### CCPS Process Safety Incident-II

<table>
<thead>
<tr>
<th>Description</th>
<th>Refinery Fire - Fractionator</th>
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<td><strong>Type of Operation</strong></td>
<td>Refinery/Petrochemical/Gas Processing Facilities-Fractionation Unit</td>
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<td><strong>Phase of Operation</strong></td>
<td>Normal operation</td>
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<tr>
<td><strong>Initiating Event</strong></td>
<td>Maintenance and repair work during Operation</td>
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| **Contributing Factor** | 1. Process Risk Management-Risk Assessment of Maintenance during Operations  
2. Process and equipment integrity |

| Detail Description | **Background:** Two weeks before the accident, operators had observed a naphtha leak coming off the fractionator. Workers located a pinhole leak in the naphtha piping and closed a series of valves in an effort to eliminate it, but the leaks kept recurring. In succeeding days, one attempt after another failed to completely staunch the flow of naphtha. Shut-off valves malfunctioned repeatedly, and drain valves were found to be clogged beyond use or repair. Ultrasound and X-ray tests were ordered, and these revealed that both the piping and the valves were severely corroded and needed to be replaced.  

On the day of the accident, workers were in the process of replacing corroded pipes at one of the refinery's oil fractionators, a 150-foot distillation tower designed to heat and separate components of crude oil. Because the project was classified as low-risk routine maintenance, no special precautions were in place. The unit operator argued for shutting down the process before attempting to replace the deteriorated piping, but a maintenance supervisor decided to do the job while the hot fractionator continued to run. The fractionator continued to operate, with large volumes of flammable vapor and liquid flowing inside the tower and its attached piping. The surface temperature of the equipment was over 500 degrees Fahrenheit.  

Earlier that morning, under the direction of a maintenance supervisor, workers had removed a section of corroded naphtha piping 112 feet up the tower, near where the piping joined the fractionator. When a second cut was made 26 feet below the first, petroleum naphtha - a volatile hydrocarbon mixture that ignites spontaneously at 450 degrees Fahrenheit - began to ooze out and workers had to immediately reseal the pipe.  

After breaking for lunch, the workers climbed 40 to 100 feet up scaffolding alongside the tower. They tried to drain the piping system |
of naphtha by opening a pipe flange 36 feet up and directing the leaking fuel into a vacuum truck using makeshift plastic sheeting and a bucket.

The operation proceeded without apparent problem for 30 minutes, when suddenly a large volume of naphtha, propelled by vapour pressure from the operating fractionator, shot out of the open pipe overhead, spraying the workers. For the five men high on the scaffold, there were few avenues of escape as the hot surface of the fractionator ignited the naphtha, engulfing them in flames. One man died at the scene, three died at the hospital and another, who had thrown himself off the scaffolding to escape the flames, survived with critical injuries.

### Key Learning

1. **Process should have shutdown**: The repeated recurrence of naphtha leaks was a strong indicator that shutoff valves were corroded and were not functioning properly. In the 13 days that elapsed between the first occurrence of the leak and the fatal accident, personnel missed numerous opportunities to reassess the hazards of the pipe replacement work and take measures to ensure the work would be performed safely. In this case, such safety measures would have included shutting down the fractionator.

2. **Plant Didn't have Systematic Authorization Process**: The plant did not have a systematic job planning and authorization process to ensure that this kind of maintenance work received appropriate scrutiny before going forward. No formal hazard evaluation was conducted before or during the maintenance project, and managers and safety specialists were not sufficiently involved in decision-making and oversight. Instead, individual workers were given the authority to put a halt to unsafe work. Vesting such authority in individuals - who may be subject to a variety of external pressures to get the job done - is no substitute for having effective safety reviews before work starts.

3. **MOC program inadequate**: The plant should have evaluated operational changes that could worsen the corrosion of piping and valves. These changes included feeding different material into the process, increasing the amounts being processed and making long-term adjustments to valve positions. Such an evaluation, known as management of change (MOC), was not applied to these process modifications. This omission contributed to the final breakdown and the fire.

4. **Deviation from safe practices uncorrected**: The incident could have been prevented had better procedures been in place for opening process equipment, controlling sources of hazardous energy,
managing process changes, and isolating piping prior to maintenance. No relevant documented safety audits were performed during the three years leading to the fire.

5. **Corrosion control program inadequate**: The naphtha piping and valves had been run to the point of breakdown due to corrosion. The valves and piping had corroded at an excessive rate because an upstream vessel known as the crude oil desalter - which removes salt, water, and solids from the oil feed - was being operated beyond its design limits. The company had routinely processed excessive volumes of crude oil with high water content, overtaxing the desalter. As a result, water and corrosive materials like ammonium chloride were carried over into the fractionator, where they began to deteriorate the piping and valves.

| Followup Actions | 1. **Program for Hazardous Non-Routine Maintenance**: The refinery should implement a program to ensure that hazardous non-routine maintenance is conducted safely. The refinery should require a written hazard evaluation by a multidisciplinary team before any hazardous job is started. The refinery should also require higher levels of approval for higher hazard jobs, develop a written protocol for making shutdown decisions, and make sure that managers and safety officials provide adequate oversight for hazardous work.

2. **Improve MOC and Corrosion Control Programs**: The refinery should improve its management of change and corrosion control programs.

3. **Conduct Periodic Audits & Document in Writing**: Investigators recommended that the plant conduct periodic safety audits of its refineries and document all findings in writing. Audits should examine the conduct of hazardous non-routine maintenance, the role of management in overseeing safety, and the corrosion control and management of change programs. Audit findings and recommendations should be shared with the workforce and tracked to completion.