



**TESORO**

Tesoro Refining and Marketing Company LLC  
Martinez Refinery  
150 Solano Way  
Martinez CA 94553-1487

December 18, 2018

**Mr. Randy Sawyer**  
Director, Hazardous Materials Division  
Contra Costa Hazardous Materials Program  
4585 Pacheco Blvd.  
Martinez, CA 94553

Via email  
Original will follow in the mail.

**Subject: Root Cause Analysis Report for the July 19, 2018 3HDS Water Injection Piping Failure Vapor Release**

Dear Mr. Sawyer:

The Tesoro Refinery is submitting a Root Cause Analysis report for the July 19, 2018 3HDS Water Injection Piping Failure Release. This report is being submitted pursuant to 19 CCR § 2762.9(h).

If you have any questions regarding this report, please call me at (925) 370-3279 or Ms. Sabiha Gokcen at (925) 370-3620.

Sincerely,

**James Jeter**  
Environmental, Health and Safety Manager

Cc: Ms. Cho Nai Cheung  
Ms. Nicole Heath

**Root Cause Analysis Report  
Tesoro Martinez Refinery  
July 19, 2018 3HDS Water Injection Piping Failure Vapor Release**

Summary of Event:

On 7/19/2018 at around 6:04 am, a section of 4" piping associated with the 3 HDS Wash Water System ruptured on the fin fan deck. Check valves in multiple fin fan Wash Water injection lines failed to prevent reactor effluent from backflowing to the rupture site, resulting in a loss of containment. The release calculation determined 34.4 lbs. of Hydrogen Sulfide (H<sub>2</sub>S) were released in the first one-hour period, making this an API Tier 2 event. There were no injuries or illnesses from this incident and no fire occurred as a result of the release.

A brief timeline follows:

05:00 hrs: Outside Operator commences water wash operation for weekly water wash flush of exchanger E-5077 per operations procedure O-076-PR-OP-16.  
06:04 hrs: Water injection piping failure occurs; outside operator observes failure  
06:05 hrs: Board Operator initiates 3HDS unit emergency shutdown  
06:26 hrs: CWS notification level 0 sent for unplanned unit shutdown  
06:30 hrs: CCHSD calls to obtain additional information  
09:25 hrs: All Clear

Agency Notification and Response:

CWS notification level 0 sent for unplanned unit shutdown.

Emergency Response Actions:

Operations immediately responded to shutdown the unit. The emergency response team responded to isolate the piping system.

Material Released:

The material released was Hydrogen Sulfide. The release amount was estimated at 34.4 lbs in one hour (total 39.3 lbs). This event met the API Tier 2 criteria. In addition, 88.1 lbs of flammable gas was released within the first hour.

Meteorological Conditions:

The weather conditions were clear and dry on 7/19/18. The average wind speed and direction, during the event was 10 mph and 275 degrees respectively (wind direction primarily from the West). The temperature was about 58 degrees F.

Injuries:

No injuries or illnesses were reported on or off site.

Community Impact:

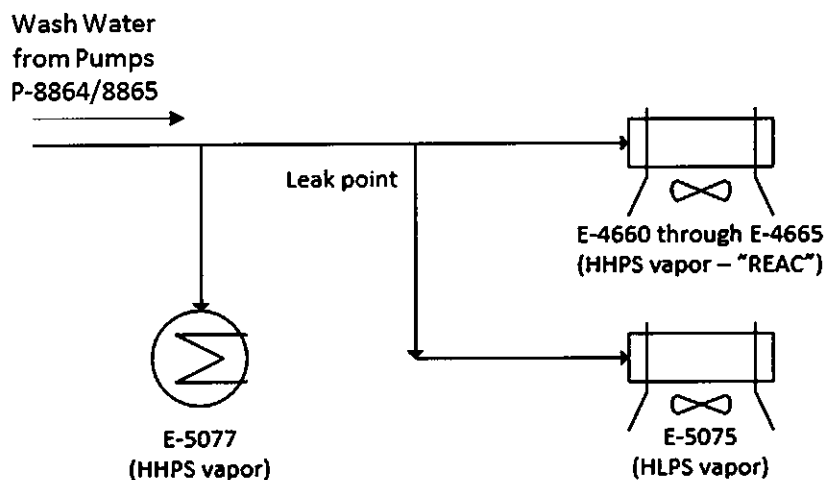
There was no community impact from this event.

Incident Investigation of the event:

This investigation focused on the loss of primary containment that occurred on the water injection piping at 3HDS.

Background:

3HDS is a high pressure gas oil hydrotreater operating at approximately 1750 psig on the high pressure separator loop. Ammonium bisulfide ( $\text{NH}_4\text{HS}$ ) and Ammonium Chloride ( $\text{NH}_4\text{Cl}$ ) salts are generated from the hydrotreating reaction. These salts can deposit on equipment, resulting in plugging and corrosion. To prevent this plugging, wash water is injected to dissolve the salts. Exchanger E-5077 (Effluent/Cold Recycle Gas Exchanger) and the Exchangers 4660-4665 (Hot High Pressure Separator (HHPS) Vapor Air Coolers, also known as REACs) have upgraded metallurgy to mitigate potential erosion/corrosion due to flow of dissolved salts. The Wash Water piping was made up of carbon steel.



Simplified process flow of Wash Water piping system

Demineralized water and clean condensate are supplied to 3HDS and pumped up to approximately 1850 psig. Wash water is typically injected at a rate of 95-115 GPM to the Reactor Effluent Air Coolers (REACs) and 20 GPM to Exchanger E-5075. Every week, water injection is routed to E-5077, which sits immediately upstream of the REACs. To obtain the needed pressure for water injection into E-5077, isolation of both the REACs and HLPS Air Coolers is required. This weekly intermittent water wash removes deposited salts from E-5077 and maintains heat transfer performance. Intermittent water washes

can occur more frequently if E-5077 exhibits signs of plugging. During the incident, operations was concluding the weekly intermittent water wash of E-5077 and restoring water flow to the REACs and E-5075.

The section of carbon steel piping that ruptured is part of the Wash Water system. The ruptured pipe was installed in 1999 during the installation of E-5075. The remainder of the piping consisted of original 1982 sections and sections replaced in 2005 due to fouling. Since installation and prior to failure, only the injection points were inspected routinely. No inspection was performed on the entire Wash Water piping.

#### 3HDS Water Injection Piping Failure Release:

The Wash Water pipe wall thinning was caused by accelerated corrosion due to Ammonium Bisulfide contacting the carbon steel Wash Water piping. Ammonium Bisulfide was present in the Wash Water piping due to periodic reverse flow of process gas into Wash Water piping due to reverse flow through the check valves and due to reliance on the check valves for isolation when performing water wash operations. During water wash operations, the pressure in the Wash Water header will be less than the pressure in the REACs. The system operated under these conditions during the execution of any of the following Operating Procedures: 1) weekly water wash (O-076-PR-OP-16), 2) Unit Shut-down (O-076-PR-SD-07), 3) Unit Start-up (O-076-PR-SU-08), and 4) Loss of Both Wash Water pumps (O-076-PR-EP-10). These operating conditions provided multiple opportunities for the process stream containing Ammonium Bisulfide to backflow and corrode the Wash Water piping.

The pipe wall thinning was not detected prior to this incident because the Wash Water piping was never inspected after it was installed in 1999. This pipe is classified as "Utilities" system by inspection. When the pipe was installed, it was not included within the scope of the inspection program because API 570 does not require inspection of water systems. In addition, the piping was not added to the inspection program because there was no prior indication of Ammonium Bisulfide corrosion found. In 2008, R&SI 14-3 "Mechanical Integrity" was revised to require utility systems within 'covered processes' be treated as process piping and inspected. However, an inspection plan was not established to achieve full compliance with R&SI 14-3 and the 3 HDS Wash Water System was not added to the inspection program.

Reverse flow through the check valves occurred due to the following reasons: 1) 9 of 12 3HDS Fin Fan Wash Water injection check valves are leaking by due to an unknown material condition issue, 2) leakage was not detected prior to this incident, and 3) a single check valve configuration was installed at the injection points.

9 of 12 check valves at Wash Water injection to REACs leaked by when they were tested in the field after this incident. These check valves had not been inspected since installation in 2006. Usually check valves are not routinely inspected and tested unless they are designated as Critical Check Valves (CCV). In 6/15/2011, R&SI 14-3-8, Martinez Critical Check Valves Rule & Standing Instruction was published to establish a refinery CCV program. In 2012, MOC 8922 was implemented to identify the CCV for 3HDS, but MOC 8922 did not include these 12 check valves to the program. In 2012, a corporate CCV standard TRS-660P5 was established that included expectations that PHA teams

determine if check valves should be added to the CCV list. In 7/16/2015, the 2015 3HDS PHA was completed, but the PHA did not identify/deliver a list of CCVs. The investigation team found that the 2015 PHA did not identify CCVs because the Corporate PHA Process governing document, PSM-005, does not reference TRS-660P5 nor require the team to identify CCVs. The check valves involved in this incident were added to the CCV program in March 2017 per MOC M2017705-001 (closed in January 2018) due to maintenance requesting process engineering to provide a list of CCVs as part of turnaround preparation. No major turnaround occurred between the time the involved check valves were added to the CCV list and when the Wash Water pipe ruptured, precluding identification of the inability of the check valves to perform their function.

The specific material condition issues limiting the check valves from preventing backflow are not known at this time. The check valve design limits the ability to perform non-destructive inspection tests of its internals. Per the results of the in-situ test, 9 of 12 check valves leaked indicating that they are in need of replacement. The corrective action plan includes replacing the check valves during the upcoming turnaround and conducting a failure analysis to determine the failure mode of the check valves.

The site has a standard (R&SI 8-22) for cross connections of utility/process systems. It requires that "all valves and material on the process side of the specification break conform to the material specification for the process piping." The cross connection installed on the discharge of the Wash Water pumps in 2006 per MOC 3329 did not meet the requirement to conform to the material specification for the process piping (Incoloy 825). R&SI 8-22 was already established when the check valves were installed in 2006.

This investigation reviewed the 3HDS Unit PHA, SPA, ISS/HCA Study and Corrosion Study (DMR) per CalARP requirements.

### **Root Causes:**

The causal analysis for this incident yielded the following root causes and corrective actions (see table):

**Root Cause #1:** Operating procedures placed the 3 HDS Wash Water System in multiple configurations where the pressure in affected portions of the Wash Water system was reduced to less than the reactor effluent stream pressure.

**Root Cause #2:** Pipe wall thinning at the rupture location was not detected because an inspection plan had not been established to achieve full compliance with requirements to inspect utilities systems. No indications of Ammonium Bisulfide corrosion within the 3HDS Wash Water system were found prior this incident.

**Root Cause #3:** PSM-005, Corporate PHA process governing document, and R&SI 14-4 "Process Hazards Analysis – Initial Unit / Revalidation" did not reference TRS-660P5 "Critical Check Valve Procedure" and did not require the PHA team to identify/validate the critical check valves (CCVs) when the 3HDS PHA was done in 2015. Therefore, these check valves were not identified as CCVs and inspected prior to this incident.

**Root Cause #4:** The Fin Fan Wash Water check valves may be in a degraded condition due to being used to isolate the system at least once a week during a routine water wash procedure. Check valves are designed to be used as safety devices and not block valves, which are used for isolation.

**Root Cause #5:** MOC 3329 (Wash Water Pipe 2005 Installation) did not completely follow the requirements established by R&SI 8-22 "Utilities-Process Systems Cross Connection" and D-50-1-138 "GER Engineering Standard Piping Anti-Backflow Device Installation Guide" for water cross-connect systems.

Corrective Actions:

	<b>Corrective Actions</b>	<b>Anticipated Date of Completion</b>	<b>Root Cause</b>	<b>ISS/HCA Level Strategy</b>
1	Publish revision to 76-OP-16 (Water Washing Effluent/Cold Recycle H2 E-5077) that: 1) Changes Step 6 to isolate 4" gate valve downstream of 4" check valve in HHPS Wash Water supply header; 2) Adds Step 7 to isolate E-5075 Wash Water to HLPS OVHD injection valves	Complete	1	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
2	Make the following operations procedure changes: A) Publish revision to Operating procedure 76-EP-10 (Loss of Both Wash Water Pumps) that: 1) Adds Step 2.1 to isolate 4" angle valve immediately after losing wash water flow; 2) Adds Step 5.1 and 5.2 to isolate (12) HHPS Wash Water Inlet Valves and (2) HLPS inlet valves if wash water cannot be restored B) Publish revision to 76-SD-07 (3HDS Unit Shutdown) that ensures 3HDS system is isolated from process piping whenever the WW pumps are secured. Check valves cannot be credited as providing system isolation. C) Publish revision to 76-SU-08 (3HDS Unit Start Up after emergency shutdown) that ensures 3HDS system is isolated from process piping whenever the WW pumps are secured. Check valves cannot be credited as providing system isolation	12/15/18	1	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
3	Add 3HDS Wash Water System to RBMI.	Complete	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
4	Performed Ultrasonic Testing on applicable portions of 1HDS, 2HDS, 4 HDS, 1st Stage HCU Wash Water System piping.	Complete	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate

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5	Added the following Hydrotreater Wash Water Systems to RBMI: 4HDS; 1HDS Discharge Side (Note: 1HDS Supply, 2HDS and 1st Stage HCU Wash Water Systems were in RBMI prior to the incident).	Complete	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
6	Develop and complete project to establish a utility system inspection plan that complies with R&SI 14-3 . Action item can be closed once the project has added to RBMI the utility systems that will be inspected.	12/15/2020	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
7	Execute notification 10088721 to replace elbow in 3HDS Wash Water System per Traveler PA076-011-18	12/15/18	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
8	Inspect 3HDS Wash Water System piping; apply data obtained to validate corrosion rate calculations.	2/28/19	2	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
9	Include malfunctioned CCVs as abnormal mode of operation in the MOC policy.	2/28/19	3	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
10	Publish revision to R&SI 14-4 "Process Hazards Analysis - Initial Unit/Revalidation" to align with expectations within TRS-660P5 (Critical Check Valve Procedure) that PHAs ensure the current list of critical check valves is revalidated and critical check valves are identified (added to the CCV program/list)	2/28/19	3	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
11	Conduct failure analysis of 1 1/2" check valve(s) removed from 3HDS Fin Fan Wash Water Injection lines. Based upon results of failure analysis for 1 1/2" check valve(s) removed from 3HDS Fin Fan Wash Water Injection lines, evaluate whether modifications to check valve (design, metallurgy) are needed to reduce risk of reverse flow occurring	9/30/19	4	<b>Level:</b> Procedural <b>Strategy:</b> Moderate
12	Evaluate the piping material and check valves configuration for the 3HDS Wash Water system based on requirements established by R&SI 8-22 (Utility-Process Systems Cross-Connects) and Engineering Standard D-50-1-138 and deliver a recommendation. As part of the engineering evaluation, evaluate the design of the (12) 1 1/2" check valves on 3HDS Fin Fan Wash Water Injection lines	5/19/19	5	<b>Level:</b> Procedural <b>Strategy:</b> Moderate

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13	Implement recommendation from the engineering evaluation performed on the 3HDS Wash Water system.	6/30/2021	5	This is procedural because the outcome of the study above (#12) is unknown at this time.
14	Review new parent company's best practices and standards for REAC systems. If new parent company has no recommendations for cross-connections, then install Type 1A cross-connections at 1HDS/2HDS/4HDS/1st Stage HCU Wash Water / process system interfaces that conform to the configuration and material specification requirements of R&SI 8-22 (Utility-Process Systems Cross-Connects) and implementing standard D-50-1-138	6/30/2021	5	<b>Level:</b> Procedural  <b>Strategy:</b> Moderate
15	Execute notification 10094692 and 10094691 to replace the 10" feed inlet valves and 8" feed outlet valves that are used to isolate feed to 3HDS HHPS Vapor Air Coolers E-4660 - 4665	6/30/19	5	<b>Level:</b> Procedural  <b>Strategy:</b> Moderate