Case Study on Fire incident at Process Cooling Tower

A. THE INCIDENT

An incident took place in Process Cooling Tower at one of the refineries. One new cell was added to the existing cooling tower. The existing cells were under maintenance and hot jobs were going in the nearby area.

The incident happened during commissioning of the new cell. Soon after opening the cooling water return header valve to the new cell, there was an explosion and fire resulting in collapse of all the five cells of the cooling tower. The incident resulted in serious burn injury and fatality to a number of persons working in the cooling tower area.

B. BACKGROUND / SEQUENCE OF EVENTS

1. The Process Cooling Tower was commissioned during 2009-10 with four cells. During operation, the fills of all the cooling tower cells collapsed within 2-3 years.

   The reason for collapse was investigated by refinery's internal team and it was concluded that failure was due to improper load distribution / design of the cooling tower.

2. Refinery analyzed the reason for collapse of the fills in two occasions. One of the major reasons was the imbalance in load of two distribution headers on the top of cooling tower cells. To reduce the load on the cooling towers, a process modification scheme was issued whereby the cooling water return headers were proposed to be re-routed to the ground level, and construction of riser pipes from the bottom header to the top of each cell, for uniform supply of hot cooling water to the Cooling Tower. With this, the load of return header, which earlier was on top of the cell, would be shifted from Cooling Tower structure to the separate supports outside the Cooling Tower. Refinery also envisaged one new cell to meet the requirement of New DHDT unit as shown in Fig. 1 attached.

3. Actions were initiated to reconstruct all the cells of the cooling tower. The re-construction job of old cells of the cooling tower was being carried out under the

supervision of Maintenance Department. The construction job of new cell was in progress under supervision of Project Department.

4. Though the reconstruction jobs were in progress, to sustain unit operations, the cooling water return from the units was routed directly to the sump through one Cell. Since adequate cooling could not be achieved, the temperature of cooling water was reduced by increasing water make up.

5. To meet the cooling water requirement of the process units, an interconnection between old cooling tower with new cooling tower was made through supply as well as return header.

   With the above arrangement, though the process units were running but due to higher temperature of cooling water, sustaining normal processing level of the refinery was not possible. Coupled with low throughput operation, refinery also faced much higher flaring of gases from the Flare Stack.

6. Since the return header and risers of old cells were not ready, an interconnection was made to the riser of Cooling Tower new cell, to enable commissioning of the new cell bypassing old cell for which reconstruction activity was in progress.

7. It was considered to commission the new cell hurriedly with several unfinished jobs (including fan and gas detectors) to achieve as much as natural cooling of water only by free fall of cooling water through new cell with the objective to reduce the cooling water temperature to achieve the followings:

   i) Increase of unit throughput
   ii) Reduce flaring
   iii) Reduce blow-down of cooling water

   The hot work of these headers and riser pipes were going on at the time of incident. On the date of incident, total 16 jobs were going on, out of which hot job permits were issued for 9 jobs. **The explosion took place after opening of the valve on the CW return line connecting to riser of new cell** (shown in Fig 1).

C. ANALYSIS

- The reason for explosion and major fire is gushing out of hydrocarbon from the entrapped portion of cooling water return header to the new cell which got ignited since hot job was being carried out near the cooling tower.

- The ingress of hydrocarbon in the cooling water was from leakage of cooler / condenser in process units connected with this return line.

- There is distinct possibility of entrapped / accumulated light hydrocarbon in the portion of the new line since it is located at an elevation and that there was no escape route for this entrapped hydrocarbon as the other end of the header was closed by valve.

- The entrapped hydrocarbon gushed into the Cooling Tower as soon as the CW return line valve to the new cell was opened. The hydrocarbon got ignited by the spark of welding jobs being carried out nearby causing explosion and major fire. The wooden structure of the Cooling Tower got ignited in the process which continued for about 45 minutes till the fire was extinguished by F&S personnel.

D. ROOT CAUSE

1. The reason for explosion and major fire is gushing out of entrapped hydrocarbon from the cooling water return header to new cell, which got ignited since hot jobs were being carried out in close vicinity. The ingress of hydrocarbon was from leakage of hydrocarbon in cooler/condenser in connected process units.
2. Not adhering to the practice of stopping all work (especially hot work) and prohibiting all unrelated contractor and company personnel at site, before commissioning a new system/ facility. Also, carrying out hazard analysis/ risk assessment would have probably indicated that there could be trapped HC gas, and prompted commissioning/ operation team to vent out entrapped gases.
3. Failure to prevent commissioning activities, even though several jobs were unfinished:
   - ✓ HC and H_2S detectors were not installed.
   - ✓ Instrument cabling, cooling fan jobs were still unfinished.
   - ✓ Decision to go ahead with commissioning at fag end of the day.
   - ✓ Improper coordination amongst Operation, Maintenance and Project departments.
   - ✓ Unable to ensure the gaps identified in internal safety audit & operation check-list are liquidated before commissioning.

E. RECOMMENDATIONS AND LEARNING

1. Do not allow simultaneous hot work and commissioning activity at site; this increases manifold the chances of accidents at site,

2. While commissioning activity is planned / undertaken, it must be ensured that other than minimum number of required operating crew, nobody should be allowed to be present at the work site,

3. Hazard analysis must be done prior to commissioning of any new facility,

4. HIRA must be carried out before commissioning of any new/ temporary facility / system; this analysis by a multi-disciplinary group can easily identify the risks involved and suggest measures to overcome the same,

5. No facility should be commissioned unless it is ensured that internal audit points / pre-com check-list points are liquidated; further a multi-disciplinary group must carry out the internal audit.

6. There must be a proper coordination amongst the various departments ; in the instant case there was clear communication gap and lack of coordination amongst Operation, Project and Maintenance Departments,

7. No facility must be commissioned unless safety devices like Hydrocarbon or Hydrogen Sulphide detectors are installed,

8. Standard Operating Procedure must be prepared; shared with operating personnel and ensured its display at site prior to commissioning,

9. Proper house-keeping must be done at the commissioning site; the site should be clear of unwanted materials and debris,

10. Facility(s) must not be commissioned unless pre-com audit is carried out.

Fig. - 1 : Sketch of Cooling water lines