventing lube oil from draining back to the reservoir, which allowed oil to escape at the compressor and ignite.

Recommendations

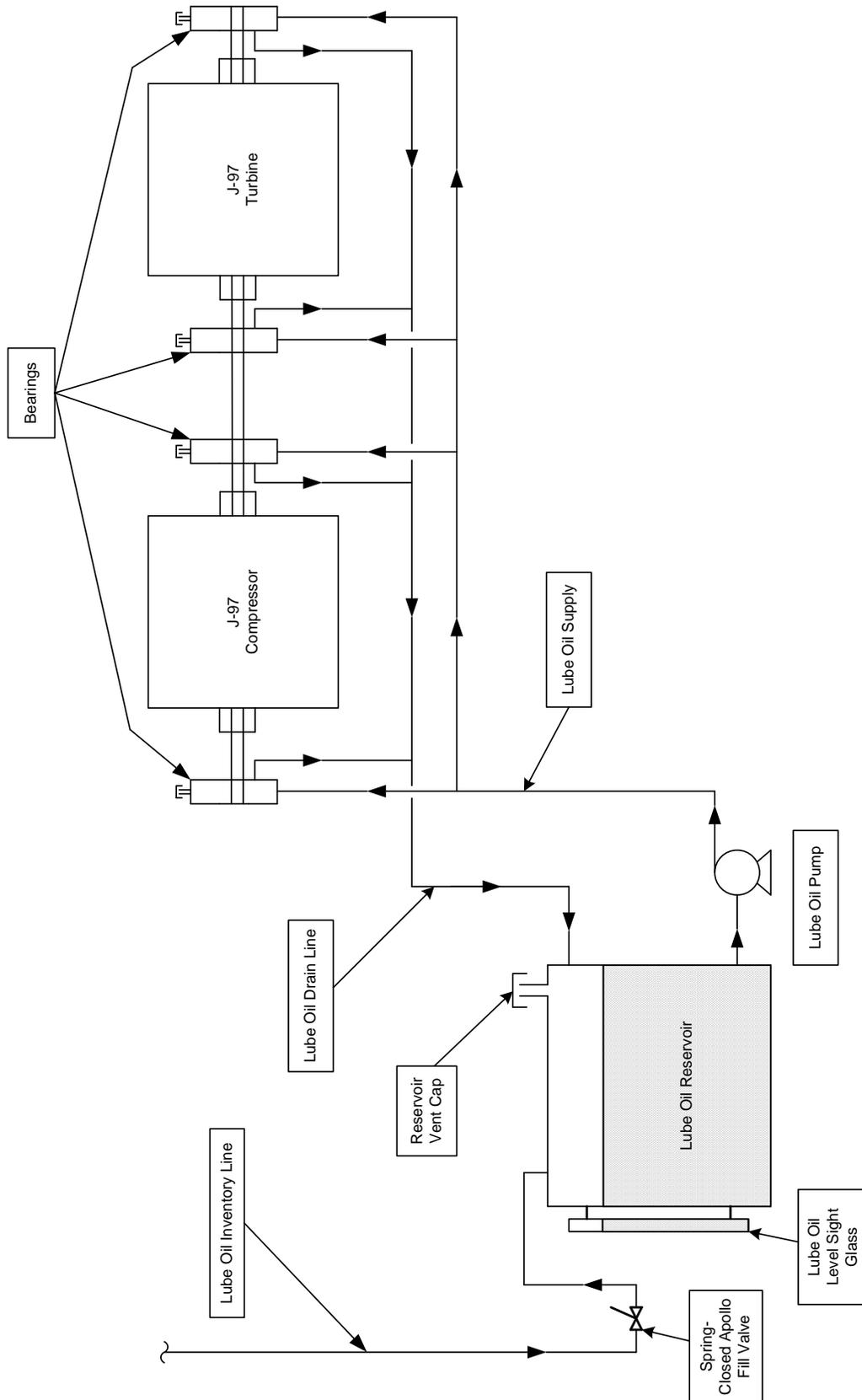
Cause	Recommendation	Responsible Manager or Individual	Estimated Completion
LCC-1	1. Provide awareness level training to Operations that describes this event and explains how overfilling a lube oil reservoir can lead to a fire.	Production Unit Manager	12/31/2012
LCC-2	2. Review ergonomics of the reservoir filling operation for opportunities to reduce discomfort on longer filling operations.	Production Unit Manager	6/30/2013
LCC-3	3. Review the reservoir design for the liquid overflow scenario. Consider design alternatives that allow excess liquid oil to overflow to a safer location instead of escaping at the compressor, or instrumentation or controls that would reduce the risk of overflow.	Production Unit Manager	6/30/2013

Attachments

A – J-97 Reservoir Diagram

B – Fault Analysis Diagram

Attachment A – J-97 Reservoir Diagram



Attachment B – Fault Analysis Diagram

