



## CASE STUDY

OISD/CS/2020-21/ P&E/04

Dt.: 22/04/2020

### **INTRODUCTION**

Title: **Fire/ Explosion Incident in CDU (Crude Distillation Unit).**

Location: **Near Atmospheric section of CDU**

Loss/ Outcome: **Naphtha Leak, fire, explosion and property damage**

### **BRIEF OF INCIDENT**

A major fire followed by an explosion broke out at the atmospheric section near to the naphtha stabilizer feed pump. Duration of fire was approx. 105 minutes. There was no injury to any of the operating or contract personnel, whereas equipment and property damage was observed due to the severity of fire.

### **OBSERVATIONS/ SHORTCOMINGS**

- On the day of incident, CDU was running at 85% capacity and unstabilised naphtha produced from CDU was being fed to Naphtha Stabiliser Unit (NSU), located in a separate plot.
- Normally, pump "A" is used as unstabilised naphtha feed pump from stabilizer feed accumulator to Naphtha Stabiliser unit. Pump "B" is a common spare for pump "A" as well as pump "C" which is used to transfer naphtha from separator to stabilizer feed accumulator.
- Four days prior to the incident, pump "B" was taken in line and preventive maintenance (PM) check was done. PM team observed high vibration in the pump and advised to change over back to pump "A". Therefore, pump "A" was taken on load on the same day.
- During night hours on the same day, inadequate flow was experienced with pump "A". So, it was changed over to pump "B". Since then, pump "B" was running till the time of the incident (approx. 4 days).
- One day prior to the fire incident, field operators observed that there was a mild vibration in pump "B" in morning hours.
- In the early morning hours of the incident date, unstabilised Naphtha had leaked from the flange joint of  $\frac{3}{4}$ " diameter NRV bypass line on discharge line of pump "B" due to loosening of some bolts at flange  $\frac{3}{4}$ " diameter joint caused by vibration in pump "B" discharge line and  $\frac{3}{4}$ " NRV bypass line.
- Approx. after two minutes, sudden profuse leak was started at junction of main discharge line and  $\frac{3}{4}$ " NRV bypass line due to rupture of the vertical  $\frac{3}{4}$ " diameter pipe of NRV bypass line welded to coupling
- Heavy vapour cloud formed in the pump area and subsequently vapour cloud got ignited.
- Fire & explosion with high sound was observed by the field operators at the same time.
- Refinery fire crew and unit operating started firefighting activities
- Fire was completely extinguished after 1 hour and 45 minutes on the same day.

### **REASONS OF FAILURE/ ROOT CAUSE**

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- The integrity of the flange joint of ¾” NRV bypass line was disturbed and ¾” diameter downstream pipe piece joining pump discharge line had sheared off exactly at toe of the fillet weld with coupling due to vibration of pump “B”.
- Vertical structural support and spring support of common suction line of pumps “B” and “C” were found fallen on the ground. The base plate of support was not grouted to RCC foundation. RCC foundation was found not having foundation bolts to fix structural support and structural support top plate was found not having bolts holes to fasten the spring support with structural support.
- No maintenance notification nor communication to Maintenance Dept. was raised from the Operations Section about the low flow condition of pump “A” and vibration issue in pump “B” since last 4 days.
- Falling of spring support could be one of the possible reason for the shearing off of the pipe from half coupling. Renewal of spring support on common suction line of pumps “B” and “C” was recommended by Inspection Department on the last turnaround which was not renewed. Therefore, this spring support remained inactive for such a long period and may have contributed in increasing vibration in pump “B”.
- Hot Vacuum Residue (VR) line and VR Manifold which operates at a temperature of 3400 C was located just behind pump “B” & “C”.
- Motors in CDU-1 plant were Non-Sparking type.
- Pumps “A & B” were fitted with single mechanical seal.
- Pumps “A & B” were found having push button stations with double compression gland, whereas other nearby pumps were found having switches with single compression glands. The cables in all single compression gland were found loose and thereby diluting the requirement of hazardous area classification.
- Gas Detector (GD02101) which is located near to pump “B” was not working due to sensor problem.
- There was no bonding (Continuity jumpers) provided in the flanges of Class-A hydrocarbon lines.

### **CONCLUSION**

- Leakage of unstabilised naphtha from ¾” diameter NRV break up flange due to loosening of bolts and failure of downstream ¾” pipe section due to vibration induced fatigue.
- Ignition of naphtha vapour cloud caused by:
  - Spark generated due to metal to metal friction at the above noted two leaky points of the ¾” diameter NRV bypass line or from electrical switches having loose cables in cable glands.
  - Exposure of leaked naphtha to nearby high temperature VR line leading to auto ignition of naphtha vapour.

### **RECOMMENDATIONS**

- Internal system shall be developed/ strengthened for better equipment health monitoring.
  - Operation Department shall take necessary action to follow up with Maintenance Department for rectification of defects/ abnormalities observed in the equipment.
  - Performance issues of pump to be investigated by operating and process engineering team and action to be initiated.
  - Condition monitoring team must analyse the vibration issue, reasons for vibration, and recommend the remedial measures to both maintenance and operating teams.
  - Monitoring frequency (vibration, temperature, lube oil etc.) of equipment shall be reviewed as per OISD-RP-124. Deviations in the existing checks shall be rectified.

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- Guidelines/ strategy shall be devised by the Management and the same shall be properly communicated to the operating team to enhance the field surveillance in order to mitigate the maintenance/ operational issues in the process units.
- Review of critical and long pending inspection notifications shall be taken up by Management and shall set appropriate priority, keep a follow up, and ensure the recommendations are completed in time bound manner.
- Unit In-charge should take a prompt action against the issues mentioned in the logbook rather than just signing in the logbook.
- Dual Mechanical seal shall be provided for the pumps as stipulated in clause 4.0 of OISD-STD-125.
- Calibration of gas detectors using test gas should be done once in every six months or as per manufacturer's specification whichever is earlier in line with clause 16.10 of OISD-STD-116. Checking and calibration records shall be maintained.
- Dedicated hooter alarm shall be provided in the control room to activate in case of gas leak in the plant area to alert the operating personnel's as per OISD-STD-116.
- Pipeline spring support and structures shall be inspected for correct functioning during shutdown and commissioning as per OISD-STD-131. The movement of spring supports shall be monitored and recorded as per OISD-STD-130. Pipe supports to be grouted and spring support must be fastened with structure to avoid falling due to vibration.
- Electrical maintenance team must ensure that all electrical equipment/ fittings fitted in the plant area are meeting the hazardous area classification.
- All the cable glands, junction boxes shall be inspected for tightness as per OISD-RP-147 and records shall be maintained. Frequency of checking shall be done once in a year as per OISD-STD-153.
- Refinery shall consult with licensor for the requirement of having NRV bypass line in class A pumps.
- MOV's shall be installed at the outlet of accumulators. Heat/ Fire Resistant coating shall be applied on power and control cables of critical MOVs. Cables shall be routed away from the heat prone area.
- Process Safety Management system shall be implemented in all the process units and the gaps/ deviations/ failures/ spurious alarms observed shall be appraised in the monthly Safety Committee meeting.
- All the safety related issues should be highlighted in the sectional Safety Committee meetings and the same should be addressed within the stipulated time period. If the same is not addressed it should be escalated to the next level of Safety Committee meeting.
- Panel operators, shift in charges and field operators shall be provided with appropriate training to equip themselves for better emergency handling as per OISD-STD-154, OISD-GDN-206 and ERDMP and the same has to be recorded.

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